THE EFFECT OF VOLATILE BUSINESS CONDITIONS ON NEW PRODUCT DEVELOPMENT IN THE INFORMATION TECHNOLOGY INDUSTRY

by

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THESIS SUMMARY

THE EFFECT OF VOLATILE BUSINESS CONDITIONS ON NEW PRODUCT DEVELOPMENT IN THE INFORMATION TECHNOLOGY INDUSTRY

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The purpose of this thesis is to create an information technology industry management view on the effect of volatility experienced by project and product development management.
The key research problems being investigated in this research:

- The market demanding new technology and subsequent responses to volatility may force IT clients to change their adoption/procurement of technology during negative/positive periods
- Although businesses attempt to understand their industry they can potentially not have sufficient detection mechanisms for volatile conditions and respond too late with too little
- The selection of products that must be built for project deliveries to clients while the business environment changes as a result of volatility lead to uncertainties in the business and technology strategy
- When business strategy changes, it impacts on the technology product portfolio selection. The changed product portfolio must be build whilst business operations are being executed;
- The IT business orders will be impacted by changing economic conditions and balancing the product/project order book with the limited organisational resources is a constant risk for businesses.

The research objectives are as follows:

- The study combines aspects of business, management and market research.
    - Market research was performed to understand quantitative and qualitative aspects of IT client behaviour in volatile trade conditions.
    - During volatile conditions business may require more efficiency, effectiveness and focused productivity.

    - Some organisational development aspects may require management intervention during periods of volatility since planned behavioural change efforts may impact on organisational culture, human and social processes.
- Determine the general responses of IT businesses during periods of volatility and how the technology strategy repositioning, formulation and execution in the business are done.
- Collect and analyse data to define the impact of unstable trade conditions on the product development in IT businesses.
- Determine the measures IT businesses have adopted to ensure that product development sustains business operations profitably during volatile conditions.

New theory is formulated via exploratory research and tested with hypothesis to establish the association strength between key variables. The subsequent responses and best practices determined from industry investigation are documented and new methods formulated to assist in managing innovation in project/products development.

TESIS OPSOMMING

DIE EFFEK VAN WISSELVALLIGE BESIGHEIDS KONDISIES OP NUWE PRODUK ONTWIKKELING IN DIE INLIGTINGS TEGNOLOGIE INDUSTRIE

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Die doel van hierdie tesis is on ‘n inligting tegnologie industrie bestuur siening te bou op die effek van wisselvalligheid wat ervaar word deur die bestuur van projek en produk ontwikkeling.
Die sleutel navorsing probleme wat ondersoek is in die navorsing is:

- Die mark verwag nuwe tegnologie en gevolglike reaksie tot wisselvallige/onbestendighede mag IT kliente forseer om hulle aankope van tegnolgie tydens onstabiele periodes aan te pas.
- Al probeer IT besighede die industrie verstaan mag hulle dalk nie voldoende bespeurings meganismes hê om onbestendige kondisies te bespeur en reageer te laat met te min.
- Wanneer maatskappy se besigheid en tegnologie strategiëe verander, het dit 'n impak op die tegnologie produk portefeulje seleksie. Die veranderde produk portefeulje moet gebou word, terwyl huidige sake bedrywighede uitgevoer word.
- Die IT besigheid bestellings sal beïnvloed word deur die verandering van die ekonomiese toestande. Die balansering van die produk/projek bestel boek met die beperkte organisatoriese aflewer hulpbronne, is 'n konstante risiko vir besighede.

Die navorsing doelwitte is as volg:

- Die studie kombineer aspekte van die besigheid, bestuur en die mark navorsing.
    - Mark navorsing is uitgevoer kwantitatiewe en kwalitatiewe aspekte van IT kliënt gedrag in wisselvallige/onbestendige handel omgewing te verstaan.
    - Gedurende wisselvallige toestande mag besigheid meer doeltreffendheid en produktiwiteit fokus vereis.
    - Sommige organisatoriese ontwikkeling aspekte kan bestuur ingryping benodig tydens periodes van onbestendigheid, aangesien beplande gedragsverandering pogings 'n impak kan inhou op organisatoriese kultuur, menslike en sosiale prosesse.

- Bepaal die algemene reaksie van die IT-ondernemings in tye van onbestendigheid en hoe die tegnologie strategie herposisionering, formulering en uitvoering in die besigheid gedoen word.
- Versamel en ontleed data om die impak van onstabiele handels toestande te bepaal op die produk ontwikkeling in IT besighede.
- Bepaal die maatreëls wat IT-ondernemings aanneem om te verseker dat die produk ontwikkeling onderhou sake bedrywighede winsgewend gedurende wisselvallige toestande.

Nuwe teorieë word via eksplorasie navorsing geformuleer en getoets met hipoteses om die assosiasie tussen sleutel veranderlikes te bevestig. Die daaropvolgende reaksies en beste praktyke van die industrie word gedokumenteer om nuwe metodes geformuleer om te help met die bestuur van innovasie in die projek / produkte ontwikkeling.

A few words of gratitude

I hereby wish to express my sincere gratitude to the following persons:

- My esteemed study leader, Professor Leon Pretorius; for his Socratic approach to guidance and patient willingness to help me surmount the numerous obstacles, which were presented during the research and study**.**
- My wife, Lorette; for her love, support and interest in my work. Her understanding and sacrifices for family time during my journey over the past years of study. She is the reason I am. She is all my reasons.

Soli Deo Gloria

TABLE OF CONTENTS

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LIST OF FIGURES

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List of Tables

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1. CHAPTER I - BACKGROUND, RESEARCH QUESTIONS

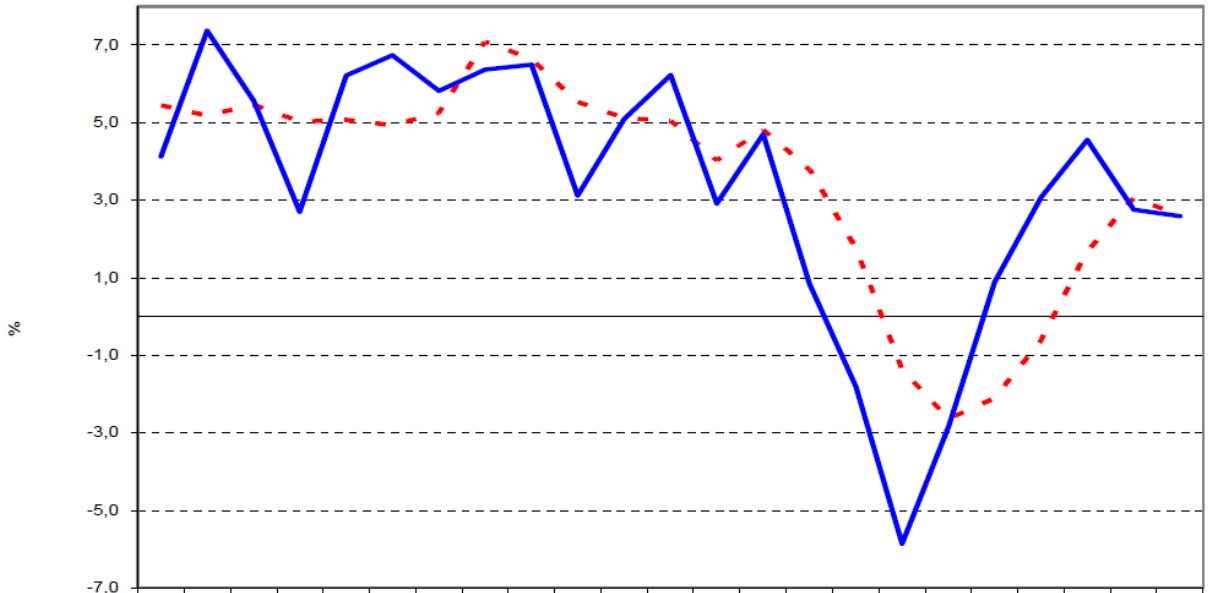
1.1 INTRODUCTION

1.1.1 The technological, industrial and organisational context of the study

During late 2007 to 2010 deteriorating economic conditions had a major global financial impact on trade and industry (including the information technology industry) in South Africa. The country has a strong regulatory system governing the financial industry but being a global player, external economic conditions still impact on the country on an on-going basis. The IT Industry in South Africa is still experiencing a cautious investment from business due to continued uncertainty in economic conditions (Business Monitor International, 2011, p.6). This lack of investment **may have** an impact on new projects being initiated and product development slowing down - The core of this study.

The global financial crisis and South African specific market conditions resulted in:

- Reduced economic activity which led to job losses in South Africa with an unemployment growth rate, (measured from the second quarter) of 2.6 per cent during 2008/2009 and 1.7 per cent during 2009/2010. (Statistics South Africa, 2009), (Statistics South Africa, 2010a). This is indicative of a reduction in business activity with less people active in the formal business sector.
- Reduced expenditure in the Information Technology industry. (Business Monitor, 2011).
- Currency exchange rate fluctuations: The South African Rand is prone to currency fluctuation which effects procurement of raw imported material and export of completed products.
- Higher inflation during 2009 and interest rates slowing down as a result of weaker global growth which resulted in a decline in demand for South Africa's exports from foreign nations. (Donohoe, 2009, p. 53-56).
- Reduced availability of credit due to inability or unwillingness of financial institutions to provide funding for projects and illiquidity in short term funding. (Kana, 2009, p. 20).
- The reduced ability of debtors to pay accounts at due dates and creditors pushing for quicker payment; this impact on organisational cash flow. (Kana, 2009, p.21).
- Gross domestic product growth as indicator of economic activity also slowed down in several countries quarter on quarter where governments are attempting via trade policies and financial support to revitalise economic activity. See Figure 1 where negative growth in GDP follows a cyclical GDP forecast for 2005 to 2008. (Statistics South Africa, 2010b).



	05/1	05/2	05/3	05/4	06/1	06/2	06/3	06/4	07/1	07/2	07/3	07/4	08/1	08/2	08/3	08/4	09/1	09/2	09/3	09/4	10/1	10/2	10/3
Y/Y	5,4	5,2	5,5	5,0	5,1	4,9	5,2	7,1	6,6	5,5	5,1	5,0	4,0	4,8	3,8	1,8	-1,4	-2,6	-2,1	-0,6	1,7	3,1	2,6
Q/Q	4,1	7,4	5,6	2,7	6,2	6,7	5,8	6,4	6,5	3,1	5,1	6,2	2,9	4,7	0,9	-1,8	-5,9	-2,8	0,9	3,1	4,6	2,8	2,6

Figure 1: GDP growth of South Africa

As there are periods of downturn so there are periods of sustained growth such as South Africa experienced with yearly GDP growth from 2005 to 2007 reaching above five per cent growth per year. This is indicative of a good performance in trade, high foreign direct investment in South Africa, high consumption (its citizens are able to spend and acquire goods) and high government spending on technological advancement, labour development and infrastructure. The demand for IT products and services may potentially stimulate innovation.

The Industrial innovation in South Africa report (Oerlemans et al. 2003), based on the South African Innovation Survey 2001, investigated the following criteria for hampering innovation (figure 2):

Type of bottleneck	Explanation
Economic risks	Cost-benefit analyses presented too many doubts
Short of staff	Lack of qualified personnel
Knowledge gap	Lack of information/familiarity with technologies
Costs too high	Estimated costs too high/exceeding initial budget
Short of finance	Lack of appropriate external financial sources
Time to market	Could not meet required market introduction time
Partnership	Cooperation with partners not proceeding smoothly
Demand risks	Too many uncertainties on (future) product markets
Regulations	Restrictive public or other government regulations
Rigidities	Internal organisational rigidities hampered innovation

Figure 2: Description of factors hampering innovation

The results of the survey identified trends for projects not being started, abandoned or seriously delayed. The results in Figure 3 indicated that:

- Specifically economic risk and demand risks lead to the planned projects not being started.
- Financial problems such as high costs (11 per cent), budgets exceeded and funds lacking (11 per cent) are important reasons for abandoning projects. Demand side risks (ten per cent of businesses) also lead to projects being abandoned.
- Serious delays of innovation projects are caused by mainly a lack of information / familiarity with technologies (39 per cent of businesses), a lack of qualified personnel (53 per cent of businesses), economic risks (36 per cent of businesses) and time to market (36 per cent of businesses).

The findings from the industrial innovation in South Africa report seem consistent with the listed view that the IT industry is still experiencing cautious investment due to continued uncertainty regarding economic conditions. Periods of downturn and growth do not necessarily inhibit demand for IT products and services and may potentially stimulate innovation. This study will test IT consumer behaviour as well as attempt to understand the demand for IT innovation during volatile business conditions.

Factors are measured as percentage of businesses that responded in relation to the criteria requested in Figure 3.

Bottlenecks	No bottleneck	A bottleneck and as a result innovation projects were		
		Not started	Abandoned	Seriously delayed
Economic risks	37	22	4	36
Short of staff	30	14	3	53
Knowledge gap	47	11	3	39
Costs too high	43	11	11	34
Short of finance	41	15	11	33
Time to market	50	6	7	36
Partnership	70	6	7	17
Demand risks	41	19	10	30
Regulations	62	12	7	20
Rigidities	66	4	4	26
Other bottlenecks	21	54	6	19

Figure 3: Factors hampering innovation and their consequences

The deteriorating economic conditions as a result of global volatility impacted on several of these factors between 2007 and 2009 hence the conditions may have impacted on innovation in businesses. Saville (2012) states that South Africa has been exposed to extreme market movements such as the E Business bubble during 2000,the financial market crisis of 1987 and the Asian crisis of 1997. The Rand has also according to Saville (2012) been one of the most volatile currencies in the world through this period.

The focus of this study is the impact of volatile business environment on the IT industry in particular from a technical managerial and not an economics viewpoint.

The causal effect of volatility in business on the project portfolio and resulting new products is of specific interest. The impact of changes in the project portfolio and required new products supporting these projects potentially requires a refocus of innovation in product development.

1.1.1.1 The Information Technology Industry

Pelgrum and Law (2003) state that near the end of the 1980s, the term 'computers' was replaced by 'IT' (information technology) signifying a shift of focus from computing technology to the capacity to store and retrieve information. This was followed by the introduction of the term 'ICT' (information and communication technology) around 1992, when e-mail started to become available to the general public. According to a United Nations report (2000) information and communication technologies (ICTs) are a complex and heterogeneous set of goods, applications and services used for producing, distributing, processing and transforming information - included in this set are the outputs of industries as diverse as telecommunications, television and radio broadcasting, computer hardware and software, computer services and electronic media (e.g. Internet, electronic mail, electronic commerce and computer games).

ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries as examples. The OECD (Organization for Economic Co-operation and Development 2002) defines ICT in the following context:
For *manufacturing* industries, the products of a candidate industry:

- Should be intended to fulfil the function of information processing and communication including transmission and display.
- Should use electronic processing to detect, measure and / or record physical phenomena or control a physical process.

For *services* industries, the products of a candidate industry:

- Should be intended to enable the function of information processing and communication by electronic means.

IT and ICT terminology are used similarly in publications of applications of information technology and communications. IT is used in conjunction with information systems as it provides the base for information systems to execute. Information systems can be defined as a set of components that help collecting process and sharing information and data with the help of software, hardware, core ware and organ ware. According to Nikjoo et al.(cited in Lipajcik and Davidaviciene p.38) these kinds of systems are fundamental principles of economic development of any size of a business, both small and large. Through better information management, information systems can help individuals or groups of people in an enterprise, or even with customers or suppliers, perform their duties, in a more efficient manner, which would lead to emergence of benefits Davenport (cited in Lipajcik and Davidaviciene p.42). Peppard et al. (2007) noticed that benefits could be received

only through managers and users of a company who are using the system both directly or indirectly.

In South Africa the IT industry is expected to maintain a cautious attitude to IT investment, due to continued global economic uncertainty. (Business Monitor International, 2011, p.6). Business Monitor International (BMI) utilises univariate ARMA (autoregressive moving average models) for forecasting of the IT industry's sub-component variables. IT forecasting is complicated due to little transparency of vendor data and low agreement between many sets of figures in terms of market definition, base and methodology. According to Business Monitor International (2011) spending on IT services still depends substantially on government programmes. In the current economic environment the government will remain the largest spender on IT services followed by the financial services and telecommunications industries. External and internal political and economic figures may also affect forecasting.

Figure 4 depicts the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis for the IT sector in 2011 as proposed by Business Monitor International (2011).

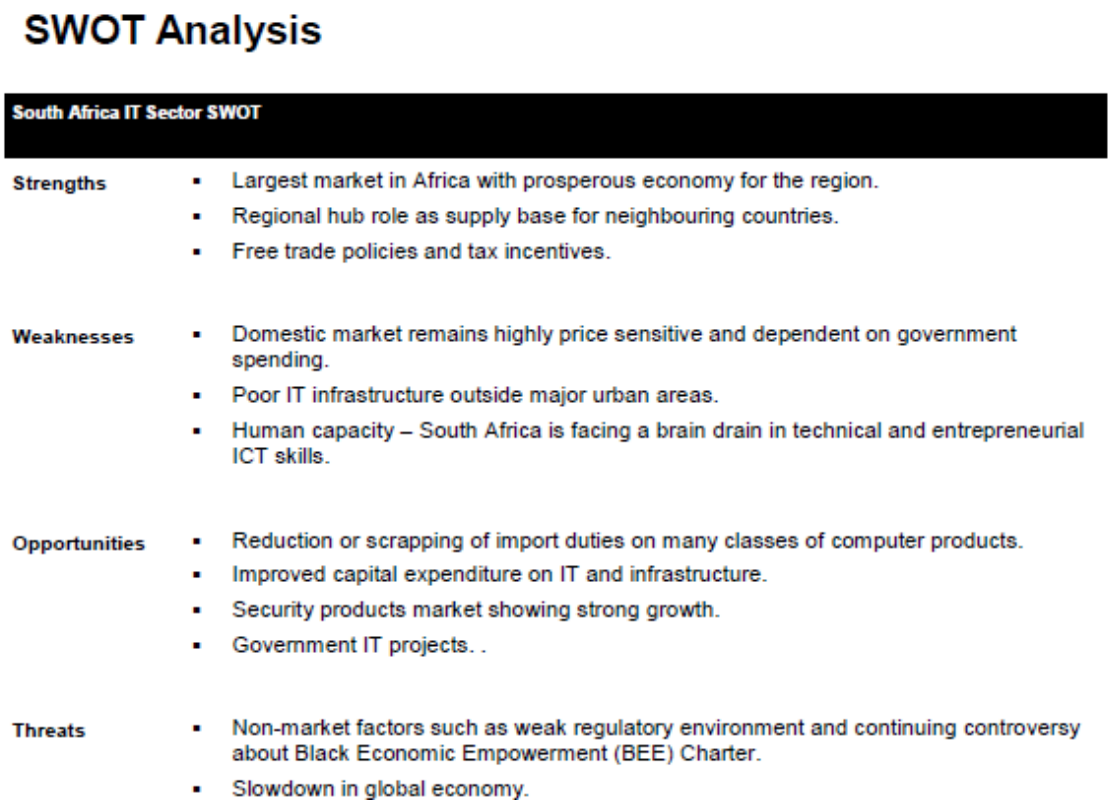


Figure 4: South Africa 2011-2015: IT sector SWOT as proposed by BMI (Business Monitor International, 2011, p.8)

A threat indicated in the SWOT analysis is the slowdown of the global economy which may impact the growth in IT investment in South Africa. BMI predicts that business confidence may remain weak and IT vendors will have to adapt to an environment where business customers prioritise value and return on investment. Increases in unemployment also reduce wage increases. The

economic recession of 2009/2010 resulted in decreased IT investment which during 2011 required more investment in computer hardware to replace out-dated end of life equipment.

During 2009, IT spending reduced drastically in IT vertical markets (groups of similar businesses and customers that engage in trade based on a specific and specialised need). (Business Monitor International, 2011). The economic slowdown especially affected private sector businesses, top-scale back-in projects with non-commissioned projects and projects in their early stages being most vulnerable and typically stopped.

This could potentially influence the internal processes of businesses as they respond to external changing business conditions. According to Kaplan and Norton (2004) businesses require internal business processes capable of servicing identified opportunities with service and product innovation during these volatile economic and trade conditions.

In high technological industries secondary activities of product design, development, manufacturing as part of technology development and delivery assist in the creation of economic value (Porter, 1985). The ability to select the optimal **project portfolio** with the supporting **product development**, manufacturing and delivery of these technological products remains a challenge in ever-changing business conditions.

Nagji and Tuff (2012) indicate the importance of creating an organisational structure and operational processes that match and support the business strategy. Several medium and large IT businesses have a business strategy focused on international IT product and service deliveries. These businesses are subjected to very diverse changing economic factors occurring internationally and locally. (Buys, 2012: Business Monitor International, 2011). Some resulting questions which become important for this study include: What impact have global economic crises had and were there increased levels of defaulting and bankruptcy of IT consumers as well as levels of consumer spending? Will customers spend less? Will customers be able to pay for IT products and services or delay payments? Is the net effect that available funding for project execution and supporting product development for IT product and service providers reduced? This study should measure IT consumer behaviour in this regard as well as the end impact on ICT product and service innovation and development.

Small and medium businesses establish internal processes for product conceptualisation, design, development, manufacturing and delivery, but the processes should remain highly cost efficient to be viable for these businesses. A key question for businesses remains how to effectively invest product development resources. The prioritisation of development projects and allocation of resources amongst approved projects require constant and careful attention.

In examining organisational context the changing external environment must be reviewed in terms of its impact on business in the areas of:

- Business strategy as a response to changing client behaviours.
- Organisational structure (operational and infrastructure).
- Resources utilised by the business.
- Functions that should be executed by business role players.
- Behaviour and culture of the employee workforce.
- Changing internal and external environments that can impact on the business.

1.1.2 Proposed Topic of the research

Having extensive personal experience in the IT industry as well as in an action research capacity with many high technology projects executed for and at the premises of international clients, it remains a challenge to run the business successfully with the correct project portfolio. As part of potential action the aim is to research the following problems:
These projects include elements of:

- Market development, client interfacing and commercial processes;
- Electronic engineered products including large volume discrete electronic manufacturing;
- Information systems product development;
- System engineering and product integration;
- Logistical management of support services for client systems on an on-going basis.

Creating re-usable IT products that can be adapted to client requirements have been a key focus since this has proven critical for longer term business growth. Business performance can be increased pursuing strategic goals of a business through information technology. Improvements in IT or information systems could result in lower costing business processers and increased efficiency of activities performed by workers. This leads to improvements in monitoring and coordination inside the organisation (Hendershott, 2006).

From the work place servicing the ICT industry and action research difficulties experienced by the researcher and industry participants as a result of volatility in the international business have been identified. Some key risks impacting the business environment in project execution, product development and delivery to clients include:

- Project execution pressures as a result of fluctuating currencies which make financial planning for development, integration and delivery expenditure difficult;
- Clients halting projects due to operational and financial constraints imposed by their governing authorities as a result of economic slowdown. This potentially results in lengthy delays, cancelled projects or the reduced scope of projects;

- Logistical challenges with increases in export/import process complexities since shipments may be halted as a result of volatile business environments;
- Financial institutional challenges because of the unavailability of performance bonds and letters of credit. Financial institutions have become more credit restrictive and prefer less exposure to credit;
- Technical and commercial complexities in projects where clients rely more on older IT technology which is not phased out but integrated into newer IT systems and products;
- Increased excessive competition in the market space where more competitors are competing for less market size resulting in projects which are not profitable and straining new product development;
- Political turmoil in the Middle East limits exports and the creation of new business hence less projects with fewer new products is the result;
- Clients demand more products (hardware, software and system integration services) for less financial funding;
- Time scales for development and delivery of products are changed by clients and often not in line with contractual dates;
- New market entrants are disturbing current client relationships and client relationships are put under pressure. Barriers for market entry are forcibly removed by clients and as a result competitors gain easier access to clients;
- New market entrants mean new rules from clients including different product specifications, new logistical requirements and less client co-operation;
- More clients demand no cost, no commitment proof of concept demonstrations of new generation products requiring more investment from the IT supplier. The clients are in control of their requirements and demand more from competitors;
- Quality systems engineering practise is becoming more in demand by clients since the clients are becoming more technically sophisticated and requiring advanced technical help. In essence clients have fewer projects and still wish to obtain a certain level of sophistication;
- If IT businesses consist of several departments then it is becoming critical to use a single integrated information base since changes in schedule, scope, and financial controls may impact on several departments. Processes are becoming more formal as soon as the organisations work with higher volume more complex projects;
- Input costs of products should be lowered since clients have lower price vs. higher performance requirements. Thus IT suppliers start to use more commercial off- the-shelf equipment to be competitive and less of their own innovative products;
- The Internet opens up communication barriers which means clients are more informed of all similar class IT products and suppliers in the market. Clients seem more prone to demand specifications which are unrealistic and these specifications are changed as

volatile global events unfold i.e. financial credit restrictions, limited skills, wars, natural disasters, political turmoil, and so forth.

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The action research which resulted in the above-listed experienced risks, are to a certain extent aligned to theory.

In the following Table 1, some practical cases are lined up with existing theoretical literature to understand which cases are related to existing theory.

Some relationships exist as follows:

Item	Action and ICT industry risk	Theory
1	Increased excessive competition in the market space where more competitors are competing for less market size resulting in projects which are not profitable and straining new product development.	Andra and Scrinivasen (cited in Halkos & Tzeremes p.169) argue that generally, manufacturing firms in order to compete in a competitive global market need to optimally utilize their inputs (such as R&D activities), which in turn will have a positive impact on their performance. The external forces of industry influence businesses relatively, because they influence all businesses in the industry, the ability of businesses to get on with the factors influencing the industry are not the same in all businesses. The strength of competitive forces influences the industry concentration. The number of firms concerned and business size structure indicate the concentration or fragmentation of industry. Industry structure consists of several factors, such as entry and exit barriers, changes in industry growth, innovations, etc. (porter, 1980, pp. 200-221).
2	Clients halting projects due to operational and financial constraints imposed by their governing authorities as a result of economic slowdown. This potentially results in lengthy delays, cancelled projects or the reduced scope of projects.	Gibson (2008) suggests that IT consuming businesses review the declining economy to determine which level of spending is required to maintain operational focus. A mixed scenario exists where demand for IT storage and processing are growing as well as IT being at the core for businesses processes. ICT expenditure cannot be drastically cut for these requirements. Companies may, however, experience a decline in market demand for their

Item	Action and ICT industry risk	Theory
		products which will reduce available budget for IT products.
3	Technical and commercial complexities in projects where clients rely more on older IT technology which is not phased out but integrated into newer IT systems and products. Clients extend legacy IT systems lifetime due to budget constraints.	According to Richmond, Nelson and Misra (2006) to make a well-informed decision about whether or not to install a particular system. The ICT consumer needs a good estimate of system life — that is, how long the system is expected to outperform replacement alternatives (i.e., when planned obsolescence occurs or when its functions are more cost effectively performed by a replacement software system or manual labour). New IT systems and technology may also enable capabilities that the business or organisation did not previously possess yet it may be a key requirement to continue business.
4	Input costs of products must be lowered since clients have lower price vs. higher performance requirements. Thus IT suppliers start to use more commercial off--the-shelf equipment to be competitive and less of their own innovative products.	Voas (1999) suggests that business opts to use commercial off-the-shelf (COTS) IT products in an attempt to reach productivity gains, a shorter time to market, lower cost, management mandates and accessibility to parts. An over dependency on COTS IT products with out-of-the-box functionality may lead to composite IT systems which does not fulfil business requirements and lead to disposable information systems.
5	The Internet opens up communication barriers which means clients are more informed of all similar class IT products and suppliers in the market. Clients seem more prone to demand specifications which are unrealistic and these specifications are changed as volatile global events unfold i.e. financial credit	Tam and Ho (2006) conclude in a hypothesis-based study that content relevance, self-reference, and goal specificity affect the attention, cognitive processes, and decisions of web users in various ways. Also, users are found to be receptive to personalised content and find it useful as a decision-making aid.

Item	Action and ICT industry risk	Theory
	restrictions, wars, natural disasters, political turmoil, and so forth. Client requirements change!	ICT consumers may perceive their requirement change and according to Tam and Ho's findings adapt their requirements for ICT products to be relevant to their organisational requirements.

Table 1: Action research outcome items vs. theory

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In reviewing the above-listed, challenges experienced, the question arises if other businesses are experiencing the same challenges? Is there sufficient material for the research idea of combining the results of several businesses, comparing these to the existing theory project portfolio management and new product development? There may be room for new or additional theory on project portfolio management and product development in volatile business conditions. The causal effect of volatility in business on the project portfolio and resulting new products are of specific interest.

It is planned to use questionnaires and interviews to obtain the experiences from other businesses in the same industry, the international domain and type of business.

The proposed topic of the research addressed in this thesis is:
"THE EFFECT OF VOLATILE BUSINESS CONDITIONS ON NEW PRODUCT DEVELOPMENT IN THE INFORMATION TECHNOLOGY INDUSTRY".

1.1.3 The rationale and overview for the research approach

Economies change states of growing, downturn, recovery and stability on an on-going basis with states of stability in between (Venter, 2009). As can be seen in Figure 5, the South African economy grew at an elevated growth path followed by a receding period throughout 2008 into 2009 indicating the upward phase of the business cycle had come to an end. IT Suppliers were directly exposed to these conditions of the business cycle. (Business Monitor International, 2011, p.6).

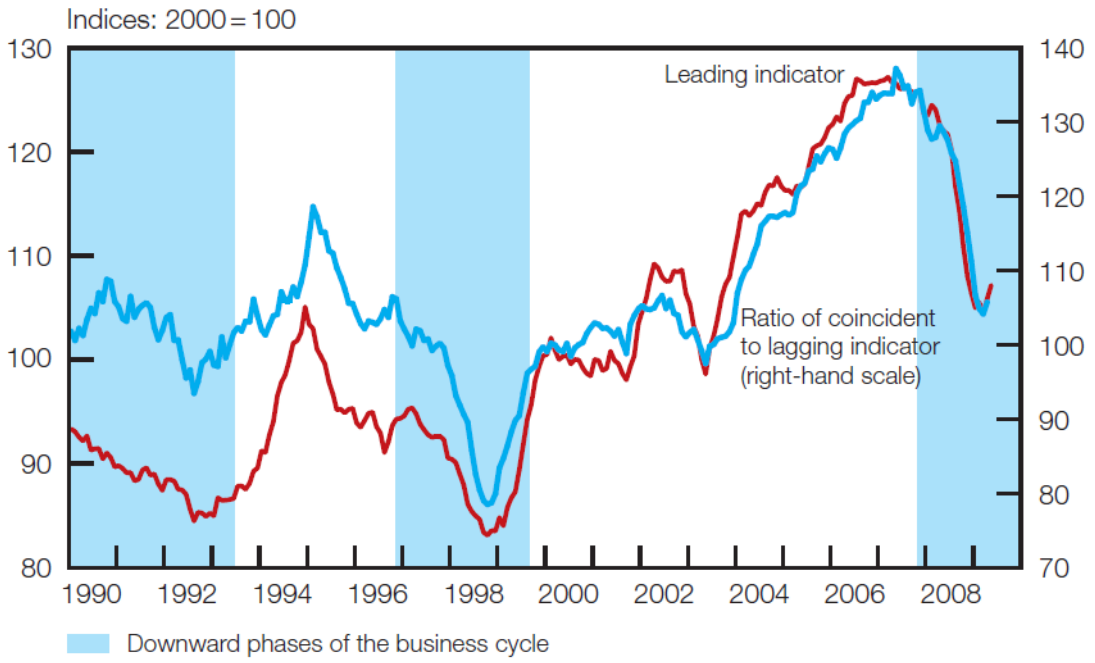

Figure 5: Cyclical South African Business

In reviewing the ability of businesses to sustain and grow operations, thereby creating value for shareholders, factors like economic and trade conditions can influence the way businesses make decisions on IT expenditure (Gibson, 2008).

As can be seen in Figure 6, IT service / product suppliers must be more aware of changing economic conditions as early as possible to adopt their product/project portfolio and product development capacity in line with changing economic conditions. The potential impact should be evaluated in both a short-term operational and longer-term business and product portfolio strategy.

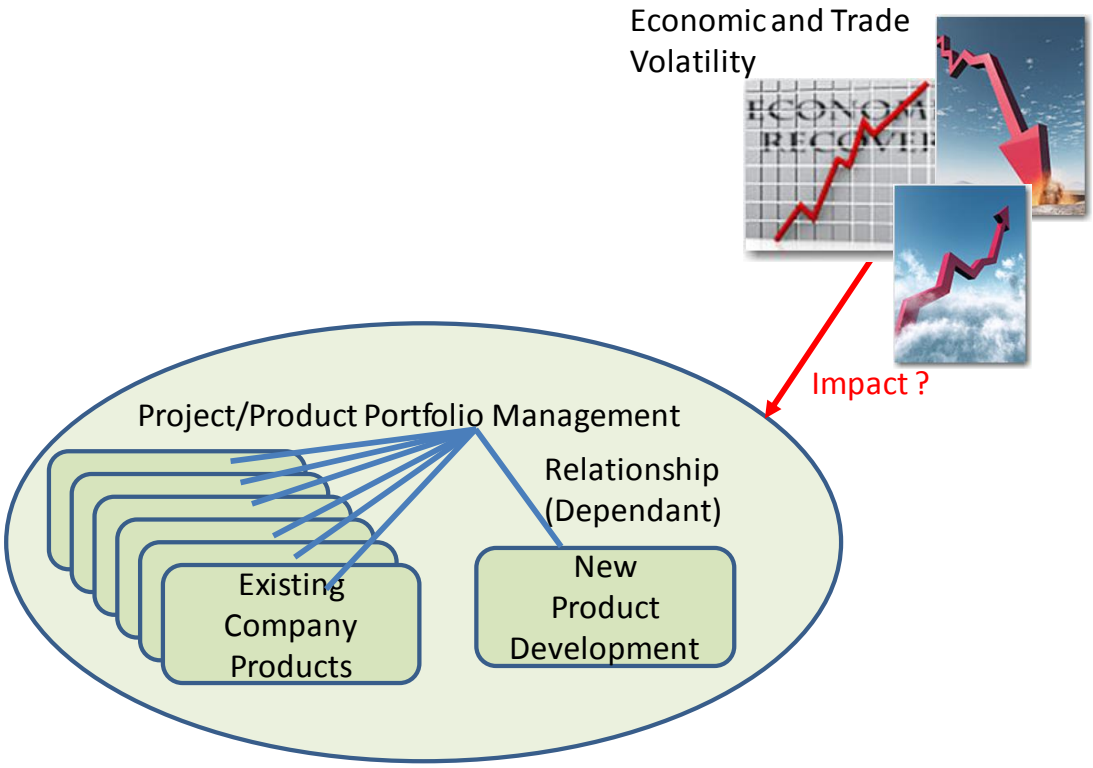

Figure 6: Economic volatility impact on Project / Product Portfolio

Applying best practise project portfolio principles and IT product development such as promoted by Cooper (2001) with the Stage-Gate model in Figure 7, provides a basis for new product conception in a structured approach. The process is initially aware of the market requirement and check points ensure that the product passes reviews in progress to ensure the ultimate end-product aligns to the original scope as well as organisational objectives.

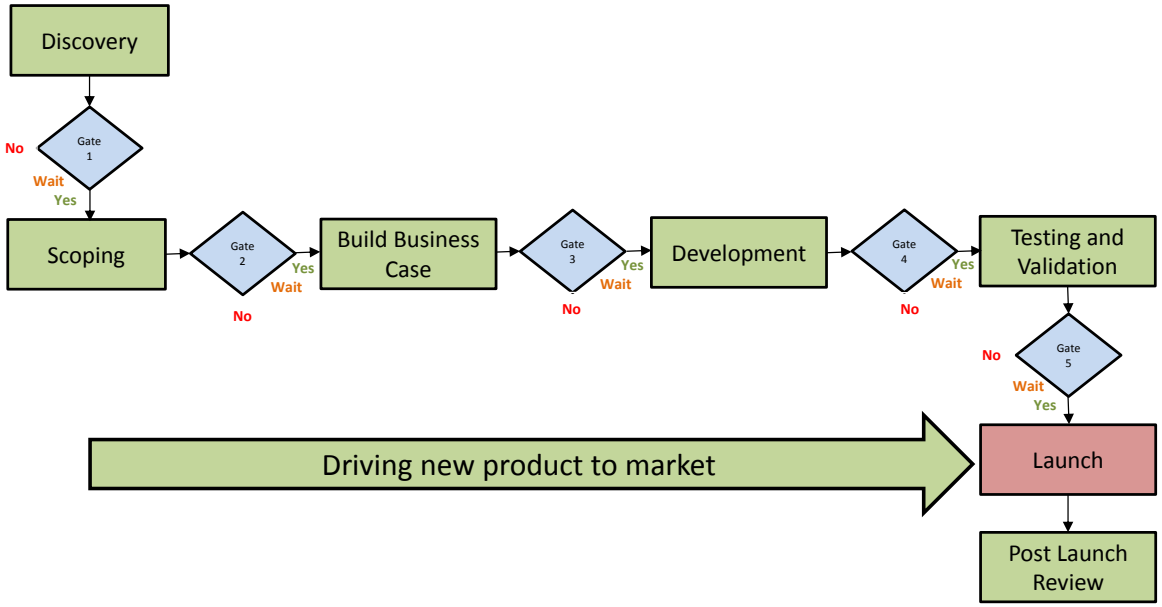

Figure 7:Cooper (2001) Stage Gate product creation metholodology

A question arises whether the gated approach is adequate in changing economic conditions without ample warning and may influence project portfolio selection of businesses as well as product development selection, time and cost when project execution and product development meet, is already underway as depicted in Figure 7.

The core focus of the study is an engineering technology management study and not the quantification or detailed analysis of changing economic conditions. The **impact these business environmental changes have on businesses in their operations, is of concern. The selection and change of the project and resulting product portfolio can potentially impact on the new product development's execution.**

The fundamental reasons for this study are:

- IT clients in the formal corporate sector are also in the same business environment as IT businesses and **they experience the same shocks** as a result of volatility. They change their short- and long-term business strategies as well as requirements for IT systems, products and services.

- The IT business adapts its business strategy for the changing economic and trade conditions. Although businesses attempt to understand their industry and technology products potentially they cannot have sufficient **detection mechanisms** for volatile conditions and respond too late with too few actions.

- When business strategy changes it impacts on the project and product portfolio selection. Changes in the output of new product conceptualisation, design, development, production and delivery processes will be required in response to changes in project/production portfolio selection. The changed project/product portfolio must be done whilst business operations are being executed. Thus businesses **need to change and still get current products to clients**. The transitional change state requires detailed planning for internal process changes and remains risky.

- In high technology product/project environments products may already be ordered before they exist. The IT business orders will be affected by changing economic conditions and this means the business needs to adapt its resource allocation and utilisation. **Balancing the product/project order book with the limited organisational resources is a constant risk for businesses.** The study needs to review mechanisms that businesses use to balance the order book and delivery schedule in the light of increasing changes in economic conditions.

The purpose of the study is then to postulate and assess how business strategy, product development and project portfolio management/delivery need to be practically aligned in volatile conditions to facilitate sustainable business growth in the IT industry.

In brief the research approach is:

- Practical experience on the part of businesses is combined to determine the approaches in use TODAY. The results of the practical findings are compared to the theory and new findings are then published.

- The Research Design: The planned research has scientific value as well as practical value for business.

- Linkage to Theory: The study combines both exploratory research and theory building research to derive new or additional theories, models and practical methods.

- Type of study: Elements of hypothesis and exploratory research types are present in the research.

- Data acquisition techniques to be used: Data is primarily collected from survey questionnaires and commentary in the questionnaires.

The research type started off predominantly from an action research context by means of real life case experiences but during this study conforms to both exploratory as well as theory testing focused research.

- From an **exploratory research** view the research seeks a measure of association between volatility and project portfolio/new product development. It is attempted to seek, to identify patterns or themes as a result of the impact of volatility on the relationship between project portfolio management and new product development. (Page and Meyer, 2006). The research problem contains several association questions. The research hypothesis is still broad but hunches may be possible based on practical feedback from knowledgeable and contributing resources. This research thesis is aimed at identifying the patterns or themes and **creating a hypothesis to be tested** as well as **building new theory** and refining the research hypothesis during the process.)
- From a **hypothesis testing** view in the industry the research is critically assessing theory and best practices in use by business. The theory available currently is more broad product development area focused and does not clearly depict the relationship between volatility and project portfolio management/new product development. However, some changing economic and volatile conditions may create changes in business strategy, project portfolio management and new product development. Statistical techniques will be used to test whether research findings do, or do not, support the predictions arising from the newly identified theories at statistically significant levels.

  The key focus is, however, the formulation of new theory possibly such as to discover resiliency triggers, measures and controls in the process of project development as well as supporting product development that can counter business environmental volatility up to a point, as long as the process is actively managed.

1.2 PROBLEM STATEMENT

From the previous section it follows that some aspects of the listed business challenges require further research and are outlined in a conceptual model/structure developed and presented in Figure 8:

- The market demanding new technology and subsequent responses to volatility may force **clients to change their adoption/procurement of technology during negative periods;**
- IT clients in the formal corporate sector are also in the same business environment as IT businesses and **they experience the same shocks** as a result of volatility. They, change their short- and long-term business strategies as well as requirements for IT systems, products and services. Projects may be halted as a result of budget constraints and ROI required with available IT funding;

- The IT business adapts its business strategy according to the changing economic and trade conditions. Although businesses attempt to understand their industry and technology products they can potentially not have sufficient **detection mechanisms** for volatile conditions and respond too late with too little;
- When business strategy changes it impacts on the project and product portfolio selection. Changes in the output of new product conceptualisation, design, development, production and delivery processes will be required in response to changes in project/production portfolio selection. The changed project/product portfolio must be done whilst business operations are being executed. Thus businesses **need to change and still get current products to clients**. The transitional change state requires detailed planning for internal process changes and remains risky;
- The selection of **products** that must be built for **project** deliveries to clients while the business environment changing as a result of volatility leads to uncertainties in the business and technology strategy;
- Businesses struggle to cope with **project changes** as a result of volatility while executing current business operations;
- In high technology product/project environments products may already be ordered before they exist. The IT business orders will be impacted by changing economic conditions and this means the business needs to adapt its resource allocation and utilisation. **Balancing the product/project order book with the limited organisational resources is a constant risk for businesses.**

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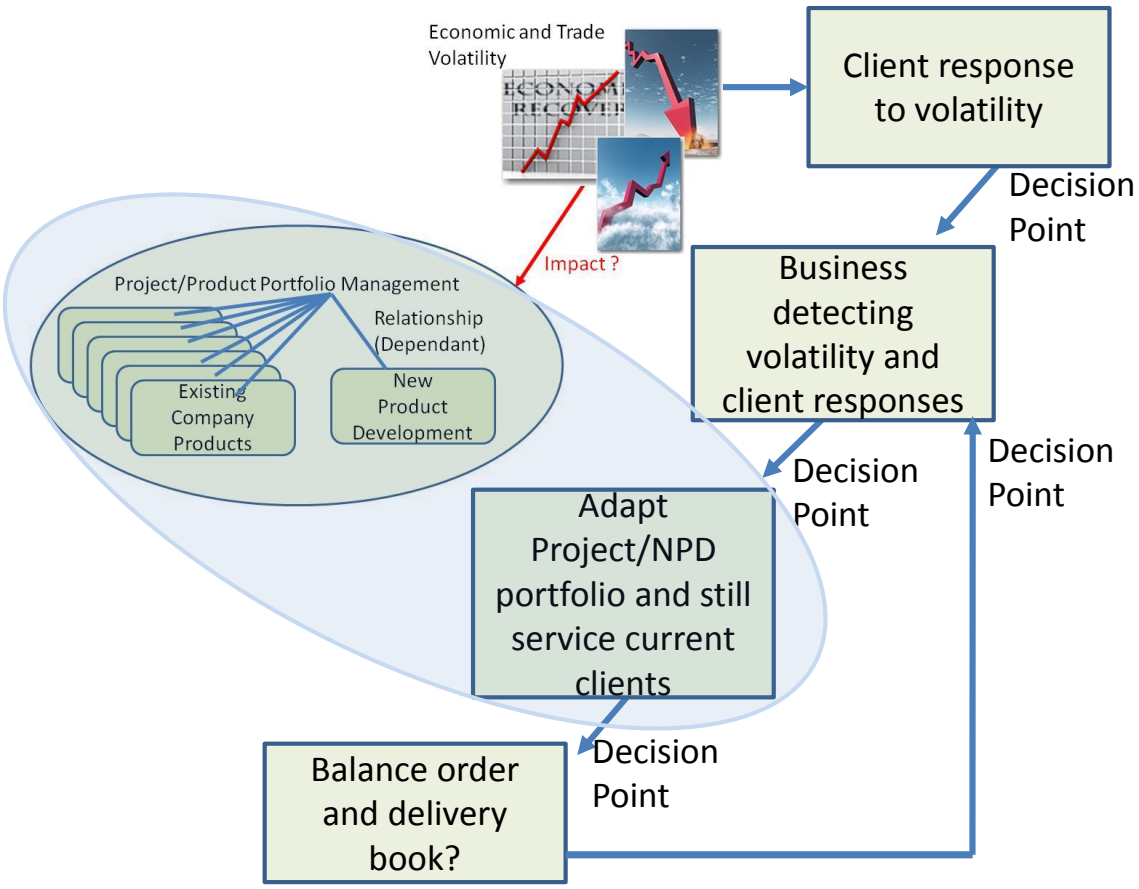

Figure 8: The proposed business decision points in relation to volatility

The core problem statement derived from the changes businesses make as a result of a changing business environment is stated as:

What is the effect of volatility on project portfolio selection and new product development?

Several decision points indicated in Figure 8 require decisions and action on the part of business leadership, programme/project managers, product managers and production managers. The proposed research in the thesis is focused in these areas.

The importance of the business decision points in response to volatility and resides in having appropriate information to:

- Understand what do IT customers do when volatile conditions impact their operations;
- Understand how businesses sense the volatility and create an urgent demand for change internally;
- Understand if business takes a structured approach to work with and adjust to the impact volatility has on the business. How is risk managed to ensure maximum business value with acceptable levels of investment in technology project and product development?

- Understand what businesses need to do to balance their order and delivery books when the effects of volatile conditions hit the business.

1.2.1 The research questions

In addressing the problem statement developed in the previous section, four key aspects become apparent:

- Volatility conditions (Aspect A).
- Project management (Aspect B).
- New product development (Aspect C) and
- IT industry (Aspect D).

In evaluating volatile business conditions the impact on the business starts at the client behaviour level and a change in this behaviour as a result needs to be taken into consideration. This leads to:

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as result of volatility shock have on IT business project portfolios and new product development?**

This supports aspects A and D since the business end product is used by clients who also respond to conditions imposed by volatility in the business environment.

The sensing of business environmental volatility and the transfer of the information into the business planning and technical projects / products needs to be investigated. This leads to:

- **Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients and volatility detection mechanisms? What is the impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?**

  This supports Aspect A and D since the business needs to detect changes in the business environment sooner and use the information for decision making.

Once the new information is in the organisation, certain decision-making processes need to be activated and the impact on current execution of business processes such as project portfolio management and new product development quantified. This leads to:

- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility**?

This supports aspects B, C and D since product development may support larger systems, projects or product development may be the project under execution.

From an organisation's capability perspective the organisation has limited resources including people (labour/hours), infrastructure (equipment) and finance (money to fund operations). How are these factors balanced so the organisation can perform at maximum output and support the business plan for growth / profit? Care should be taken not to exceed the capabilities of the organisation including new orders and the shareholder and management approved risk profile of the business. This leads to:

- **Research question 6 and 7: How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?**

This supports Aspects A, B, C and D since the organisation needs to balance internal capability with external demand in the IT industry for its products.

1.3 THE RESEARCH OBJECTIVES

In answering the questions the following research objectives can be achieved:

- The study combines aspects of business, management and market research as follows:
    - By performing **market research** the aim is to understand quantitative and qualitative aspects of IT consumer and client behaviour in volatile economic and trade conditions;
    - The impact of volatility may influence the work behaviour of people in the service of IT businesses. During volatile conditions **business** may require more efficiency, effectiveness and focused productivity. These aspects need to be focus areas of the research;
    - Some organisational development aspects may require **management** intervention during periods of volatility since planned behavioural change efforts may impact on organisational culture, human and social processes;
- Determine the **general responses of IT businesses during periods** of volatility and how the technology strategy repositioning, strategy formulation and strategy execution in the business is done;
- Collect and analyse **current best practice** approaches in use during volatility by IT businesses for **project portfolio execution** in technology intensive product suppliers;
- Collect and analyse the **best practice** approaches in use during volatility by IT businesses for **new product development execution** in technology intensive product suppliers;
- Collect and analyse the data business uses to **define the relationship and impact of project portfolio selection on IT product development;**

- Collect and analyse data to define the **impact of unstable economic and trade conditions on project portfolio management and product development** in IT businesses;
- Determine the **measures** IT businesses have adopted to ensure that project portfolio selection and product development **sustains future business operations profitably** during volatile conditions.

1.4 THE IMPORTANCE OF THE PROBLEM

The necessity for addressing the problem can be summarised as follows:

- Increasing economic turmoil and volatility have influenced the way IT businesses make decisions about capital projects and new product development. Even in a recovering economy increased cash flow is still important for businesses to sustain operations. A higher cash reserve for economic downturn/upturn does not by default imply capital is readily available for project portfolio and new product application.
- As a result of economic downturn and volatility, financial institutions have become more demanding in the criteria used to grant medium-term financed project loans, short-term bridging finance, forward cover and performance guarantees. This may potentially limit the growth of businesses since funding of project portfolios and new product development are under pressure.
    - A typical example is the Rand/Dollar exchange rate fluctuation during the past 24-month period that has made it very difficult for businesses that utilise imported raw material, since product costing is subjected to a significant amount of variance in cost. In the process of delivering products in the international market, fluctuating currency value has also made the delivery of products/projects difficult. Contracted work is often completed at a different level of currency exchange than the level at which the contract was signed. Financial instruments like forward cover is becoming more utilised for international contracts executed from a Rand monetary cost basis.
- Approved capital projects face increased levels of scrutiny on the part of shareholders (private or public), executive management and technology programme management. More has to be done with less money and this influences the way people work — a changed mind-set of increased delivery with fewer resources.
- The speed at which businesses need to execute projects have changed as well due to:
    - Increased market pressure for new products (less expensive products with increased features supporting changed consumer/buyer requirements).
    - Shareholders demand a faster and higher return on capital invested in IT projects.
    - Survival strategies and **higher levels of accepted risk** seem to leave little room for project planning, due diligences and organic business growth.

- The question arises if IT business requires more sophisticated approaches to project portfolio management and new product development to balance growth objectives with cost and **risk management**. How can businesses improve their visibility of volatility, return on investment potential and associated risks?
- Exogenous volatility and short term shocks such as commodity prices affect the base product that IT businesses use. Interest rates affect the cost at which IT businesses can fund their operations. Natural catastrophes may affect the availability of products used to build IT products such as electronic components (floods in Asia impact on sourced sub-components). IT businesses in South Africa are exposed to currency fluctuations since many base products are imported. (Business Monitor International, 2011).
- Endogenous shocks in South Africa including evolving Black Economic Empowerment, irregular governmental IT spending, poor IT infrastructure outside urban areas and IT skills shortages may impact on IT businesses since they have to operate within the boundaries of these challenges. (Business Monitor International, 2011).

The problems being focused on in **this study extend existing theory with new findings.** Benchmarking studies conducted by Cooper and Edgett (2010), which indicate some of the problems arising when portfolio management is lacking are:

- Projects are not high value to the business.
- Portfolios have a poor balance in project types.
- Resource breakdown does not reflect the product innovation strategy.
- A poor job is done in ranking and prioritising projects.
- There is a poor balance between the number of projects underway and the resources available.
- Projects are not aligned with the business strategy.

During periods of volatility the impact of poor project portfolio management may be more severe due to external conditions of trade that businesses need to examine:

- The number of projects underway (the wrong ones).
- Resources utilisation that may be spread too thinly and across too many projects.
- Projects that are taking too long to get to market, and
- The value of projects in order to focus on higher value projects that is at lower risk.

These aspects must relate back to the research questions posed previously. Some practical (non-theorised) associations may be present in the following ways:

- Related to research question 1 and 2: Clients may experience reduced budget IT projects as a result of volatility shock. This may be due to market demand and business decreasing for products as a result of negative conditions in the economy. The counter side is also possible

that increased demand in a period preceding or during growth may increase demand for IT projects and products.

- Related to research question 1 and 2: Clients may likely reduce budgets and be more demanding on specifications of delivered IT projects and products. Since potentially many suppliers compete for business the delivery of the IT projects at low cost, acceptable specifications with lower levels of non-recurring engineering to reduce cost is required.
- In relation to research question 3 and 4: Business may wish to reduce overhead costs and execute operations with the smallest number of capable personnel. This implies dependence on key personnel to be aware of what is happening in the business market and changing conditions in the market (using volatility detection mechanisms). If project or product development takes too long for market delivery then there is a reliance on key people to raise awareness risks for the business which could impact on project and product development. Changes in the product portfolio with limited resources can impact on operations as existing products should still be delivered to customers on time.
- In relation to research question 5: Constantly remaining focused on what makes the business successful financially and on possible risks are of importance. Large ICT projects may generate more funding for new project and product development yet they may also introduce financial, time and quality risks in the delivery of these products or services.
- In relation to research question 6 and 7: Key problems arise when too few resources must ensure delivery of several concurrent projects and products if capacity is not managed. When the wrong type or too many projects for the available resources are contracted, business management will have problems balancing ability to execute development and deliveries with new, arriving business. If the business environment changes and clients demand more or fewer IT products, the question arises if prioritisation and focus in business are affected?

1.5 LIMITATIONS OF THE ON WHICH THE RESEARCH ARE BASED

It is foreseen that the research has the following limitations:

- The research field is focused on the IT industry and needs to be limited in width of scope to ensure that an adequate and new depth of scope is reached. The survey and questionnaire should be limited in width of scope.
- Only technology product businesses (IT focused industry) in South Africa will be targeted for research. Questionnaires will be distributed and interviews held for clarification of structured and unstructured questionnaire results. **Generalisability** and **external validity** of the study and results must however be maintained (Page & Meyer, 2006 and Olivier, 1997). The results of the research findings need to apply outside the particular research situation that produced the findings since scientific value is the goal. **Rigour** of the research requires that effort has been taken in this research to ensure that observations and measures are empirical, public,

repeatable and may be generalised to a broader population than that used to generate the information provided by this research. (Page & Meyer, 2006).

- Complex economic modelling of volatility is excluded from the scope of study as the impact of volatility on project portfolio management and new product development is the focus of the research.
- Time constraints: The research had to be completed in a period of 48 months from 1 January 2010 after the research concept including research structure was formulated during 2009.
- Survey-based studies have the potential for bias and the problems inherent with results based on aggregated measures. This research had to utilise input from **all** respondents of the questionnaire/survey who completed the survey and returned results only.
- Although qualitative research design is not preferred in studies of engineering and technology management, volatility is typically event or period driven and this research is also intended to understand the impact of these events. Thus some level of qualitative design is required in the design. The questionnaire provides data that statistically is analysed via structured questions, however some question need to be of a more unstructured nature requiring perception-based responses from respondents. These qualified perception responses will require more qualitative data analysis. Some key variables may be uncovered as a result of the qualitative response.

It is foreseen that the research is to be based on the following assumptions:

- It is assumed that the research sample of technology businesses in South Africa is representative of the population of IT businesses
- It is assumed that the questionnaire with structured and unstructured questions will have validity and is measuring the desired constructs.
- It is assumed that respondents will answer the survey truthfully and knowledgeable.
- It is assumed that the citation of external literature is evidence of use and the use is reflected in the citation.
- From practical experience during past research a minimum simple random sample size of 68 minimum must be used.
    - A larger sample ensures more confidence in the population representation via the sample.
    - The sample size will not be dependent on the size of the population.
    - A principle of disproportionate stratified sample from the research population will be followed since
        - There needs to be representation of smaller strata (job categories) for larger population representation are included to still use statistics and comparisons. This ensures generalisability of results to be valid in larger population.

        - This also facilitates comparison between strata.
        - Probability of selection of a respondent is known but differs by strata.
        - A less biased deterministic is achieved since the variation in the research population size will prevent biasing.
    - At least five cases per variable will be used in the questionnaire.
    - At least 30 cases need to be present in the sample for statistical analysis.
    - During the research process a significant test result will be concluded if the P-Value (Probability of obtaining results indicating a chance of the null hypothesis being true) is less than five per cent. This will be checked and validated later in the study.

Expected Nature of the results

According to Page & Meyer (2006) the research results need to:

- Be supported by attention to the principles and practice of repeatable research methodology.
- Be the results of a systematic investigation and still be generalisable to the broader population where it is applicable.
- Make a significant contribution to scientific knowledge.

The expected nature of the research results should typically include where appropriate results of type:

- New theories, models and methods formulated as part of this research.
- New collected data (Questionnaires) supporting the results, collected must be recorded for later checking.
- Statistical analysis of gathered structured questionnaire results.
- List of supported and unsupported propositions.

1.6 CONTRIBUTION OF THE RESEARCH RESULTS TOWARDS SCIENTIFIC KNOWLEDGE

The benefit of this study resides in the quantification of the practical experiences of IT business during volatile periods on project portfolio management and new product development. Several responses may become apparent ranging from direct intervention for short term survival to establishing a clear, long-term direction and commitment to the longer term business and product innovation strategy. In either case the results of external environmental changes due to volatility with resulting external influences may lead to internal strategic and or operational adjustments in businesses. These external business environment changes may lead to adjusting mitigation or operations for identified external environment risk. Klinke & Renn (2006) propose that risk must be managed in a process of categorising risk in classes, evaluation criteria applied and management

strategies be formulated in mitigation of systemic risk. The external business environment which may change as a result of volatility may be one such risk class.

The contribution towards scientific knowledge can be established by:

- Analysing current theories around best practice project portfolio management and product development. This adds value to the scientific community by understanding the theoretical gap between existing theory, models and methods and impact of volatile economic conditions on these theories, models and methods;
- Gathering data from technology product businesses about how they respond on actual volatility detected by these businesses. Thus real life responses on actual events are collected. This adds value to the scientific community by understanding the changes in management processes of technology-based businesses as a result of volatility;
- New derived theories, models and methods are tested with the collected data thus adding scientific knowledge on project/product portfolio management and product development;
- The advancement of management theory and practice are supported with derived propositions supported with collected data.

1.7 WHO WILL BENEFIT FROM THE RESEARCH?

The following groups of professional people typically stand to benefit from the research:

- The scientific community studying the fields of:
    - Engineering and Technology management
        - New product development functions in organisations and businesses.
    - Business leadership and operations management
    - Risk Management specialists and auditors

- Students studying courses related to:
    - Technology Management and Engineering
    - Programme Portfolio Management and Project Management
    - Product Development
    - Engineering: New product development

- Business Community of high technology product businesses including:
    - Executive level business management:
        - Chief executive officer
        - Chief operations officer
        - Divisional Managers
    - Programme Managers

- Engineers in the field of product engineering, development and industrialisation of products.
- Project Managers.

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1.8 CONCLUSION

IT businesses in South Africa competing in a global market have adapted their operations in the light of pressure for survival and shareholder expectations. They have learned to cope, build longer term strategy and short-term flexibility in technology project and new product developments. These practical lessons may provide valuable research material that needs to be investigated, collected, disseminated and used to build theory that can be practically used by more IT businesses.

To be successful IT businesses need mechanisms to:

- Understand their customer requirements for the business products.
- Understand the business environment and what affects the business directly.
- Adapt their project selection criteria to take factors into consideration that may affect the IT projects to be executed.
- Adapt their product development strategy in line with the chosen IT projects.
- Evaluate the impact of their technology project and product roadmap in support of the business strategy and plans.

Defining the relationship between project portfolio management and new product development are key since the planned questionnaires will focus on the impact that volatility in the business environment has on the relationship.

Existing theory from the literature in the domain of project portfolio management and new product development needs to be evaluated next and its relevance or gap to volatility established. An understanding is required of which volatility theory should form the basis of measuring the theories of relevant management of project portfolio and product portfolio management. This forms the basis of the research material covered in Chapter Two.

A structured approach in establishing the base for the research is depicted in Figure 9

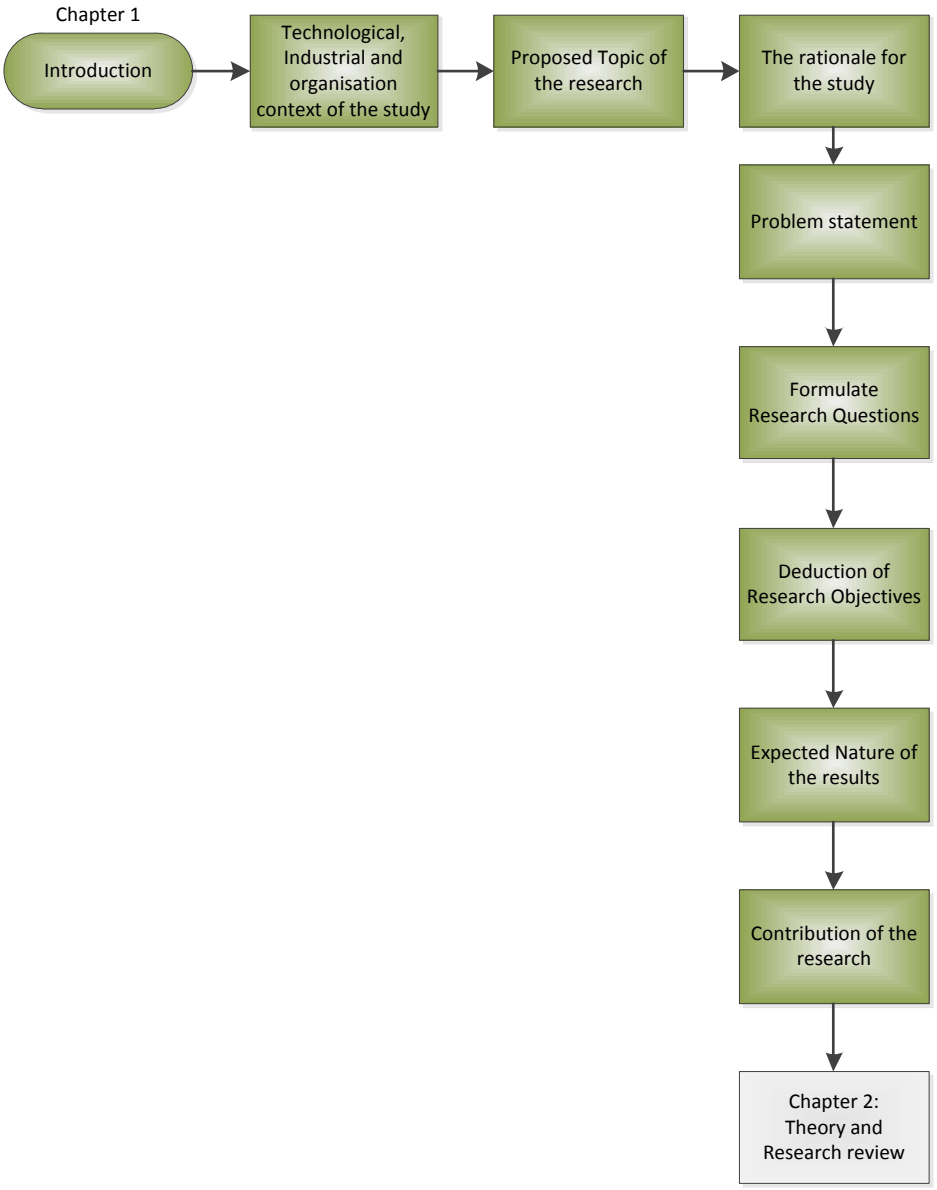

Figure 9: Chapter 1 process review

2. CHAPTER II- THEORY AND RESEARCH REVIEW

2.1 REVIEW OF THEORY

The classic work of Knight (1921) proposed theory defining **uncertainty** as a situation where several possible outcomes are associated with an event, but the assignment of probabilities to the outcomes are not possible. **Risk** in contrast permits the assignment of probabilities to the different outcomes.

Aizeman and Pinto (2005) formulated the theory that economic volatility is more than being the study of business cycles and the composition of economic growth in cyclical and trend components. They postulated that **volatility** is allied to risk in that it provides a measure of the variation or movement of a particular variable (for example economic variables) or some function of the variable.

There seems to be some controversy in the view of the relationship between volatility and growth (Nazari & Mobarak, 2010). Higher volatility has through a growing body of research become more associated with lower rates of economic growth. Nazari and Mobarak (2010) argue that if investment projects are large enough, it may be rational for businesses to postpone an investment decision. Since business cycle volatility increases the uncertainty, some of the planned investments for a certain period (for example a year) may not be conducted. Therefore, volatility may have a negative effect on growth through a reduction in investment.

In contrast some literature suggests a positive relationship between long-term growth and business cycle volatility. Black (2009) suggests that economies face a positive aggregate risk-return trade off in their choice of productive technology. Buch and Döpke (2007), however, suggest that neutral economies should be associated with higher productivity and growth. This is when the economies' high technology investment projects with high returns are performed, so a positive relation between volatility and growth are possible. When economies are risk averse, the positive relationship is confirmed by the concept of precautionary saving under income uncertainty. Sandmo (cited in Nazari and Mobarak, 2010) suggest that income uncertainty may lead to higher savings and investments. The relationship between volatility and growth is plausible. Aizeman and Pinto (2005) further distinguish between normal volatility and extreme volatility. This is when extreme volatility is a significant change in an economic variable resulting where the movement exceeds a threshold and leads to economic shock. Normal volatility may refer to cyclical business conditions or events of lower magnitudes where the economy can absorb the changes without severe negative impact.

In understanding current business investment activities and change not only to respond to, but also to be ahead of market opportunities and threats, businesses can grow competencies to seek and detect patterns of weak and strong signals of business change (Burton et al, 2009). Businesses examine investment profiles and determine if they reflect the requirements of new business context for the organisation, industry and region.

Similarly “Resiliency Management” embodies both a proactive and reactive approach to face unprecedented, unexpected and unforeseen events that influence the organisation’s operational activities. Executives and managers need to ensure that the underpinning values, beliefs, norms and expectations that give rise to a culture of resiliency are woven into the day-to-day interaction and extensive dialog. (Weeks, 2009).

"Pattern-based strategy" is the discipline to enable business leaders to actively seek, amplify, examine and exploit new or novel business patterns. To support pattern-based strategy, organisations should begin to understand in which activities they are investing, and how these investments need to be changed or adjusted to enable them to exploit new patterns within their own businesses. They should also be able to understand new patterns of signals coming from external sources that indicate a business opportunity or threat. Chief executive officers and strategy officers need to expand their investment analysis beyond the two investment categories (defined and creative). (Burton et al, 2009).

Both theories of Resiliency management and Pattern based management suggest that an organisation requires mechanisms to be aware of the upcoming market events and take corrective action in advance to deal with the net effects of such market trends. These corrective actions could include optimisation of product development and delivery of new products to clients as a result of focused project portfolio management.

In adding the theory of Brentani, Kleinschmidt and Salomo (2010) who found that having an organisational posture that at once values innovation plus globalisation, as well as a senior management that is active in and supports the international new product development effort, leads to strategic choices that are focused on making the firm truly global in terms of both market coverage and product offering. Sitho , Pan & Yu (2014) argue that companies business models change in different phases of product creation. The main reason being the result of different nature of project activity during different phases of product development as well as access to critical information.

Different opinions such as that of Aaron (2009) suggest that business objectives may likely change as a result of business cycle downturn. Aaron (2009) suggests that when an organization has pressure to optimise costs, there is a risk of damaging critical capabilities that are needed to

survive the downturn and thrive in the upturn. Alignment between business objectives and projects are still crucial during the downturn. Poor alignment can lead to wasted effort and resources despite completing a project within the triple constraints. (Marnewick & Labuschagne, 2009).

However, there is a fundamental management problem facing managers of portfolios of projects, who are using formal project portfolio management methodologies to conduct their projects. This problem is referred to as the release problem by Viljoen (2005). Projects should generate value for the organisation. Value may be seen as the amount of money generated by the organisation for a given period (through sales). Two conditions need to be satisfied to meet the objective:

- "The demand of every client must be satisfied because that increases their perception of value." (Viljoen, 2005).
- "System productivity must improve because it is fundamental to the value of an organisation through the metric of return on investment (ROI)." (Viljoen, 2005).

Das and Joshi (2012) found in their research that firms with a high level of process innovativeness will be able to respond better to hostile environmental conditions because they possess to a greater degree and also utilize more effectively the appropriate process-related knowledge resources to evolve a set of responses to enhance organisational performance. Managing the project portfolio and subsequent products in the portfolio for better performance are reliant on the process maturity of the organisation.
Cooper and Edgett (2001, pp. 3-5) indicate four common denominators (goals) across businesses for project portfolio management:

- Maximising the value of your portfolio
- A balanced portfolio
- Build strategy into a portfolio
- Pick the right number of projects (organisational resources capacity)

The findings from Viljoen (2005) in regard to the push problem and Cooper (2001) in regard to the four project portfolio denominators may be combined since the denominators of Cooper may possibly assist in improving the two prerequisites listed for Viljoen's "Push Problem". The aim is to formulate theory focused on the selection of the right project portfolio and resulting new product development to support IT business strategy under volatile conditions.

2.2 ANALYSIS OF CURRENT THEORIES, MODELS AND METHODS

Aizeman and Pinto (2005) formulated a framework to build theory for explaining the effect of different type of shocks and impact of volatility (see Figure 10):

- **Exogenous volatility** derives from sources of volatility that are outside the control of both households and policy makers in the short term.
- **Endogenous volatility** derives from sources of volatility that include unstable macro policies, political instability, and to some extent financial crisis brought about or amplified by domestic market imperfections.

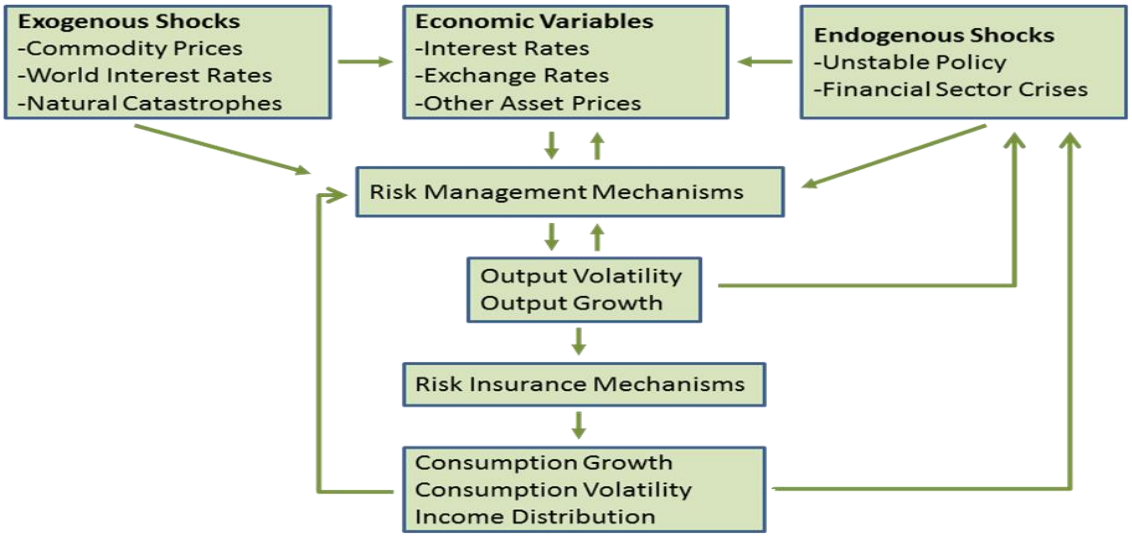

Figure 10: Model for Identified Sources of volatility and impact (Aizeman and Pinto, 2005)

A business responds to exogenous volatility, endogenous volatility and subsequent changes in economic variables with risk management mechanisms which require either absorbing the shocks or adapting the business in response to the shock.

Aizeman and Pinto (2005) state further that businesses typically manage volatility by applying:

- Risk-Reduction measures to directly affect the probability of an event occurring. Firms can use prudent balance sheet policies regarding maturity and currency mismatch and diversifying their client base.
- Market insurance which would limit exposure of individuals to stochastic events by spreading costs over a large pool of individuals.
- Self-insurance which would use precautionary savings, building up savings in good times to sustain consumption in bad times.

Previous research by Gavin and Hausman (1996) build the theory that shock may impact on economic variables like exchange rates, interest rates and other asset prices. In practices, however, Dedee and Vorhies (cited in Wu & Lin p.76) argue that when a downturn arrives, business executives rush to make across the-board cuts in everything from R&D spending to employee headcounts. When signs of recovery appear, businesses turn on the spending to rebuild their strategic orientation. Although these approaches seem reasonable, they can damage long-

term competitive positions and corporate performance. Thus business risk needs to be managed to cope with of volatility.

Olausson and Berggren (2010) concluded that product development in highly uncertain environments requires experiential and improvisation tactics based on intensive interaction, learning and exchange of real-time information. From an analytical perspective McDermott (cited in Olausson and Berggren), De Meyer et al. (cited in Olausson and Berggren) and Hällgren and Maaninen-Olsson (cited in Olausson and Berggren), indicated that research into uncertain product development emphasizes the value of late design freeze, flexibility, and interactive lateral communication.

Grant (cited in Wu & Lin p.76) builds a theory indicating that uncertainty requires that strategy should focus less on specific actions and more on establishing a clear direction, within which short-term flexibility can be reconciled with the overall co-ordination of strategic decisions. This duality requires that long-term strategic goals are established and that the firm should commit to them through strategic intent and growing of competencies (Hamel & Prahalad, 1989).

The question arises; to what extent can endogenous and exogenous shocks be absorbed via longer term focused product development strategy yet retain room for short term flexibility for decision making?

From a technology management perspective the selection of a project/product portfolio supporting the strategic direction with resulting research and product development, builds long-term competencies in the business. The project product portfolio management decisions may be impacted on by the resulting effects of the source's volatility. We need to consider the goals of project and product portfolio management.

Cooper and Edgett (2001) indicate five goals of project and product portfolio management:

- Maximise the value of the portfolio via selecting new product projects so as to maximise the sum of the values or commercial worth of all active projects supporting a business objective;
- Seek balance in the portfolio in parameters of short- vs. long-term projects, high vs. low risk, markets, technologies, product categories, project types;
- The portfolio should be strategically aligned and spending across projects areas, markets, and so forth should mirror strategic objectives;
- Pick the right number of projects with the limited resources available;
- Ensure that the revenue (or profit) goals set out in the product innovation strategy are achievable given the projects currently underway.

From the goals listed, it can be concluded that businesses have limited resources for product development and need to align organisational resources including product and portfolio optimally to ensure maximum business value. This goal should still be achieved while trade conditions continuously change as a result of volatility. The research questions as formulated in 1.2.1 need to address the aspect of change impact on the goals of product and project portfolio as listed above by Copper and Edgett (2001).

Ulrich and Eppinger (2008) report five measures which are commonly used to assess the success of product development:

- Product quality: The product quality is ultimately reflected in the market share and price customers are willing to pay for a product;
- Product cost: The product cost determines how much profit accrues to the firm for a particular sales' volume and particular sales' price;
- Development time: The development time determines how responsive a firm can be to competitive forces and technological developments, as well as how quickly the firm receives the economic returns from the team's effort.
- Development cost: The development cost is usually a significant fraction of the investment required to achieve the profits.
- Development capability: The development capability of a team as a result of experience determines the capability of a firm to develop products more effectively and economically in future.

Whether volatility impacts on the pressure for reduced time and cost in product development are unclear (needs to be tested via hypothesis) but the market still requires a product of acceptable quality. The business builds development capability as a result of new product development and this may improve business performance.

Cooper and Kleinschmidt (2007:6) investigated the critical factors in product development that drive performance at business unit level. They found nine factors which distinguish better performing businesses:

- A high quality new product process;
- A defined new product strategy for the business unit;
- Adequate resources of people and money;
- Research and development spending for new product development;
- High quality new product project teams;
- Senior management committed to and involved in new products;
- An innovative climate and culture;
- The use of cross-functional project teams;
- Senior management accountability for new product results.

Lerch and Spieth (2013) came to the conclusion that innovation project portfolio management (IPPM) is a vital capability to reconfigure competencies to address the challenges of a rapidly changing environment, while the companies have to innovate and bring new products to the market. IPPM includes the ability to acquire and control resources in order to setup an organisation that can absorb and apply resources to achieve competitive advantage. Effective and efficient IPPM includes elements that may be organisation specific to drive organisational performance. Interviews conducted by Lerch and Spieth (2013) indicated that

- IPPM process design in terms of degree of formalisation
- Transparency and characteristics of projects

can significantly influence IPPM performance. Their research indicated a strong link between IPPM, project and firm performance constructs.

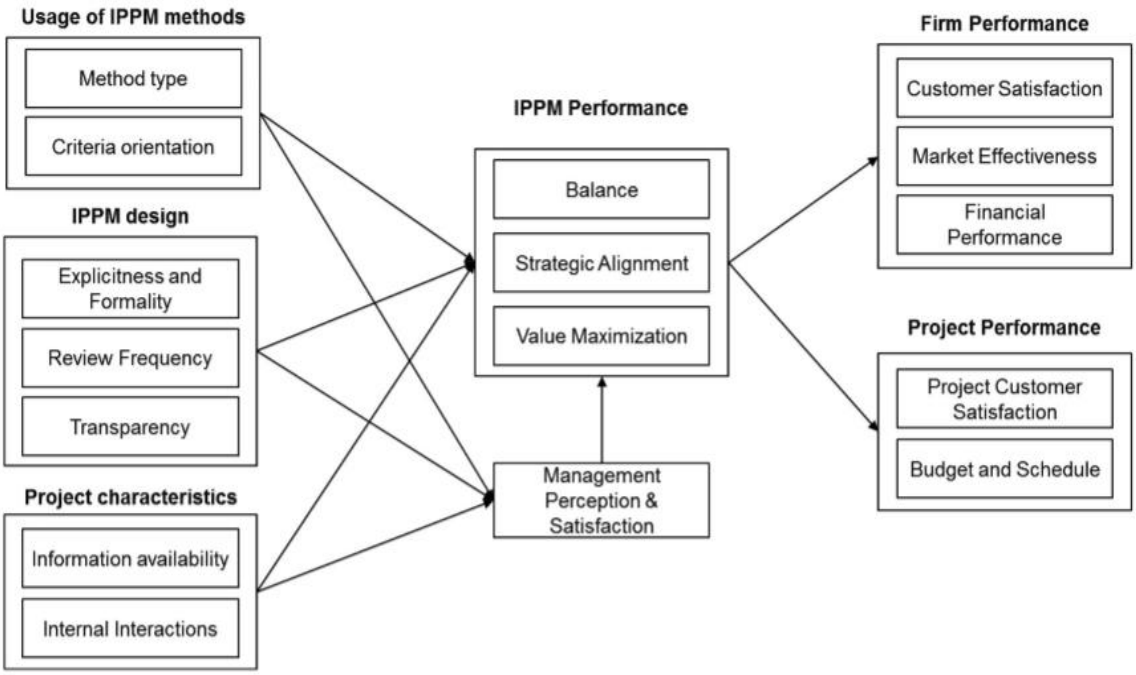

Figure 11: A typical IPPM framework from Lerch and Spieth (2013)

From Figure 11it can be seen that

- Information availability as input,
- Market effectiveness and project customer satisfaction

are nodes that interact in making IPPM successful.

The impact of volatility needs to extend from customer reaction (during volatility) and information that can influence project and subsequent product development.

From the listed factors that drive development and create high performing businesses the following questions may arise:

- Does volatility impact on product strategy?
- Will volatility impact on the number of people and the amount of money available for development?
- Will all levels of people in the business still be committed to new product development?
- Will the business still foster an innovative culture and climate under volatile economic conditions?
- Is there any relationship between volatility and accountable?

The study's research questions as listed in 1.2.1 need to address the above questions in the following way:

- Does volatility impact on product strategy? Related to research question 1 and 2.
- Will volatility when detected impact on the number of people and amount of money available for development and changes to the portfolio while current products are shipping out? Related to research question 3 and 4.
- Will all levels of people in the business still be committed to new product development? Related to research question 3, 4 and 5.
- Will the business still foster an innovative culture and climate under volatile economic conditions? Related to research question 5 and somewhat to research question 6.
- Is there any relationship between volatility and accountability? The activities performed in business require management to act responsibly and be accountable. The research questions are indirectly associated with this question.

Le (2004) suggests that three factors affect the quality outcome of the new product performance and highlight the impact of project portfolio management on new product performance as a result of successful product development in Figure 12:

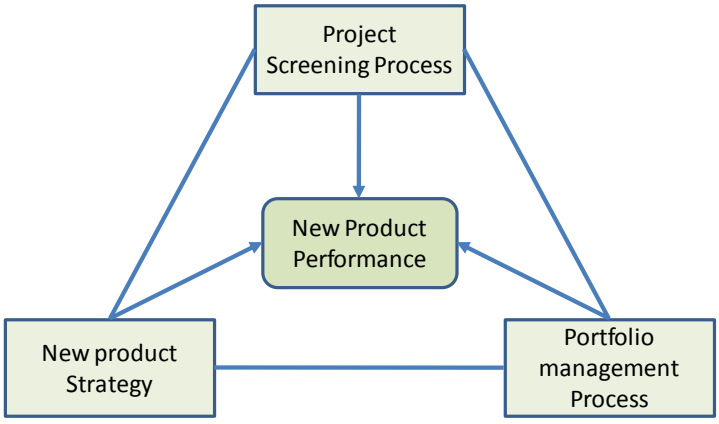

Figure 12: Cornerstones of new product performance (Le, 2004)

The cornerstones of new product performance include:

- The **project screen process** refers to the discipline of selection of projects and further execution accordance with expected quality requirements.
- The **portfolio management process** ensures that the business prioritises projects in such a way as to ensure the new product development resources' capability is not exceeded. Over utilisation of the capability of a new product's development resources can lead to the firefighting syndrome according to Repenning, Congapues & Black (cited in Le, p.1013).
- The **new product strategy** ensures that the long-term developments receive strategic direction and align with the business's objectives.

The impact of volatility on the cornerstones of new product performance needs to be investigated. Cooper and Edgett have published extensive theory and best practice on the **project screen process, portfolio management and new product strategy**.

Cooper and Edgett (2006) build their theory stating that picking the right portfolio of projects is paramount to maximising new product development (NPD). They identified several best practices to aid in the improvement of project portfolio management.

- Focusing on data integrity: The best project selection is worthless unless data used for project selection has substance.
- Installing a systematic idea-to-launch process to identify key tasks should be undertaken at every stage of the project and selecting what information is really needed at each selection gate.
- Adopt an incremental commitment or option-based approach. Limit risk by taking small investment steps before committing fully to the project execution.
- Know when to walk away. The correct kill can also be a success since money is saved and trouble is limited.
- Categorise your development projects into buckets to identify differences such as
    - New products.
    - Platform and technology developments.
    - Improvements, modifications and extensions.
    - Customer requests.
- Utilise multiple selection methods in combination to hone in on the correct project selection decision.
- Utilise score cards to rate and rank projects: The development funnel is a method proposed by Wheelwright and Clark (1992), to select between various product development proposals. Proposed products are reviewed to see which fit the business strategy best. Products of lesser fit are eliminated earlier in the product selection

process. Successful product development results in products that can be produced and sold profitably.

- Utilise success criteria at every stage in the project selection process to evaluate if projects meet agreed criteria for success and agreed expectations.
- Utilise the right financial approach to select projects including, net present value (NPV), sales-to-cost ratio, and probability adjusted NPV and productivity index.
- Build periodic portfolio reviews to rank projects ensuring that business has:
    - The correct set of projects in execution.
    - The right mix of projects.
    - The right balance of projects.
    - The right priorities of projects, and
    - Sufficient resources to undertake approved projects.

When reviewing the factors impacting on the right project selection as listed by Cooper and Edgett the impact of volatility on these factors should be investigated as there is a theoretical gap. Some questions arise:

- Would volatile economic conditions impact on data integrity used for decision making?
- To what extent are investment steps affected by volatility before a final decision for IT project execution is made?
- Would there be more kill IT project decisions made as a result of volatility?
- To what extent is the categorisation of planned IT developments affected by volatility?
- Categorise your IT developments projects into buckets to identify differences such as
    - New products (less or more?)
    - Platform and technology developments (less or more?)
    - Improvements, modifications and extensions (less or more?)
    - Customer requests (less or more?).
- Even in using the right financial approach to select projects including, net present value (NPV), sales-to-cost ratio, probability adjusted NPV and productivity index, what would the impact of volatility be on these financial formulas?
- When volatile conditions are present, will the periodic reviews to rank projects occur more frequently to impact:
    - The correct set of projects in execution;
    - The right mix of projects;
    - The right balance of projects;
    - The right priorities of projects;

Sufficient resources to undertake approved projects?

From a risk perspective Oehmen et al (2014) indicates a lack of empirical research that investigates the effective integration of specific risk management practises proposed by various standards with

new product development programs. The research findings from Oehmen et al. (2014) propose six risk management practises that are most effective:

- Develop risk management skills and resources
- Tailor risk management to integrate it with new product development
- Quantify impact of risk on main objectives
- Support all critical risk decisions with management results
- Monitor and review risks, risk mitigation actions and risk management results
- Create transparency regarding new product development risks

Cooper (2001) suggests that the following questions be answered at gate review meetings to reduce risk and make 'go, kill or hold' decisions for product development:

- Is the project strategically aligned with the business's strategy?
- Is there a market need for the project?
- Is the project technically feasible?
- Does the project have a unique advantage for the customer?
- Does it meet all safety, health, environmental and legal requirements?
- Does the project make financial sense?

Thus some conclusion is possible by balancing the following:

- return on investment for the projects/products (the business's order book);
- the ability to execute the work with limited resources (delivery book) may influence the project portfolio selection and successful new product development.
  The prioritisation of the projects in the portfolio needs to address this balance:

- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?** as well as;
- **Research question 6 and 7: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?)**

In relation to the above listed conclusion, the IT product portfolio may be adapted to ensure the required return on investment.

Cooper and Edgett (2001) base their **product selection process** on a scoring **model** for project prioritisation comprising:

- Strategic Alignment:
  - Degree to which project aligns with the strategy

    - Strategic importance
- Product/Competitive Advantage:
    - Offers customers/users unique benefits
    - Meets customer needs better
    - Provides value for money for the customers/users
- Market Attractiveness:
    - Market size
    - Market growth rate
    - Competitive intensity in the market (high-low score)
- Synergies (leverages - Core Competencies):
    - Marketing synergies
    - Technological synergies
    - Operations/manufacturing synergies
- Technical Feasibility:
    - Size of technical gap (large -low score)
    - Technical complexity (barriers to overcome) (many/high - low score)
    - Degree of technical uncertainty (high -low score)
- Risk Vs. Return:
    - Expected profitability (magnitude: NPV)
    - Return on investment (IRR)
    - Payback period (years; many -low score)
    - Certainty of return/profit estimates
    - Low cost and fast to do

Each factor must clear a minimum hurdle. It is then added (weighted or unweighted) to yield the "Project Attractiveness Score" which is used to make Go/Kill decisions at gates and prioritise projects. It does seem as if the scoring model does not address the suitability of the product in the business portfolio.

Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43) plot the portfolio of projects along two specific dimensions: The extent to which project involves a change in the product line and the extent to which the project involves a change in production processes called a product-process change matrix (Figure 13).

This perspective can be useful to illuminate imbalances in the portfolio of projects under consideration and in assessing the consistency between a portfolio of projects and the competitive strategy needed for changing economic and volatile conditions. A business may identify that it has essentially no breakthrough opportunities or that it has no projects aimed at incremental improvements.

Linking technology to business planning that needs to take the volatile business environment into consideration may become challenging. The question arises if Wheelwright and Clark's work is taking the following in consideration:

- Business planning for target markets.
- The current technology base in the business- people, skills, infrastructure, tools, and so forth.
- Have technology audits been done in the business?
- What is the gap between the current technology base and the business planning?
- Which projects and associated products should be bought (licenses, acquired) or be newly developed?
- How well is the external market complexities defined?

The planned research needs to take into account Wheelwright and Clark's as well as Cooper and Edgett's work and research the impact of volatile conditions on their models, frameworks and best practices.

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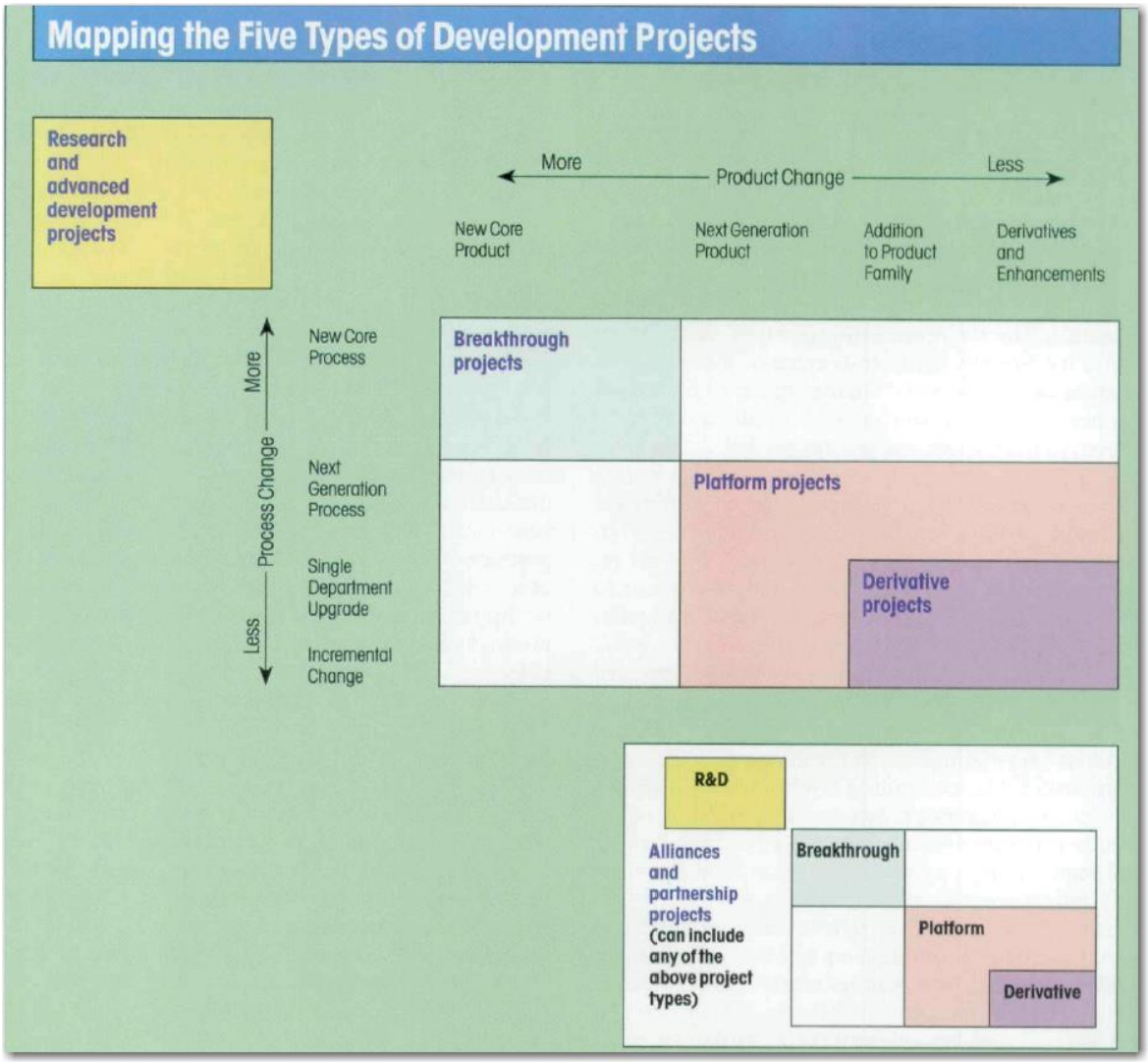

Figure 13: Product Process change matrix

Wheelwright and Clark highlight the valuable requirement that even though business may use a structured gated project and product development decision process (Cooper and Edgett), the bigger business project/product portfolio should also be reviewed to ensure decisions are not made on single projects/products alone.

Measuring client response for the planned product may even be more important during volatile conditions.

Some intangible benefits as a result of investing in IT are usually grouped in 2 categories:

- Internal improvements for the IT user
- Benefits for the customers of the business that invest in IT (Hares and Royle, 1994).

It is important to realise the benefits a planned product can create for the customers and business value for the IT business that create the products.

Cooper (2001) formulated product portfolio selection theory that incorporates customer participation in product/project selection.

According to Cooper (2001) the following should be done when presenting a new product /project concept to the customer:

- The customer's interest in the product should be measured.
- Facets of the concept that the customer likes and dislikes should be measured.
- How the customer rates your product against the competition should be measured.
- What the customer expects to pay needs to be ascertained.
- The customer's purchase intent at a specific price needs to be determined.
- Information useful in finalising the positioning strategy should be gathered.

As volatile conditions increase, customers may respond differently as their available funds and priorities change. Reviewing the above factors as listed by Cooper (2001) questions arise:

- Whether customers will show **interest** in the product.
- The customer may require **different performance** from the product (less expensive product with fewer features?)
- **Which product features** are important as perceived by the client?
- The customer **purchase intent** may reduce or increase and the right price should be determined.
- **Positioning the product in the right markets**, at the right price may prove more important when volatile conditions are present.

The above listed question relates closely to research question 1 and 2:

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response have on IT business project portfolios and new product development?**

The above listed attributes of client interest, performance expected from products, product features, purchase intent and right market are of specific importance and relates closely to research question 1.

No discussion on volatility would be complete without understanding the impact it has on risk management practices in business. Nocco and Stulz (2006) argue that in using the theory of enterprise risk management, businesses measure and manage their risk consistently and systematically. By giving the business manager the information and incentives to optimise the trade-off between risk and return, a business strengthens its ability to carry out its strategic plan.

If the IT business takes on a project that increases the firm's total risk, the project should be sufficiently profitable to provide an adequate return on capital after compensating for costs associated with the increase in risk.

The theory of enterprise risk management (Nocco and Stulz, 2006) dictates that:

- Management needs to determine the firm's risk appetite which includes the probability of financial distress that is expected to maximise the business value.
- Given the target level of risk, management estimates the amount of capital it requires to support the risk of its operations.
- Management then determines the optimal combination of capital and risk that are expected to yield the target risk rating. However, project portfolio selection can influence the risk level. Alternatively for a given amount of risk, the business can increase capital available to achieve the target risk rating.
- Risk is decentralised in the business with the help of capital allocation and performance evaluation that motivate the business manager to make investment and operating decisions that optimise this trade-off.

When volatility introduces more business execution risk for example i.e. commodity prices, skilled labour and currency exchange rates, more expensive equity capital are required to support operating risks.

It is debatable if an understanding of what external factors influence the business is sufficient to quantify what realistic levels of capital and resources are needed for new projects and product development.

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2.3 NEED FOR IMPROVED THEORY

During the investigation of theory related to the project portfolio management and volatility it became apparent that research in the product development domain seems to be more generalisable and not specifically measured in line with volatile conditions. Some risk management theory touches on changing conditions only. Cooper (2001) as well as Cooper and Edgett (2001) indicate practical many best practices but they need to be aligned to conditions of volatility.

In the field of product development in IT execution several best practices are continuously being published by authors such as (Buys, 2012), (Cooper & Kleinschmidt, 2007), (Cooper & Edgett 2010), (De Brentani & Kleinschmidt & Salomo, 2010) based on organisational experience in the field of product development and project portfolio management.
Key attributes of improved theory of this study should extend the best practices via research and include the following:

- Ensure the previous theory is measured with the research results and gaps identified.
- How IT businesses differentiates between smaller volatility vs. extreme volatility.
- Extending the work of Weeks (2009) for resiliency management and Burton et al (2009) for pattern-based management to detect early changes in trade volatility. These are critical organisational capabilities in business strategy for external event detection.
- March (cited in Olausson and Berggren) indicated that there are certain risks in managing uncertain projects where there is a trade of between formal processes to ensure efficiency vs. responding to external factors which may reduce efficiency. Theory should be explored to determine how business respond with project execution during volatile periods to retain efficiency.
- Project portfolio selection according to Cooper and Edgett (2001) should include:
    - Value attainment in project portfolio selection.
    - Balance in the project portfolio of short vs. longer term projects.
    - Strategy in the project portfolio.
    - Right number of projects to balance organisational resource capacity.
    - Ensure revenue/profit goals in the product innovation strategy are achievable.
- According to Aizeman and Pinto (2005): Businesses should measure and respond to detection of volatility with responses of:
    - Risk reduction measures
    - Market insurance
    - Self-Insurance.
- Ahuja (2011) clearly raises the issue that external acquisition of technology in initial product development stages may be necessary in high technology areas, the industry

requires an own product portfolio to be reliant on to remain competitive. For this to realise, organisations must embrace change. There is room for investigating how IT suppliers should change to become self-reliant in products by means of building core competencies as well as what the IT market require generally in technology features.

- Lee & Phaal & Lee(2011) stresses the importance of aligning the product as well technology developments with the business goals using technology roadmaps. For this research we intend to use the technology roadmaps as one of several factors for mitigating volatility impact during product innovation processes.
- Building organisational long-term competitive position and high corporate performance into down turning economic conditions.
- Gaining strategic focus (direction): reconciling short-term flexibility in response to volatility with strategic decisions.
- The impact of volatility on influencing product development attributes of:
    - Product quality.
    - Product cost.
    - Development time.
    - Development cost.
    - Development capability.
- Combine the work of Le (2004) as well as Cooper and Kleinschmidt (2007:6) to measure the impact of volatility on product development:
    - The existing product processes in the business.
    - New product strategies.
    - Resourcing: People, equipment and money.
    - Research and development spending or new product development.
    - New product teams.
    - Senior management commitment and involvement in new products.
    - Innovation culture and climate in the business.
    - Cross-functional project teams executing new product development.
    - Senior management accountability for new product results.
    - Project screening processes and gate keeping on NPD selection.
    - Product and project portfolio management processes.
- The impact of volatility on best practices of project portfolio management as indicated by Cooper and Edgett (2006) needs to quantified in volatile conditions. Does volatility impact on the following?
    - The data used for project selection;
    - The idea-to-launch process tasks and information needed at each selection gate;
    - When to walk away and save costs and trouble;
    - The categorisation of development projects into:

  - New products.
  - Platform and technology developments.
  - Improvements, modifications and extensions.
- Customer requests; The selection methods for making project selection decisions;
- The financial approach so the selection of projects including: net present value (NPV), sales-to-cost ratio, probability- adjusted NPV and productivity index;
- Review for project ranking and impact of volatility on:
  - The correct set of projects in execution;
  - The right mix of projects;
  - The right balance of projects;
  - The right priorities of projects, and
  - Sufficient resources to undertake approved projects.
- The impact of volatility on the product-process change matrix as suggested by Wheelwright and Clark (cited in Ulrich and Eppinger p. 43);
- The impact of volatility on enterprise risk management when executing projects and new product development.

The final research should build on the above listed aspects to uncover new trends and practices that the IT industry applies.

2.3.1 The gap in theory being established

When looking at the title of the thesis “THE EFFECT OF VOLATILE BUSINESS CONDITIONS ON NEW PRODUCT DEVELOPMENT IN THE INFORMATION TECHNOLOGY INDUSTRY” some key topics are apparent

- “Effect” indicates a causal relationship.
- “Volatile business conditions” which signifies risk and uncertainty
- “New product development” where IT products are developed as part of projects.
- “Information technology industry” creates a limited applied scope focus for the research for the industry in question.

From a gap analysis perspective a current state of the three topics in theory the following is apparent:

The current state:

- Illevare & Probert & Phaal (2014) also found that in spite of the significance of uncertainty and risk in strategy, there is still a **general lack of attention** to their consideration in the strategic planning processes. Only 3.4% of 650 product roadmap product case studies provide for addressing risk **and uncertainty during innovation**. They propose risk aware road mapping for innovation support to identify risk and uncertainty as well as resolve it as far as possible

and communicate it to stakeholders (Eirma, 1997), Petrick and Provance (2005). The findings are consistent with Oehmen et al (2014) as depicted in section 2.2 where there is a lack of empirical research that can investigate the integration of uncertainty focused risk management practises in new product development programs.

- Given a lack of attention to risk as a result of low manager guidance during innovation, this lack of attention can also be extended to strategy and innovation planning (Bromiley et. al, 2001; Euchner, 2011). The need for new theory resides in the practical aspects of how risk and uncertainty mitigation must be built into the product roadmap for specifically information technology products. Euchner (cited in Illevare & Probert & Phaal) also indicates that the very un-clarity (fuzziness) of risk data makes it easier for personal agendas and organisational dysfunction remains hidden. **New theory should look what is required in getting the risk addressed and aligning organisational dysfunction and inability to respond timeously.**
- Chua and Hossain (2012), state that external change activities relative to a project may affect project objectives causing changes in many design parameters for downstream activities. The possible impact of volatile conditions on a project needs to be investigated in this research since it is an external activity that can cause delays, cost overruns as a result of design changes which can impact customer satisfaction (Dvir and Lechler, 2004).

The future state for the gap analysis:

The future state is closely related to the research objectives as stated in section 1.3 which will create theories based on the quantitative Hypothesis testing and **descriptive qualitative** research results to substantiate the quantitative findings.

The volatility risk impact and mitigation is not only restricted to product development but rather consider upstream (client) changes as a result of volatility and also downstream activities (organisational capability) to work with volatility. The upstream and downstream activities in Figure 8 may also impact the product development in a causal relationship.

- The study combines aspects of business, management and market research as follows:
    - By performing market research the aim is to understand quantitative and qualitative aspects of IT consumer and client behaviour in volatile economic and trade conditions; this is an upstream activity (Figure 8) in relation to new product development and seek to quantify the potential behaviours from customers during periods of positive/negative volatility. This approach addresses the above listed concerns of limited research from Illevare & Probert & Phaal (2014) as well as Chua and Hossain (2012),
    - The impact of volatility may influence the work behaviour of people in the service of IT businesses. During volatile conditions business may require more efficiency, effectiveness and focused productivity. Some organisational development aspects

may require management intervention during periods of volatility since planned behavioural change efforts may impact on organisational culture, human and social processes;

- Determine the general responses of IT businesses during periods of volatility and how the technology strategy repositioning, strategy formulation and strategy execution in the business is done; this approach addresses the aspects raised by Illevare & Probert & Phaal (2014) where strategy planning is adjusted as a result of volatility.
- Collect and analyse current best practice approaches in use during volatility by IT businesses for project portfolio execution in technology intensive product suppliers. A descriptive qualitative approach is followed to list best practises and relate them back to the attention lack as indicated by Illevare & Probert & Phaal (2014).
- Collect and analyse the best practice approaches in use during volatility by IT businesses for new product development execution in technology intensive product suppliers. A descriptive qualitative approach is followed to list best practises and relate them back to the attention lack as indicated by Illevare & Probert & Phaal (2014).
- Collect and analyse the data business uses to define the relationship and impact of project portfolio selection on IT product development; the causal relationship where products are developed as part of projects are qualified using quantitative as well as qualitative descriptive statistics in the research.
- Determine the measures IT businesses have adopted to ensure that project portfolio selection and product development sustains future business operations profitably during volatile conditions. The research can supplement Chua and Hossain (2012) theory where volatile conditions can impact cost, time and quality aspects of projects. The research focus on the limited capacity which organisations have to execute development and delivery of projects hence new propositions are created on balancing limited execution capacity with changes in products as a result of volatility; this is a downstream activity from product development (Figure 8).

2.4 CONCLUSION

The focus of the research is not on the economic variables but rather the impact they have on the technological project selection and new product development processes.

To ensure new ground for the research is established a gap should be identified between existing theory and the demand for new theory.

The process followed in establishing the theory gap includes the steps depicted in Figure 14

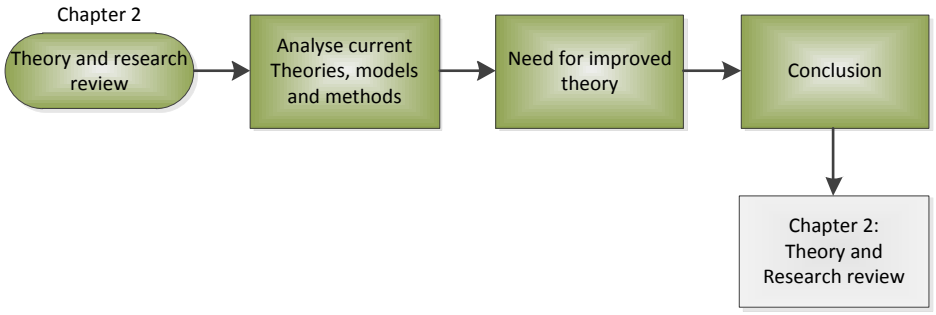

Figure 14: Process followed during the theory and research review

The work of Aizeman and Pinto (2005) indicates that volatility is more than the components of cyclical business trends but is rather a variation in the movement of particular economic variables as well as economic drop and growth.

The differences between exogenous volatility and endogenous volatility was highlighted and tied to risk management. Thus via enterprise risk management practices, risk is managed and should fall within the boundaries of the approved risk level in the approved business plan. (Nocco and Stulz, 2006). The technology project portfolio and new product development strategy needs to support the business planning.

Weeks (2009) promoted the theory of pattern-based strategy whilst Burton et al (2009) proposed pattern-based management to detect business environmental changes.

Cooper (2001), as well as Cooper and Edgett (2001) published extensive theory which are useable in the domain of project portfolio management and product selection. The fit of the selection into the greater organisational portfolio requires more investigation and Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43) focus more on the overall portfolio integration of projects and products.

The link between volatility and project portfolio management as well as new product development seems to require more focus in the research. The typical best practices for project portfolio management and product selection as promoted by Cooper (2001) should be tested in the planned research questionnaire with the impact of exogenous and endogenous volatility shocks.
Several questions arise from the analysis of current theories which were linked to the research questions in of 1.2.1 specifically in terms of:

- Client behavioural changes
- Product and project portfolio development changes, and
- Organisational execution strategy changes.

The development of new conceptual theories and models need to address these aspects in Chapter Three.

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3. CHAPTER III - CONCEPTUAL MODEL / THEORY / METHOD

3.1 DESCRIPTION OF CURRENT THEORIES IN TERMS OF PRACTICAL METHODS

In causal systems the output of a system is determined by the past / current inputs but not future inputs. Navarro (2009) conducted research to understand what proficient business cycle managers do in anticipation of the business cycle changes. As depicted in Figure 16 business cycle managers follow a non-causal business cycle response system whereby the *anticipated* future events explain the response (relationship) of business cycle management actions. Lessons learned during previous cycles are loosely applied to direct future event handling.

According to Navarro (2009) business cycle changes lead to decisions being made with regard to:

- Capital Financing
- Production, Inventory and Supply Chain Management
- Advertising and Marketing
- Pricing and Credit Management
- Capital expenditures
- Acquisitions and divestitures

It is **noteworthy that the project portfolio for delivery and supporting product development is not fully addressed** by Navarro (2009) as part of activities preceding Production, Inventory and Supply Chain management. Practical methods describing project portfolio and resulting product development during the business cycle are lacking.

From a historical perspective businesses fail to detect recessions early and seem to build larger product inventories without anticipating the recession. The businesses then cut production on the economic slowdown and inevitably begin to lay off people as well as cutting overhead costs. This contributes further to a weakening in the economy. Successful business-cycle businesses will according to Navarro (2009) cut product inventories in anticipation of a recession and build inventories in anticipation of an expansion or economic growth period. The research questions proposed as part of the study may be measured in terms of Figure 16 from a purely practical application perspective.
The question arises if the impact of volatility on the business cycle's speed and amplitude may also determine responses from the business?

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the**

resulting client response because of volatility shock have on IT business project portfolio and new product development?

The consumer approach to consumption is, according to Navarro (2009), based upon three dimensions:

- How much is a consumer willing to spend? – The consumer mood and confidence.
- How much can the consumer afford to spend? – The consumer budget constraint which is dependent on current income and longer term wealth.
- What is the consumer actually spending?- Large asset capital expenditure focus vs. shorter term operational and non-durable goods.

In the context of this study ICT consumers may experience similar responses but factors such as dependency on IT technology to do business locally and internationally, the demand for technology in the market and development of own products, may influence the business's view as to what the demand is for IT projects and products on the part of customers.

The IT industry being also subject to the business cycle may have similar experiences than what is depicted in Figure 16. The question arises; however, as to how increasing demand for IT products in the market is influenced as the demand may grow exponentially for technologies high in demand even though the business cycle may be on a downward trend for existing products. This is perhaps one distinguishing factor in the ICT industry and for general businesses in the economy. IT technology development in the market may proceed even though the business cycle points downwards!

- **Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?**

Kostoff and Schaller (cited in Lee & Phaal & Lee) define road mapping as a method to planning technologies capable of exploring future technological directions and allowing firms to weigh up alternatives for meeting highly uncertain future demand. Roadmaps will typically evaluate existing technologies and core capabilities, projecting these into the future, and cost and risk-evaluate proposed development strategies. Lee & Phaal & Lee (2011) conclude from research sample based cased studies that alignment of technology roadmaps and business strategy is a requirement and is a determinant for R&D success.

In the context of the information technology industry there are benefits in expressing information systems benefit in terms that would be easily understood by manager of the company

Gammelgård (cited in Lipajcik and Davidaviciene p.42) . This may be focussed at the IT business's client information systems market. The IT business can obtain market intelligence of the type of systems required by the customer to improve business performance.

Navarro (2009) states that in business, executive management teams should learn how to forecast the market which they know about to make the right decisions. Navarro (2009) raises the concept of a "Master Cyclist" (short for "Master Business Cycle Manager") leaders who are global thinkers with a high degree of economic and financial market literacy and who are masters at managing the business cycle.
An example of such a master cycle method is illustrated in Figure 15: Master cyclist Superior Performance Triangle. The exhibit illustrates that in order to always be a winner your organisation must become a Master business Cycle Manager by following three steps:

Step One:
Develop and Deploy strong forecasting capabilities to anticipate movements and key turning points in business cycles and effectively disseminate the forecasting information to key decision makers.

Step Two:
Apply well-timed business cycle management strategies and tactics across the functional areas of your organisation in a synergistic and integrative fashion in response to your forecasting data.

Step Three:
Over a longer term, **build your organisation with a strong business cycle management orientation**, an executive team with a high degree of economic and financial market literacy, and an organisational structure and culture that strongly support and facilitate all strategic business cycle management activities.

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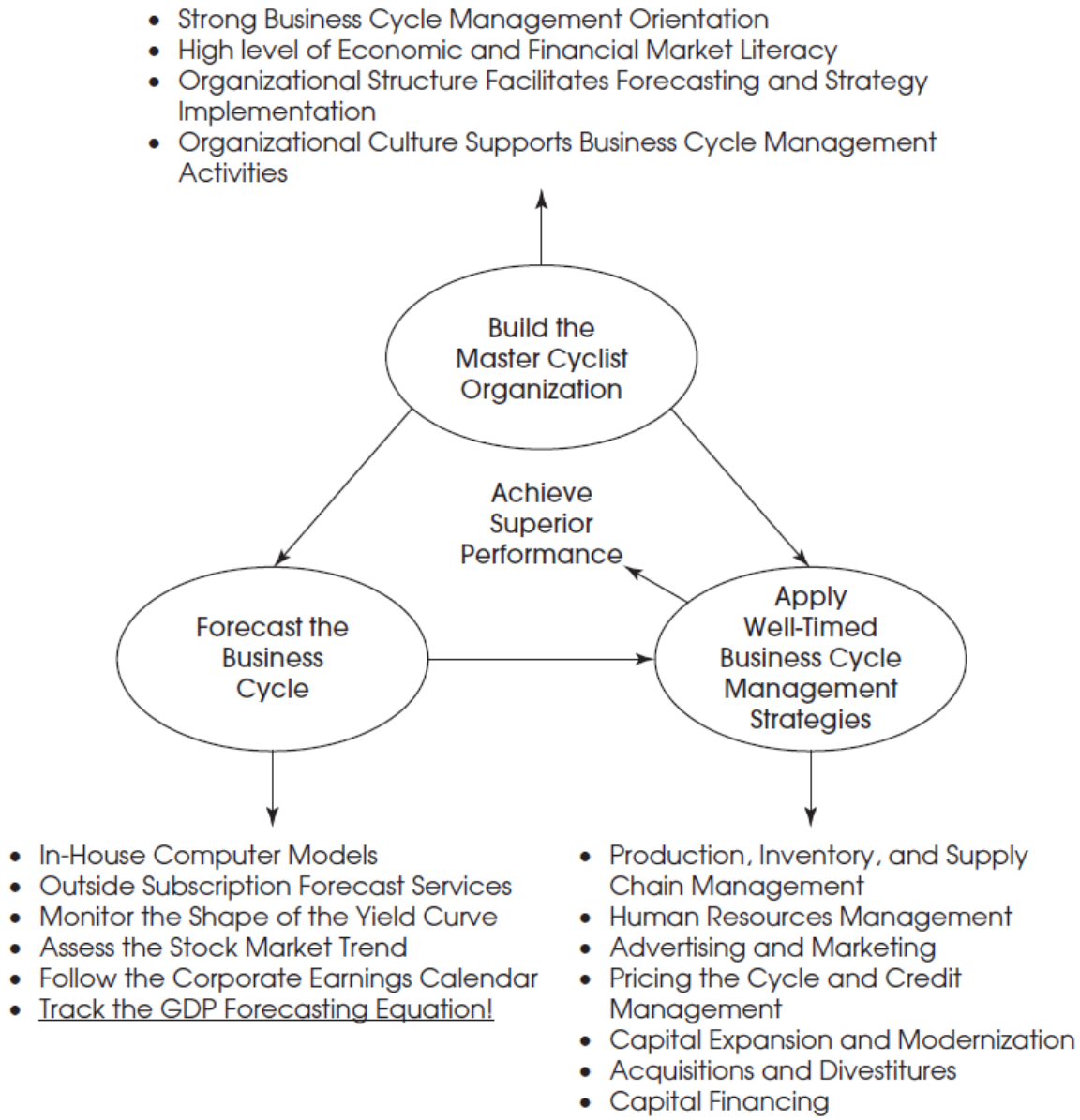

Figure 15: Master cyclist Superior Performance Triangle (Navarro, 2009)

- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?**

To build an IT product portfolio that is ahead of the competition requires capital for development. Navarro (2009) highlights the importance of cutting capital expenditure in anticipation of recession to build up cash and avoid over capacity. Capital expenditure into for

example IT product development during recession should be timed to be first in the market with products that reflect the latest innovation and product style.

The importance in this study is to determine reactive responses of IT businesses vs. proactive response to a volatile business environment. Three key aspects should be addressed as part of the research:

- Obtaining skills to forecast the IT market, product, client base and pricing.
- Apply battle-tested IT project and supported product portfolio strategies and tactics throughout the course of the business cycle to anticipate and cope with volatility.
- Being able to reposition and rebuild the organisation to reflect the strategic intent of the organisation to survive and prosper will require hard and clear decisions on projects and products that must be developed.

- **Research question 6 and 7: How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance their order and delivery books during periods of volatility?**

Navarro (2009) indicates the importance of adapting the product mix to match the changing moods of the business cycle and increasing advertising of products during recessions to capture consumer response. In terms of this study the ICT product portfolio may almost counter business cyclically and be promoted to clients to remind them of the product's value. By boosting advertising the building of a product inventory can be reduced whilst other competitors are reducing advertising as a result of cyclical downturns.

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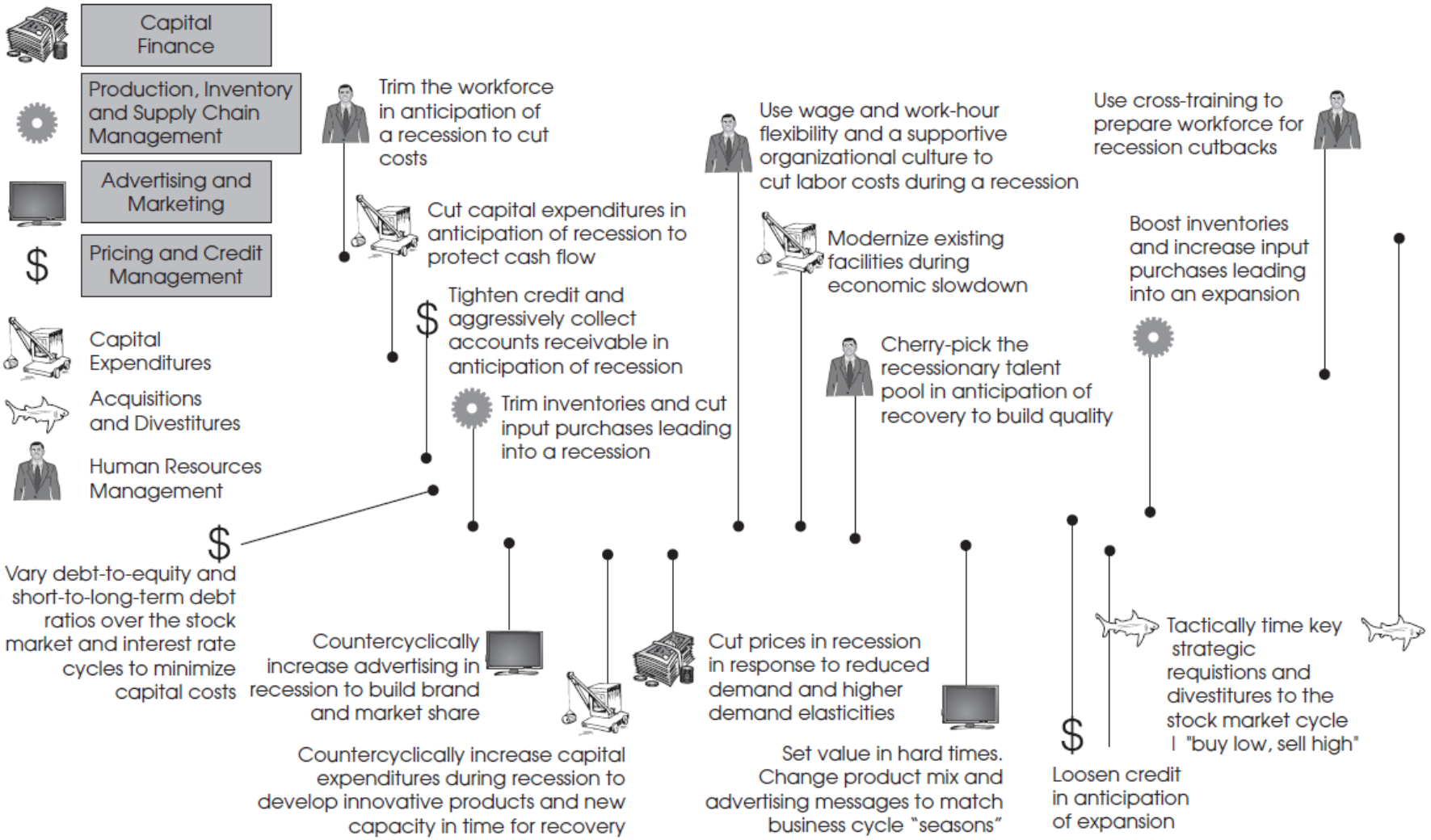

Figure 16: Winner Strategies over the Business Cycle (Navarro, 2009)

Current theories relating to Figure 8: The proposed business decision points in relation to volatility require some description in terms of procedures or techniques used to apply the theories.

In Figure 16 Navarro (2009) summarises the business cycle activities in his research findings. This is of relevance as business environment volatility influences some aspects of the business cycle and can speed up/slow down cycle execution.

Table 2 indicate the importance of understanding volatility and the potential impact it has on IT product delivery.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
1	Aizeman and Pinto (2005) formulated the theory that economic volatility is more than being the study of business cycles (although important) and the composition of economic growth in cyclical and trend components. They postulated that **volatility** is allied to risk in that it provides a measure of the variation or movement of a particular economic variable or some function of the variable. Higher volatility has through a growing body of research become more associated with lower rates of economic growth. Previous research by Gavin and Hausman (1996) builds the theory that shock may impact economic variables such as exchange rates, interest rates and other asset prices. In practice, however, Dedee and Vorhies (cited in	The focus of this study is the impact of a volatile business environment on the IT industry in particular from a managerial technical and **not** an economic view. At its core the IT industry comprises of: • IT strategy, functions and processes definitions from a business process support perspective; • IT product procurement and supply; • Consulting services related to information systems design, development and testing. • Consulting Services related to the supply of post-delivery support and outsourcing. IT as an enabler for business operations is subject to the forces that influence the overall business strategy and operations. The IT business project portfolio prioritisation and subsequent supported product portfolio should fit into IT clients' business strategy goals. If a volatile business environment influences the business operations fundamentally, such as when demand consumption increases or decreases, the IT industry may be affected to

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
	Wu & Lin p.76) argue that when a downturn arrives, business executives rush to make across-the-board cuts in everything from R&D spending to employee head counts.	increase or decrease IT product and service supply accordingly. However, if volatility is cyclical and businesses foresee the effect thereof, longer term IT strategies may practically foresee this and compensate for the effect. The IT industry is a service-centric industry and with decrease expenditure by businesses, a reduction in IT personnel due to decreased demand was probable in the year 2000 after the e-business fallout and the 2008 recession. Decreased budget for expansion due to lower market demand may have potentially influenced IT expenditure and subsequent projects and product portfolios.

Table 2: Impact of volatility on demand for IT products

Table 3 indicates some management best practice approaches in use in organisations to build the ability to overcome volatility in the business environment.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
2	"**Resiliency Management**" theory embodies both a proactive and reactive approach to face unprecedented, unexpected and unforeseen events that influence the organisational operational activities. Executives and managers need to ensure that the underpinning values, beliefs,	The IT industry comprises of both hardware and software product deliveries. A very large portion of the IT industry delivery requires skilled human resources to apply IT products in business operations. Being a strong service-centric industry IT personnel must closely understand client business strategy, processes and the subsequent value IT products can add to the clients' operations.

	norms and expectations that give rise to a culture of resiliency are woven into the day-to-day interaction and extensive dialogue. (Weeks, 2009). "**Pattern-based strategy**" is the discipline that enables business leaders to actively seek, amplify, examine and exploit new or novel business patterns. The	IT businesses, internal departments and consultants thus build relationships with clients. They sustain communications and support with clients to ensure that the IT products provide adequate business value over several years. The IT industry continuously measures itself as IT business managers sustain their businesses. Questions that must be asked is how do IT businesses, departments and consultants: • Achieve the results to date? What is the core strategic, behavioural, project and product approach followed? • How has client behaviour changed in the business environment during past years and what may happen in future in the IT industry? • What are the main challenges and problems faced by IT business and the IT industry in general? • How does the IT industry overcome the challenges? This *translates to resiliency* in that the IT industry builds over time specific strategy, execution qualities (projects and product development), values, skills, attitudes and talented employees to overcome volatility in the business environment. --- The IT business management, departments and consultants need to be sensitive for new emerging market patterns or products that could influence their core business value and execution models.

	theory for the support of pattern-based strategy indicates that organisations must begin to understand in which activities they are investing, and how these investments need to be changed or adjusted to enable them to exploit new patterns within their own businesses. They should also be able to understand new patterns of signals coming from external sources that indicate a business opportunities or threats. Chief executive officers and strategy officers need to expand their investment analysis beyond the two investment categories (defined and creative). (Burton et al, 2009).	Internet connectivity of the user community has already changed the business models of IT businesses. The Internet has tuned business hours to 24 * 7 hours. Adding remote connectivity of less expensive wideband data connectivity services to mobile devices (smart phones / laptops / tablets) has made IT users fully mobile, thus the point of sales location is suddenly *everywhere*. Emerging social media networks may also impact IT marketing models in terms of relationship building and one-on-one communication with clients. The possible extent of this change should still be measured. Being sensitive for new technology development patterns may assist business leaders to have a project portfolio and subsequent product portfolio that is entering the technology life cycle at the correct time for realising business. This can potentially unlock IT business opportunities or indicate potential threats. The extent of using a structured approach to technology strategy and policy must be measured in the IT industry. The following practical questions arise: • How do IT organisations derive a business strategy sensitive for an external environment including market (clients), industry and upcoming economic changes? • How is the internal organisational environment changing in terms of ▪ Organisation ▪ Structure, culture and values

		▪ R&D resources ▪ Talent development and retention ▪ Risks • What technology planning processes are followed to: ▪ Measure existing project and product portfolios; ▪ Technology life cycle fit levels; ▪ Quantify what is needed in the project and product portfolio; ▪ What IT products are needed and how will these fit strategically; ▪ Cost / benefit analysis performed; ▪ Change proposals and gated R&D expenditure. o How are project and product development focus controlled, leading to corrective actions taken in line with pattern changes in the market as a result of volatile conditions?

Table 3: Resiliency and pattern based management impact

Table 4 highlights the importance of IT organisations to be able to respond in the short term to operational changes while maintaining the ability to focus on longer term strategic goals.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
3	Grant (cited in Wu & Lin p.76) builds a theory that indicates that uncertainty requires that strategy focus less on specific actions and more on establishing a clear direction, within which **short-term flexibility can be reconciled with**	Within the IT industry several businesses compete for the same client base that often has the same basic IT requirements. The ability to identify unique client requirements or key value drivers as well as a longer term strategy that can fulfil these requirements can set an IT supplier apart from its competitors.

	the overall co-ordination of strategic decisions. This duality requires that long term strategic goals are established and that the firm commit to them through strategic intent and growing of competencies (Hamel & Prahalad, 1989).	In volatile market conditions, especially during periods of economic downturn, IT businesses that commit towards a longer term strategy seem to be more successful since they: • Know what they can deliver; • How to create value; • Know exactly which clients to serve even though clients may not order immediately. Business strategy changes may lead to changes in the project portfolio and required products to support the business strategy due to volatility. Subsequent IT Strategy changes may take several years to realise value since IT projects may require several years to be delivered in full. Porter (2010) also highlights the theory paradox of economic downturn. Companies need to integrate short- and long-term strategy to survive. The ability to cope with short-term volatility without damaging or undermining the unique value imperative of the business in the long run differentiates successful businesses. Over reaction for short-term survival may proof less successful since it may only realise short-term value. IT businesses should be clearer on their strategy during periods of economic downturn. They can use the opportunity to realise changes that could otherwise not be achievable since more short term financial scrutiny appears to be present during periods of economic downturn. The proposed changes may improve the financial positions of the business and hence obtain more support from

		management and shareholders. This may be because all IT industry businesses are “in the same boat” and results in the industry may be bleak across the entire industry. Thus business opportunity is also present during economic downturn. This could stimulate new projects and subsequent product development for economic growth. Some aspects must be clarified later in the study: The short term vs. longer terms strategy decisions and the impact on IT project portfolio selection and product development needs to be quantified in terms of: • Identification of new market opportunities for new IT projects and product development; • The impact volatility has on industrialisation of new IT technology products to be ready for market introduction; • The evaluation of new IT project business cases or “proof of concept” projects by customers; • The evaluation of new IT product prototypes by customers; • The weighted business case for every new product; • How is the IT technology product life cycle influenced by volatility and how do businesses in the IT industry respond?

Table 4: Short vs. longer term focus

Table 6 highlights the importance of the release problem as indicated by Viljoen (2005). This problem is especially prevalent in the IT industry where concurrent deliveries should be executed to create return on investment and satisfy client expectations.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
4	There is a however a fundamental management problem faced by managers of portfolios of projects, who are using formal project portfolio management methodologies to conduct their projects. This is referred to as the release-problem by Viljoen (2005) see Figure 17. Projects should generate value for the organisation. Value can be seen as the amount of money generated by the organisation for a given period (through sales). Two conditions need to be satisfied to meet the objective: • "The demand of every client must be satisfied because that increases their perception of value." (Viljoen, 2005). • "System productivity must improve because it is fundamental to the value of an organisation through the metric of return on investment (ROI)." (Viljoen, 2005).	The IT industry is a service-centric industry. The IT industry is dependent on client project investment that may realise at an irregular rate, thus demand for IT deliverables can fluctuate extensively between peak periods of demand and times of stable operational demand. This makes project delivery and product development prone to the adjusted release problem (De Klerk, 2006:46). The seven operational problems identified by Engwall and Jerbrant (cited in De Klerk p.39) are also present in typical IT project and product development namely: • The portfolio management hierarchical level is overloaded since there are many conflicting priorities; • Portfolio management carry out priority setting and resource re-allocation on a daily basis since there is no slack or free resources even though problems should be addressed; • On-going attempts of negotiation are played for key resources used between multiple projects; • Management is primarily engaged in short-term problem solving; • Priorities change often; • One project in trouble has negative effects on other projects since

		resources are shared; • Project managers keep resources working on their projects (unnecessarily) in order not to lose them. These factors are typically experienced in organisations with limited resources and a high demand for project delivery. In Figure 17 De Klerk (2006:46) highlights the potential risk in multi-project environments where projects need to realise value for the organisation while under resource constraints. The IT industry is also exposed to: • Clients who demand priority for their work (focus) • Limited resources that have to work on multiple projects concurrently • With pressure, focus and limited capable resources the work needs to be completed under project requirements • Delays in output due to multi-tasking are a daily risk in IT organisations • Work in progress budget requirements rise due to more concurrent executions and less work gets done due to resources attending to more than one project • Inputs increase in effort yet outputs or finished products and projects decrease.

Table 5: Release problem as per Viljoen (2005)

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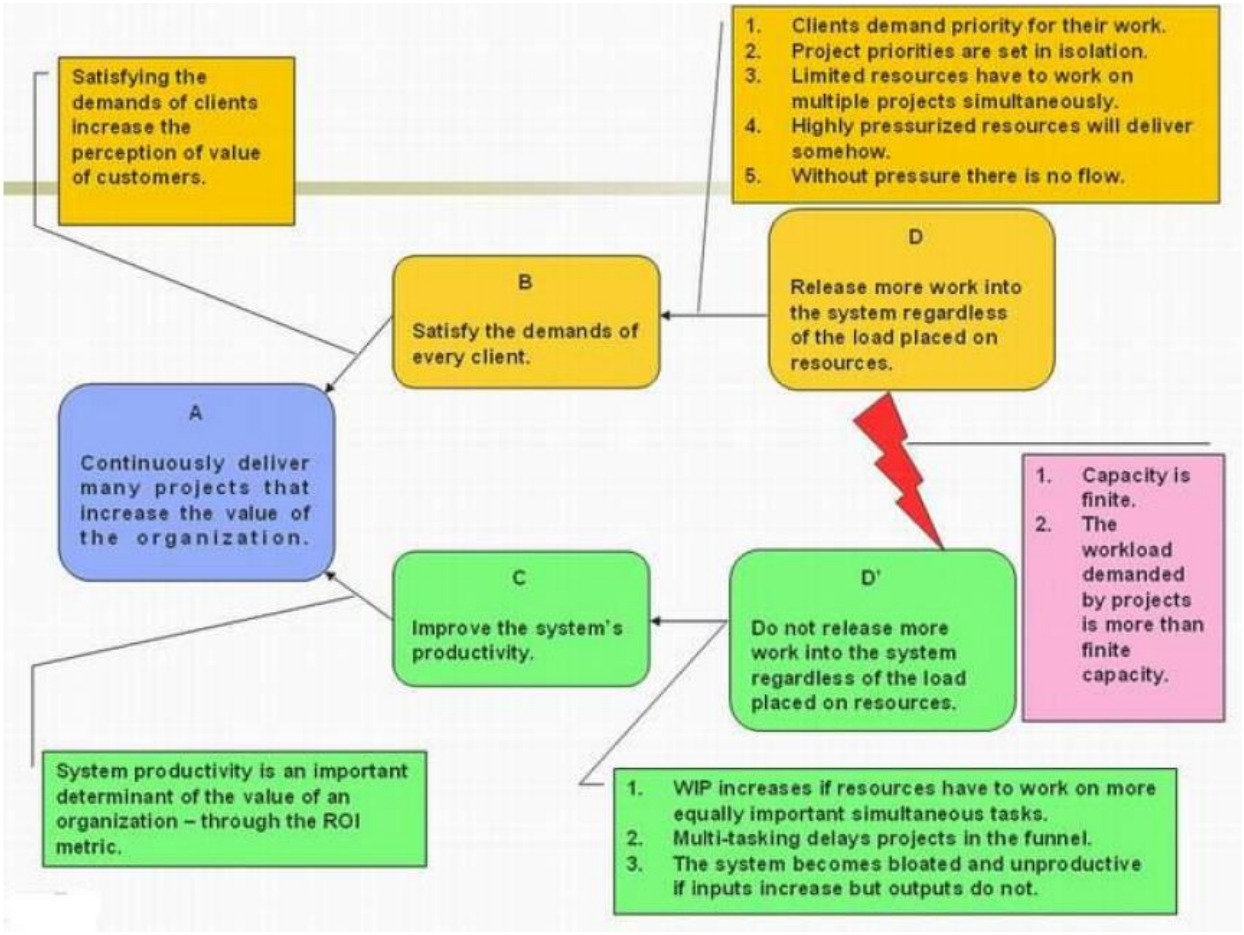

Figure 17: The release problem (adjusted from Viljoen (2005) by de Klerk (2006))

Figure 17 is applicable in the IT industry where limited capacity is always present, customers demand focus and support whilst the business need to ensure that shareholders benefit is realised. This has to happen whilst quality of products should be managed and deficiencies rectified to ensure longer term sustainability in the business.

This relates to some extent to:

Research question 6 and 7: How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

Table 6 highlights the critical factors in product development that deliver higher levels of performance yet certain practical key aspects in the IT industry have proven to keep the organisation performing at optimal levels:

- A high quality new IT product process;
- A defined new IT product strategy for the business unit;
- Adequate resources of IT people and money;
- IT R&D spending for new IT product development;
- High quality new IT product project teams;
- Senior management committed to and involved in new IT products;
- An innovative climate and culture;
- The use of cross-functional project teams;
- Senior management accountability for new IT product results.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
5	Cooper and Kleinschmidt (2007:6) investigated the **critical factors in product development that drive performance** at business unit level. They found nine factors which distinguished better performing businesses: • A high quality new product process; • A defined new product strategy for the business unit; • Adequate resources of people and money; • R&D spending for new product development; • High quality new product project teams; • Senior management committed to and	There are three distinct types of product development in the IT industry: • *Research concept demonstrator* products that are used for evaluation and budgeting for later production platforms. These products are rarely deployed in production platforms and still need to proceed through an industrialisation phase before they can be sold or deployed in volume. • *Original equipment manufacturer* (OEM) products including hardware, software and services. These products are used in original design. They are commonly referred to as *COTS*: "Commercial over the shelf" IT products. • *Applied IT products* where commercial products are applied

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
	involved in new products; • An innovative climate and culture; • The use of cross-functional project teams; • Senior management accountability for new product results. The concluding theory is that that if organisations can execute these aspects they are able to execute sound project portfolio management.	by means of IT services and development activity to meet client requirements. The impact of volatility on the contributing factors of successful product development as listed by Cooper and Kleinschmidt (2007:6) needs to relate to the IT industry. • **A high quality new product process:** In the IT industry, product development process maturity does influence product quality. The question can be asked if a product development quality-driven process is in fact at all affected by volatility. Time to market during volatile business conditions is of special importance but this does not imply that sub-standard quality will be accepted by the market. In the IT industry several IT businesses can provide similar products and services. A product or project of lower quality as a result of weaker product development processes will: • Fail the IT project successful adoption by users; • Damage customer relationships; • Open opportunities for competitors to access the

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		client. Handler (2011, p.2) in his analysis concludes that 63 per cent of IT development projects are deemed less successful. The source of these failures seems to be the lack of processes and practices. To overcome these failures the following is recommended: - The ability to capture exact and precise project requirements and translate them into meaningful estimates and schedules. - The fostering of partnerships with businesses through open communication and standard IT processes. - To understand the resource capacity of IT project staff and prevent over commitment. • **A defined new product strategy for the business unit:** The IT industry is subjected to products with shorter product life cycles due to a higher rate of new technology development. The IT industry globally consists of product and service providers with a globalisation view hence the IT industry requires a clearly defined product and market strategy to be able to compete. The client market is growing substantially for IT products and the competition is also increasing,

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		requiring business to create a unique business value strategy. The 2008-2009 economic slumps did not slow down IT product development but did influence demand for the products in the market due to lower client expenditure. This picture changed in 2010 with extensive client spending (Business Monitor International, 2011, p.7). The question needs to be asked how can businesses sustain the pace of development and have a sustainable business strategy that supports product development. • **Adequate resources of people and money:** The IT industry subscribes to best practices in project and programme management to sustain planned project execution and service delivery. The impact of volatility can be that planning for human resources requirements with uncertain project demand remains difficult. IT businesses typically recruit or contract more personnel only when upcoming projects require them to do so. The subsequent cost estimation for project demand is also based on projects that may or may not realise. Handler (2011, p7.) suggests that

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		businesses need to adopt variance tolerances in measuring cost, quality and timeliness of projects during estimation and project management duties. Handler (2011, p.7) suggests that project and portfolio managers should create the following clear measures to ensure more project success namely: • Requirements management processes and estimation processes; • Project performance standards; • Closed loop processes which monitor performance throughout the project cycle; • Resource and demand management to factor in capacity. • **R&D spending for new product development:** IT businesses typically invest in development on either; • Product level to create an IT product that is re-sellable; • Project level where an IT product in created for a specific customer based on specific customer

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		requirements. Some re-sellable products are also created in the market using this approach. Jaruzelski *et al* (2005, p.2) concluded in a study of 1000 businesses that there is no relationship between the R&D spending and the primary measures of corporate success such as growth, enterprise profitability and shareholder return. There is a high association between R&D to sales ratio where organisations have higher gross margins. Spending more on R&D does not always help unless there is a clear business strategy in place why this is being done. Spending too little will be detrimental. The maturity and quality of the innovation process is more important for product success. When a business is seeking more growth via innovation it is more important to develop a robust business model and good cross-functional capabilities than to boost the R&D budget. The IT industry and specifically computing and electronics can spend up to 25 per cent of sales on R&D. Software and Internet development focused businesses spend 15 per cent of sales per

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		annum on R&D. • **High quality new product project teams:** In the IT industry project execution is most often under a proficient team leader who will often have more than one project to lead. This may introduce risk since time is not committed adequately to a project. Appointing qualified team members fulltime is often difficult due to shared responsibilities between projects and product development. The IT industry is largely project based and frequent project update meetings and problem resolution sessions are a prerequisite for success. • **Senior management committed to and involved in new products:** Jaruzelski *et al* (2005, p.12) highlights the importance of aligning the innovation strategy (projects and new products) with the business strategy. For this to happen IT business management and technical management should synchronise planning (input) and resulting projects or products (output).

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		The involvement of senior management must ensure that - • The portfolio of projects and new products makes business sense, i.e. optimises profits and reason for existence. • Ensure the business model can deliver these products to the market. • **An innovative climate and culture:** The IT industry is by its nature a technology and innovation-driven industry. This requires people with a technology and innovation focused mind set. Creating or changing an IT business to support a culture of innovation relies on - • The senior executive support. • Training employees to understand what is expected and what behavioural changes will be required. • Value and belief systems to support innovation must be clear. The value systems are of special importance during periods of volatility to ensure people have commitment, focus and follow the

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		business strategy. • Effective communications regularly to target audiences. • Supportive organisational structures to create innovation project and product development teams. • Redesign approach to reward and give recognition to support innovation. • Review and adapting work systems including performance management, employee selection, pay practices and promotions. • **The use of cross-functional project teams:** The IT industry also further subscribes to the proposals from Jaruzelski *et al* (2005, p.11): • Customer insights from marketing, sales and service teams should be used to identify opportunities for products and services. • Project selection should be based on robust estimates of sales and profit from marketing. • Marketing can provide an

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		understanding of client needs during development. • Commercialisation: The product and service can only succeed if all functions- R&D, marketing manufacturing, sales and series function as an integrated team to support the creation of the new product. • **Senior management accountability for new product results:** Business cycle managers need to anticipate future business volatility and take mitigating actions. This requires that planned and current IT projects with the required new product development need to align closely to planned business strategy to operate efficiently. Within the IT industry many businesses do require senior managers to be closely involved with deliveries to clients since the industry has a strong service focus. The senior management on product development, marketing and client project delivery needs to closely co-operate to deliver projects that

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry.
		are successful. The result would be client requirements and product strategy that align. Being held accountable for the end result ensures that integration of activities occurs and business risk is mitigated.

Table 6: Critical factors in product development that drive performance

Table 7 measures the impact of exogenous and endogenous volatility on businesses which operates in the IT industry.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
6	**Exogenous volatility** derives from sources of volatility that are outside of the control of both households and policy makers in the short term. **Endogenous volatility** derives from sources of volatility that include unstable macro policies, political instability, and to some extent financial crisis brought about or amplified by domestic market imperfections.	The IT industry supports other industries in providing enablers like IT tools, data and information. All other industries are subjected to exogenous volatility and the business impact may spill over to the IT industry as a result of a decreased / increased short term demand for IT products, systems and services. The impact volatility has on consumers of IT products may be negated by the fact that since the IT industry is global in nature the volatility may not be present in other geographical or industry vertical markets. IT products also consist of significant amounts of sub systems which are reliant on base product providers. Natural catastrophes may affect the availability of products used to build IT products such as electronic components (floods in Asia

		seriously impacted sourced sub-components, for example storage devices). IT businesses in South Africa are exposed to currency fluctuations since many base products are imported. (Business Monitor International, 2011). Endogenous shocks in South Africa including evolving Black Economic Empowerment, irregular governmental IT spending, poor IT infrastructure including communications outside urban areas and IT skills shortages may impact on IT businesses since they have to operate within the boundaries of these challenges (Business Monitor International, 2011).

Table 7: Exogenous and endogenous volatility impact

Table 8 highlights the proven risk management mechanisms used by the IT industry to operate in the presence of risk factors induced by a volatile business environment. Risk identification and mitigation in the IT industry are of significant relevance as they create a way of tracking volatility implications for the business.

Theory Item Number	Theory	Procedures and Techniques used to apply these theories in the IT industry
7	Aizeman and Pinto (2005) state further that businesses typically manage volatility by applying: • Risk-reduction measures to directly affect the probability of an event occurring. For example diversifying their client base to reduce client	If the IT business takes on a project that increases the business's total risk, the project should be sufficiently profitable to provide an adequate return on capital after compensating for costs associated with the increase in risk. Laws in risk management and accountability require senior management to actively manage and mitigate risk. An example applicable in South Africa is the

	dependency. • Market insurance, hence limiting exposure of individuals to risk events by spreading costs over a large pool of individuals. • Self-insurance hence using precautionary savings, building savings in good times to sustain consumption in bad times. The theory of enterprise risk management dictates that: • Management needs to determine the business's risk appetite which includes the probability of financial distress that is expected to maximise the business value. • Given the target level of risk, management estimates the amount of capital it requires to support the risk of its operations. • Management then determines the optimal combination of capital and risk that are expected to yield the target risk rating. Project portfolio	King 3 Corporate Governance directive. IT businesses in South Africa are measured against such governance acts for reporting requirements and accountability standards. Making longer term decisions instead of short-term risk reduction decisions should be carefully weighted not to breach the corporate governance laws. The IT industry uses several proven risk management mechanisms including but not limited to • Creating a culture that is sensitive to risk identification, tracking and mitigation. • Actively tracking business, project and product risk progress as well as shifts in the levels of potential risks. • Part of risk management includes the capital exposure decisions and associated risk vs. reward acceptance. Tracking risks and reward are required in the IT industry as well. • Risks mitigation plans are constantly updated and tracked to ensure mitigation costs are reasonable. • The IT industry strongly invests in risk control, compliance and governance since information processing is the core of IT products. • Risks are constantly identified and managed on both operational and executive level. Risks are usually tracked in terms of impact to the organisation in different

	selection can influence the risk level, alternatively, for a given amount of risk, the business can increase capital to achieve the target risk rating. • Risk is decentralised in the business with the help of capital allocation and performance evaluation that motivate business managers to take investment and operating decisions that optimise this trade-off.	categories. The risks associated with volatile business conditions imply that businesses must closer manage risks during these periods of volatility to ensure healthy longer term business sustainability and viability.

Table 8: Application of current risk management theory in the IT Industry

3.2 DEDUCTION OF NEW THEORETICAL PROPOSITIONS BASED ON OBSERVATIONS

IT industry changes during the period 2000 until 2011 brought about some new requirements for listed theoretical propositions. The IT industry requires theories that can be used in more volatile business conditions to support technology engineering project portfolio management and resulting new product development.

Some missing **elements (organised groups of knowledge)** in the theories become visible in the IT industry as result of real life experience:

In Table 9 the ability of the customer to determine requirements that must be satisfied by the IT projects and products are established. These link back to the goals of research questions 1 and 2.

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the**

resulting client response result of volatility shock have on IT business project portfolio and new product development?

Observation Number	Observation	Observation and discussion of impact in IT industry
1	**Changing consumer behaviour**: Fierce competition in **global markets** are pushing product development cycles to become shorter, requiring organisations to strive for delivery of consumer driven technology, at lower cost and in the least amount of time, into the market.	Within the IT industry annually a new generation of products are required in certain market segments for example software for portable devices. Economics of scale in manufacturing of information technology must gear up to be able to delivery IT for a global client base. The products need to be able to compete on feature, time to market, price, solution compatibility and customisation bases with competitors in the same IT industry product market. In this research we need to extend the aspects raised by Illevare & Probert & Phaal (2014) where strategy planning is adjusted as a result of volatility with product development strategy adjustments required.

Table 9: Consumer impact on product focus

In Table 10 the ability of the business to detect volatility in the market needs to be established as this may have short and longer term impacts on the business. These link back to the goals of research questions 3 and 4.

- **Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefits during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?**

Observation Number	Observation	Observation and discussion of impact in IT industry
2	Gearing the IT organisation to **respond quicker** when **understanding the market** in volatile business conditions using **volatility detection**	IT businesses typically re-invent their approach to: • Customer requirements tracking; • Being more innovative for a clear focus on new products that will differentiate them in the market;

	mechanisms. This requires changes in the IT organisation on several levels and areas. All this has to happen while the IT business services businesses and deliveries on existing orders also need to continue.	• Build the manufacturing, project management and product development capabilities to be more agile yet of high quality and lowest possible cost; • Investing in sales and marketing to build relationships with clients and understand market requirements. • The technology roadmap (which determines product design and development priorities) for the products should include market as well as client feedback on what they require as important for the current and future sales of the products. The research aim to extend the work of Lee & Phaal & Lee(2011) whom stresses the importance of aligning the product as well technology developments with the business goals using technology roadmaps. This research also suggest that a mind-set of market and client focussed development is required in the technology road map.

Table 10: Market and client focused mind set

In Table 11, the ability of the business to operate in the international market needs to be established as IT is by nature the type of products sold internationally. This links back to the goals of research question 5.

- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
3	The **growth in information** in the past decade has made too much information available to decision makers. Creating performance measures in the organisation that are significant, measurable and	Volatile business environments can lead to more information in market activity and the **selective use** thereof to make decisions in IT business strategy, technology management, project management and new product management even more important. Measuring the result of business,

	able to compare current vs. previous results is becoming more important.	project and product decisions are more important than merely having sufficient products and not delivering to clients. Is the business successful in executing the business plan and creating sustainable business value?
		Competitive information have become the key weapons in winning IT contracts.
		The competitive information includes but is not limited to:
		• Understanding the value imperative of the product/project purchase for the customer.
		• Cost aspects of the product:
		  ○ Direct material cost,
		  ○ Indirect material cost,
		  ○ Financing of the product/project development,
		  ○ Marketing and sales costs
		  ○ Maintenance for warrantee and post warrantee contracts.
		  ○ R&D funding.
		• Sales pricing: Market pricing, competitor pricing, walk away pricing (absolute minimum recovery for meeting product costs and a reasonable profit).
		• Specification of products: own vs. competition vs. what the client wants in specifications.
		• The user's expectation of quality that must be built in to the project and supporting products.
		This is supports and extend the views of Das and Joshi(2012) found in their research that firms with a high level of process innovativeness will be able to respond better to hostile environmental conditions because they possess to a greater degree and also utilize more effectively the appropriate process-related knowledge resources to evolve a set of responses to enhance

		organisational performance.

Table 11: Establish performance measures and track results of decisions

In Table 12 the ability of the business to use information, put performance metrics in place and measure the business performance is of importance. These link back to the goals of research questions 5, 6 and 7.

- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?**
- **Research question 6 and 7: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions**? **How do IT businesses balance the order and delivery books during periods of volatility?**

Observation Number	Observation	Observation and discussion impact in IT industry
4a	Businesses have **internationalised business execution models** to deliver projects and products to international clients.	The IT industry has internationalised extensively in the past decade. Customers typically procure IT products via local value added distributors and resellers but the basic core product can be sold in the same configuration to many customers globally. The complexity with international business execution is not made easier in volatile business environments where there is increased competition, new competitive products and complex projects. An internationalised IT business will typically gear its sales, marketing, design and development, integration and delivery processes for international product and project delivery. The question arises as to how will such a level of internationalisation be reached and still be easily adaptable based on changing vulnerability?
4b	The **growth in information** in the past decade has made too much information available to decision makers. Creating performance	Volatile business environments can lead to more information in market activity and the **selective use** thereof to make decisions in IT business strategy, technology management, project

	measures in the organisation that are significant, measurable and comparable to previous results is becoming more important.	management and new product management are even more important. Measuring the result of business, project and product decisions are more important than merely having sufficient products and not delivering to clients. Is the business successful in executing the business plan and creating sustainable business value? Using "Resiliency Management" (Weeks, 2009) and "Pattern-based strategy" (Burton et al, 2009), maybe helpful, but it can only assist product development if the information and practices reach the product development function.

Table 12: Internationalised business.

In Table 13, the ability of the business to execute work in such a way as to ensure that quality of delivered products meets client expectations is of importance. This links back to the goals of research questions 6 and 7.

- **Research question 6 and 7: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility? How do IT businesses balance the order and delivery books during periods of volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
5	With reduced resources in organisations as a result of fluctuating market demand, the delivery of new **high quality products and projects the first time** are even more important.	Within the IT industry the client is part of quality management in that new projects and products address clients' wants and needs in measures, user cases and standards. All IT team members are often responsible for the quality of development or delivery to the client. Line management is still accountable for quality aspects of projects and new products. IT project teams often directly impacts on business sales turnover and profit, hence business strategy also includes measures for IT quality assessment, risk/mitigation plans and improvement initiatives.

		More and more IT businesses need to subscribe to industry accepted quality metrics, for example ISO standards from the International Standards Organisation or CMMI: Capability Maturity Model Integration (a registered trade mark of Carnegie Mellon University). IT tenders often *demand* a level of CMMI or ISO certification. To be certified for the standards the businesses require mature processes, focused on repeatability, standardisation and derived maturity or quality metrics are needed. The cost of having failures of products/projects can reduce profits which in the case of newly launched products must still be materialised. Thus the associated cost of failures in quality, results in time and resource allocation that impede new product development as resources must be re focussed to address customer complaints. Thus the cost associated with post-delivery problems fixing is too expensive and problems should be fixed during quality assessments before delivery to customers. An understanding should be formulated to see how good quality products are realised on first attempt development. This will supplement the views of Chua and Hossain (2012) theory where volatile conditions can impact cost, time and quality aspects of projects.

Table 13: Get quality right the first time

In Table 14, the ability of the business to execute work in such a way as to ensure that internal executing of IT project and product deliveries to customers are balanced with organisation capacity is of importance. This links back to the goals of research questions 6 and 7 as well as the release problem as indicated by Viljoen (2005).

- **Research question 6 and 7: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility? How do IT businesses balance the order and delivery books during periods of volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
6	Volatile business environments can influence the businesses to refocus existing business strategy and subsequent project execution and product development. The implications of fulfilment of the existing order book as well as balancing the available capacity in the organisation need to be managed on both a strategic and operational level. **Finding "balance"** between what needs to be delivered based on orders, availability of infrastructure and resources as well as ensuring the business will still be sustainable in the middle to longer term, remains a challenge.	The IT service industry is extremely overhead cost sensitive since the skilled resources need to be committed to client product and service deliveries, provide sellable services and ultimately cover costs and create profit. Uncommitted (non-billable) resources mean overhead costs are increasing and profit reducing. In the product manufacturing IT industry market demand and sales volume should be kept high to move IT product stock which can become very quickly out-dated due to new products required in the markets. The efficient utilisation of resources is also a balancing act in IT businesses since client demand determines sales and overall resource utilisation. Volatile business conditions which can impact constant client demand, organisational resource availability, sufficient product development and commercialisation time and product pricing, can significantly impact on the balance in IT businesses. IT businesses typically seek business that fully utilises resources and infrastructure for optimum turnover vs. profit vs. cost ratios. The careful planning of execution of work committed on contracts creates a view of the order and delivery **capability** of the organisation. This is consistent with the views of Cooper and Kleinschmidt (2007) where nine critical factors (see section 3.1) drive performance at business unit level. The optimum level of order intake vs. ability to execute should however be established.

Table 14: Balance the order and delivery book

In Table 15 the impact of volatility on the IT business in terms of Porter's five competitive forces is of importance. This links back to the goals of research questions 1, 2 and 5 and they are of importance.

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?**
- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
7	The classical work of Porter with his **five competitive forces** for impacting business strategy and how IT can be used for clients to yield competitive advantage, can be applied in the IT industry as well. How these five forces are impacted during volatile business conditions needs to be asked since this implies that a business strategy reaction is required should the five forces change as a result of volatile business conditions.	The Porter model should be assessed in the context of IT businesses delivering products in the context of projects as well as services for customer during periods of volatility for five questions: • Can IT build barriers to entry for competition? The IT Business will attempt to use client relationship building, superior products/projects and single supplier preference amongst other factors ensure sustained business. This will also assist in planning the order intake and delivery execution planning of resources and infrastructure. Can IT build switching costs for clients?The integration of IT and specifically information systems creates opportunities for IT businesses to effectively lock in a client, since the customisation knowledge resides in specific human resources of the IT business. Beneficial multiyear maintenance and support contracts ensure favourable costing for the customer yet also guarantees sustained work for the IT business.

		• Can IT change the base of competition rivalry? The enabling of business processes with IT and efficient execution of business can create new avenues for the customer to compete with their competition. An IT business that knows their customers business can assist in identifying these opportunities. • Can IT change the balance of power with supplier relationships? The IT business should keep product pricing at level where it is favourable for the customer to stay with the particulate IT business yet retain an acceptable or beneficial profit for the IT business. The fewer supplier choices for the customer as well as more dependency on particular suppliers wil lead to difficulty to switch to another IT supplier for the customer. • What is the Client buying power? The IT business need to understand the amount of clients , size of their business and decision factors important to obtain their business for product the IT business's products. The answer to the questions must be analysed in the context of several IT businesses and will be inherently drafted as part of the research questions in the presence of volatile business conditions. At the core of product development their remains a lack of sensitivity for uncertainty induced by volatility (Oehman et al. (2014). The Five forces can assist in determining how product development should be adjusted in light of changing in the five forces as a result of volatility in the market.

Table 15: Porter 5 forces impact on the IT industry when volatility is present

In Table 16 the establishment of critical success factors that are actively managed is of importance. This links back to the goals of research questions 1, 2, 3, 4, 5, 6 and 7 that are of importance.

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?**
- **Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?**
- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?**
- **Research question 6 and 7: How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
8	Once businesses understand the potential impact of volatile business conditions on their business strategy and subsequent projects / new products, they should consider what critical success factors will ensure - • That **objectives** can be defined to counter the volatile conditions. • Which **critical success factors** are required to satisfy the objectives. • Which **applications of projects and new**	The IT industry is highly project driven hence objectives with time limits set on business levels are carried through to project and new product level. To achieve certain objectives certain critical success factors needs to be fulfilled. Short term objectives, critical success factors and application of decided strategies should compensate for volatility and be assessed regularly. These should not remove the longer term objectives required for longer term business sustainability. This is consistent with the view of Hammel and Prahalad (1989) to build core competencies. However the product development

	products are required to support the critical success factors in the short, medium and longer term. This supports, to a certain extent, Rockart (1979) who identified critical success factor methods that are used to drive organisations to successful objectives.	still need to adjust the road map of product development to ensure the product features address changing market requirements.

Table 16: Managing Critical success factors when volatility is present

In Table 17, the impact of volatility as a risk in risk management practices needs to be actively managed and mitigated. This links back to the goals of research questions 3, 4, 5, 6 and 7 and are of importance.

- **Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?**
- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio execution with new product development in conditions of economic / trade volatility?**
- **Research question 6 and 7: How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
9	The **impact of volatility on risk management practices** in organisations needs to be quantified. The early identification of	Within the IT industry, businesses based on size will have more or fewer formal risk management practices. The ideal scenario would be to have more formal risk management practices and actively track risks induced by volatile business

	potential problems before they occur and ability to plan ahead is critical in any business. Volatility may induce risk, hence risk detection and mitigation practices need to mitigate adverse impacts and still achieve the business objectives.	conditions. These practices may include: • The identification of risks and grouping into groups of risks. • A risk analysis procedure and process. • A formal risk measurement process in the business strategy. • Risks are documented and communicated. • The ability to create mitigation plans to avoid volatile induced risk. These plans need to be pulled from business to project and to product execution level. • Risk identification and mitigation plans are reviewed periodically and adjusted in line with decisions made. • Ensure ownership of mitigation plans and track mitigation activities. Olausson and Berggren (2010) concluded that product development in highly uncertain environments requires experiential and improvisation tactics based on intensive interaction, learning and exchange of real-time information. From an analytical perspective McDermott (cited in Olausson and Berggren), De Meyer et al. (cited in Olausson and Berggren) and Hällgren and Maaninen-Olsson (cited in Olausson and Berggren), indicated that research into uncertain product development emphasizes the value of late design freeze, flexibility, and interactive lateral communication. The risk management theory in product development should be extended to continuously track the impact of volatility on product development scope.

Table 17: Volatility impact on risk management practises

In Table 18, the IT business should understand and work with the impact of volatility whilst revolutionising technology shifts occur. This links back to the goals of research questions 1,2,3, 4 and 5 and are of importance.

- **Research question 1 & 2: How do IT clients respond during periods of trade volatility to the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?**
- **Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?**
- **Research question 5: How do businesses balance their internal capabilities for IT project portfolio execution with new product development in conditions of economic / trade volatility?**

Observation Number	Observation	Observation and discussion of impact in IT industry
10	**Revolutionising technology shifts** like social media tools and channels for near real-time information exchanges change the IT playing field. During periods of volatility regular communication is even more vital for market requirements, project execution and product development.	The impact of social media tools on informal interaction between clients and IT business is not yet formally quantified. Social media enables one-on-one communications and relationship building. This implies that market (client requirements) are directly fed into the IT organisation to refine market / sales proposals, projects under execution and requirements for new product development. This extends the work of Cooper and Edgett (2001) for one on one interaction using social media with customers to refine market views more accurately.

Table 18: Revolutionising technology shifts

3.2.1 Research constructs

The above listed observations in the IT industry as a result of volatile conditions may bring about new theories in relation to IT project portfolio selection and resulting product development.

Some of the key aspects in the real world that these observations need to highlight or support on **new proposed constructs** include:

- **Construct 1: Efficient measurement of changing consumer behaviour as a result of volatile business conditions:**
  - Interpret internal and external market and consumer data;
  - Proactive client dialogues;
  - Consumer buying patterns and preferred communications channels;
  - More regular information of trends in markets and segments;
  - Understand what clients do when volatility impacts on them.

- **Construct 2: Efficient detection of volatile IT business environmental changes:**
  - Resiliency management;
  - Pattern-based management;
  - Use business and technology management experience learned from previous events/trends;
  - Actively measure Porter's five competitive forces to determine competitive intensity and market attractiveness including periods of volatility;
  - Internal organisational changes in orders, sub system demand, stock levels, and so forth.

- **Construct 3: Efficient and effective IT strategy definition when volatility is detected:**
  - Short term adjustments of business strategy with supporting technical project and product development optimisation;
  - Longer term vision, competitive business and market leading new products;
  - Technical risk identification, tracking and mitigation plans;
  - High visibility and tracking of critical success factors for the business execution including factors related to the business stage 3 balanced score card (Brown, 2007) which are often used in the IT industry. This includes variables for -
    - Financial data (sales, cash flow, EBIT, growth, cost of stock, ROI);
    - Customers (surveys, complaints, market share, loyalty);
    - Internal metrics (quality, cycle time, production, safety and productivity);
    - Learning innovation and growth (employee surveys, training hours, turnover, cost of new products, suggestions).

- **Construct 4: Efficient IT project and product portfolio selection, development and management while volatility is detected:**
  - The identification of the right project and product portfolio are of importance for IT businesses and is more precisely managed in conditions of volatility;
    - Clients can raise specific project requirements that need new types of products via personal contact;
    - Identification of new IT services which can add value for clients when clients experience volatility in their business environment for example increase support for IT systems' lifespan.
  - Performing more research on what products and services clients wish to have and specifically new products versus existing products;
  - Design and develop the new product portfolio with the following in mind:
    - Acceptable quality;
    - The shortest period of time for completion of development;
    - Sufficient levels of budget for the product development and
    - Features not present in competitive IT products.
  - The ability to industrialise and commercialise the new IT products to the market requires specialised IT industry experience. Team contribution from several contributing parties are required to be successful, including marketing and sales, research and development, finance and client interfacing.

- **Construct 5: Efficient alignment of IT project portfolio and product development:**
  - Critical stage gate analysis of projects and products can be utilised to align the supporting new products and projects with the client requirements;
  - Business case measurements of product investment versus product sales / profit and demand should oversee the approval of resources and funds;
  - The tracking of actual versus budgeted spending on R&D to support the business strategies and plans should ensure progress on development does not fall behind or overspend on budgets;
  - Amount of re-use of products in IT projects to reduce re-development of solutions or new high risk products;
  - Implement road map version focused IT development and alignment of marketing proposals can create demand for roadmap (extended) features of existing products and new products.

- **Construct 6: Effective and efficient balancing of internal IT business capabilities of delivery when volatility is detected to ensure high quality deliveries:**
  - Use historical output capacity and deliveries to service new contracts with adjusted business resource capacity planning;

- Utilise prototyping and short cycles to validate new commercialised product acceptance and ability to produce the IT products;
- Avoid pipeline gridlock where IT projects end up in the queue for execution and are not executed in time due to limited resources;
- Utilise proven techniques such as theory of constraints (TOC), current reality trees (CRT) and Goldratt's critical chain multi-project management (CCMPM) methodology project management to balance available resources with demand planning;
- Utilise stage gate buffer models as proposed by de Klerk (2005) to release project milestones for execution. The available capacity should be used optimally for quality output and funnel out less successful developments. Capacity without expansion is finite and if more than available capacity is required some decisions in terms of capacity expansion or reduction in prioritised manufacturing (IT production) is required.

- **Construct 7: Efficient risk management in IT project portfolio and product development during volatile periods:**
  - Establish an acceptable risk profile for the IT business which is accepted by the shareholders and implemented by the business leadership and technical management. The risk profile must clearly indicate what the acceptable and unacceptable levels of risk tolerance are. Volatility may test these limits of acceptable risk.
  - Maintain a visible risk detection, management and mitigation strategy in the IT organisation.
  - Actively track business, project and product risk progress as well as shifts in the levels of potential risks.
  - Risk mitigation plans should be constantly updated and tracked to ensure mitigation costs are reasonable and not over react when volatile forces are present.
  - The risks associated with volatile business conditions imply that businesses should more closely manage risks during these periods of volatility to ensure healthy longer term business sustainability and viability.

- **Construct 8: Driving forces for revolutionising IT technology shifts while volatile periods of business cycle occurs:**
  - The control of technology and technology-driven decisions are shifting out of the hands of IT organisations. These new forces that are not easily controlled by IT are pushing themselves to the forefront of IT spending. Plummer and Middleton (2011) highlight four forces that can transform the IT landscape due to rapid

development as well as business unit stakeholders that recognise the value of technology. Emerging markets are also growing rapidly in terms of technology expenditure and influence. These include:

- Cloud computing: The delivery of computing as a service and not a product.
- Social media and social networking enabling collaboration and community activity.
- Mobility: Inexpensive portable data access devices for example tablets and smart phones.
- Information management: Secure access to structured and unstructured data from multiple sources should be managed.

- Prentice (2012) highlights three unremarkable technologies that can assume importance in the business environment in Figure 18. Challenging economic conditions drive new low-cost technologies. Technology that is simple and affordable increasingly is required by the user community.

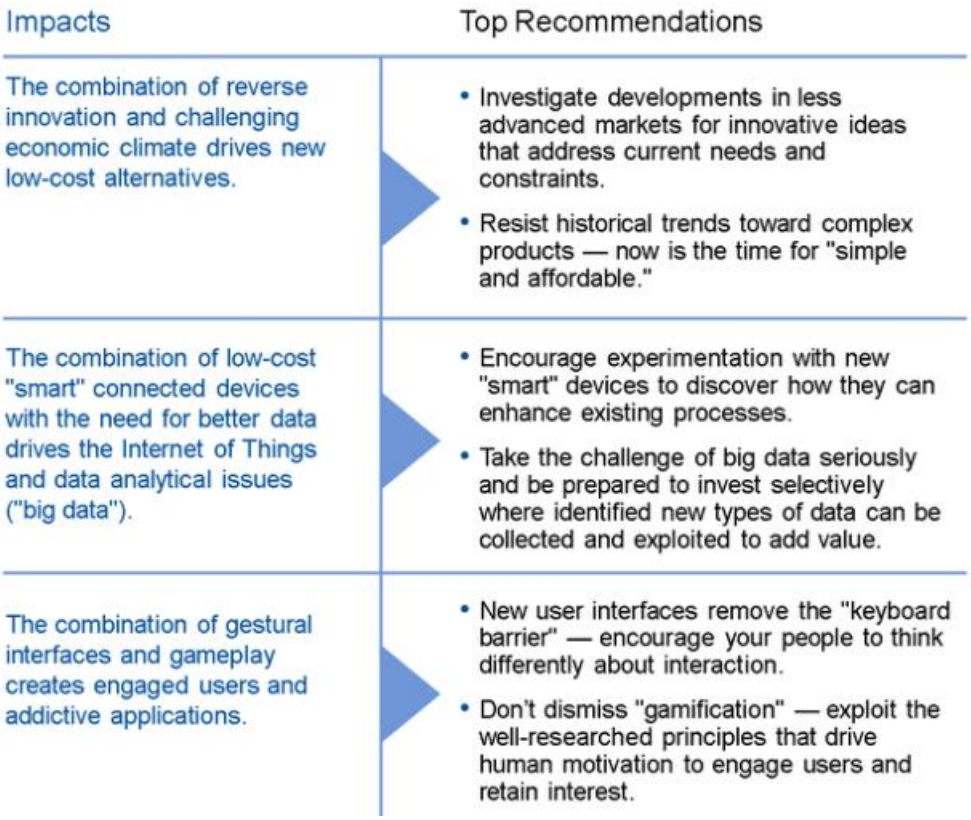

Figure 18: Three important IT drivers (Prentice, 2012).

- Cearly & Claunch (2012) highlight the top ten strategic technology trends in Figure 19 that have potential to effect business individuals, businesses and IT organisations. These technology trends occur currently irrespective of volatile business conditions and influence the business strategy as well as supporting IT

project and product development strategies. Some of these trends will radically change the *status quo* in terms of current technology, IT processes or business processes resulting in significant cost and disruption.

Some of these technologies will also become the base for technologically competitive products which IT organisations can utilise in the market.

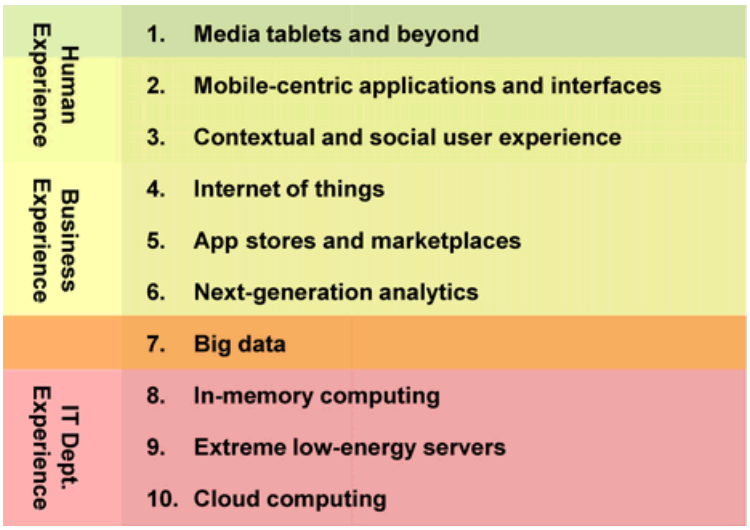

Figure 19: Top 10 technology trends in IT according to Cearly & Claunch (2012).

- **Construct 9: Critical success factors for handling the impact of volatility in IT project and product development:**
  - A rigorous and high quality product development process, sufficient planning, decisive tough stop / go decision points and a certain amount of flexibility are required to handle unique opportunities and threats brought about by volatile conditions.
  - The inclusion of all functional departments in product development should deliver a product that meets user requirements as well as having distinctive competitive advantages. This includes departments of marketing, sales, finance, technical product management, project execution and product development. The impact of volatile conditions should be reflected in all opinions raised and addressed on business and product development strategy.
  - Having a sufficient number of qualified people, the resources and money to get the product development strategy executed.
  - Creating a motivated, committed and focused team with the right level of pressure for output from applied management. In volatile conditions team input and efficient project execution are key. Shaping an innovative IT organisational culture

that supports project execution and product development can build a more innovative organisation in the longer run.

- Holding every level of the business responsible for product development and ultimately the business management accountable for results derived from product development.

- **Construct 10: Volatility impact on five competitive forces impacting IT business strategy:**
  - Can IT build **barriers to entry** for competition? IT organisations should have an excellent understanding of the customer values and priorities for spending. The IT business must create a competitive product suite that can compete with the competition offer on several levels including, pricing, quality, features, services and user expectations. During volatile conditions client behaviour should be tracked to understand how the client responds on business strategy level and what can IT business contribute to clients.
  - Can IT build **switching costs** for clients? IT businesses should -
    - Create products features, pricing and quality that will lock clients into wanting to stay with the particular products from the IT business. The ability to deliver these products should enable the client to execute their business processes efficiently and effectively ensuring they are also are delivering value for their business plan.
    - Ensuring via service and relationship building that clients experience a level of personal attention and assistance that are always available from the IT business.
  - Can IT **change the base of competition**? IT businesses create unique features and services in the IT products that they offer, which the competition cannot offer at low cost. The ability to create strong product ideas and idea selection will focus the IT business on the best ideas. A clear decision gate must be to clarify exactly what ideas (IT product features) will differentiate the business's products from the competition. The competition is also experiencing the same volatile business conditions hence a competitive strategy that clearly addresses client concerns and requirements are even more essential.
  - Can IT change the **balance of power with supplier relationships?** Suppliers also experience the volatile business environment since they trade with several clients in the business environment. Ensuring the partners remain able to deliver the required base products for IT products are vital for quick delivery of the end products. IT collaboration tools for supplier interaction including enterprise resource planning systems can play an important role in product development to

ensure base supplier products meet requirements for cost, features, quality and timelines.

- Can **IT generate new products**? To survive in a global IT market, IT businesses must continually provide new products that are able to compete in the global market. Volatile conditions have placed more focus on having products that more closely meet client requirements and have strong unique selling points. The ability to deliver products that can satisfy customer specific needs without heaving customisation (higher cost) has been a key differentiator for many IT businesses.

The resulting theories need to explain the relationships between the elements that make up the real world observations and make predictions in terms arising from the theory.

3.2.2 Proposed Theory propositions

Using **deductive reasoning (Mouton, 2001) resulting theory building,** new theories may be deduced from the mentioned principles and generalised for specific application in the IT industry.
The relationship with the research questions are listed below.
Some insight will be added to what is experienced in the IT industry and if the derived theories are applicable.

Theory proposition 1: Changing consumer behaviour amidst volatility

- **Changing IT consumer behaviour** plus
- **Volatility and its impact** on client business plus
- Having **detection mechanisms** for volatility in IT organisations

predict that:

- IT businesses must **respond faster** in having both shorter term risk mitigation and longer term vision-focused business, project and product strategy to cope with volatility.
- **Reduced time to market** projects and products are required to stay ahead of competition. **Product differentiation factors** which are of value for businesses including specification and price with a clear market penetrating strategy should be formulated and tracked.
- **Customer communication**, relationship building and retention of customers are essential for longer term sustainable business value.

This proposition is related to research question(s):

- **Research question 1 & 2:** How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?

- **Research question 3 and 4:** Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients and volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?

Theory proposition 2: Volatility impact on project / product development

- **Endogenous volatility factors** for example poor IT infrastructure outside urban areas, irregular IT spending on the part of government and businesses, skills shortages, evolving BEE laws plus,
- **Stage gated project and product development practices** in use in IT organisations plus,
- **The availability of qualified, experienced and committed** IT development personnel plus,
- **A focus on IT organisational process maturity and quality focus**

predict that:

- IT business leadership and technical product managers should **anticipate business cycle changes** and adapt product development strategies accordingly on a more focused basis using industry proven techniques.
- A **robust, mature and quality driven IT project and product development process** aids product success substantially more than merely high R&D budgets. Industry-proven techniques aid IT organisations in resource planning and balancing as well as process driven project executions.
- Product, project and product development strategists should adjust their portfolios in anticipation of volatility and **work with the volatility impact** once the results of volatility presents itself.

This proposition is related to research question(s):

- **Research question 1 & 2:** How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?
- **Research question 5:** How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?

- **Research question 6 and 7:** How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

Theory proposition 3: Risk and impact of volatile conditions

- Establishing only an **acceptable risk level profile** for the IT organisation to deal with volatility is not enough. The **early detection volatility induced risk**, response strategy as well as the formulation and tracking of **mitigation plans** plus,
- The impact of volatile conditions on **Porters 5 competitive forces** impacting IT strategy plus,
- A thorough understanding of the IT organisations' **ability and capacity** to execute concurrent project and product development with **limited resources** plus,
- Increased communications, career development and focus on high quality key value contributing personnel,

predict that:

- IT businesses will **not limit order intake** but will rather post order create capacity to deal with delivery constraints. This implies gearing and building IT organisations to a next level of resources, people and financial control to be able to fulfil order book commitments.
- IT business **risk must be formally managed** to ensure sustained business and technical operations during volatility.
- IT businesses' ability to deliver **acceptable quality of products and projects the first time** is a critical element of success since reworking can raise risk beyond acceptable levels for the business.
- IT businesses experience **constant challenges in retaining** a pool of skilled, qualified and committed personnel during project and product development. The impact of exogenous and endogenous volatile conditions may impact on employees' personal priorities significantly.

This proposition is related to research question(s):

- **Research question 5:** How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?
- **Research question 6 and 7:** How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

Theory proposition 4: Volatility and new technological products in the IT market or industry

- **New IT technological products** are introduced into the market and business managers realise the value of these IT products in business execution plus,
- **Increased focus on lower cost and easy connectivity of users** plus,
- **Cyclical business conditions amidst volatility** plus,
- **Users of IT products are shifting focus to online web hosted IT services and potentially in favour of less product purchasing. Shifting user focus/requirements is becoming a more important contributor in IT industry strategy formulation,**

predict that:

- IT businesses need to provide **constant new projects and products into the market** since the competition will not stop product introductions into the market even when volatility is present or IT business market cycles change.
- A **closer participation of end users in project and product portfolio formulation as well as a clearer constant tracking of IT market trends** can assist project and product portfolio managers in creating products that have potentially higher demand in the market.
- **New technological trends in inexpensive connectivity, portable communication devices such as tablets and social media services are becoming prevalent in the IT industry**. The provisions of **IT as services and not products** will impact IT business strategies significantly in future as businesses buy more services to aid in business process execution.

This proposition is related to research question(s):

- **Research question 1 & 2:** How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?
- **Research question 3 and 4:** Do IT businesses change their IT business/technical strategy for shorter or longer term benefits during periods of volatility with the market intelligence gathered from clients and volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?
- **Research question 5:** How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?
- **Research question 6 and 7:** How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

Some inductive reasoning and theory building (Mouton, 2001) that relies on inference from specific observations for example a sample of cases may still be possible using the feedback from the questionnaires later in the study to draw conclusions from specific instances of responses and build general theory. This is also substantiated by Page & Meyer (2006) where conclusions are drawn from a number of specific instances to form general theory.

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3.3 DEVELOPMENT OF MODELS BASED ON THE NEW THEORETICAL PROPOSITION

The four listed theory propositions:

Theory 1: **Changing consumer behaviour amidst volatility**

Theory 2: **Volatility impact on project / product development**

Theory 3: **Risk and impact of volatile conditions**

Theory 4: **Volatility and new technological products in the IT market or industry**

are aligned to the original proposed IT business process execution cycle decision points (Figure 20) where volatility impacts the business. The proposed theory relates directly back to the research questions (see previous paragraph 3.2.2)

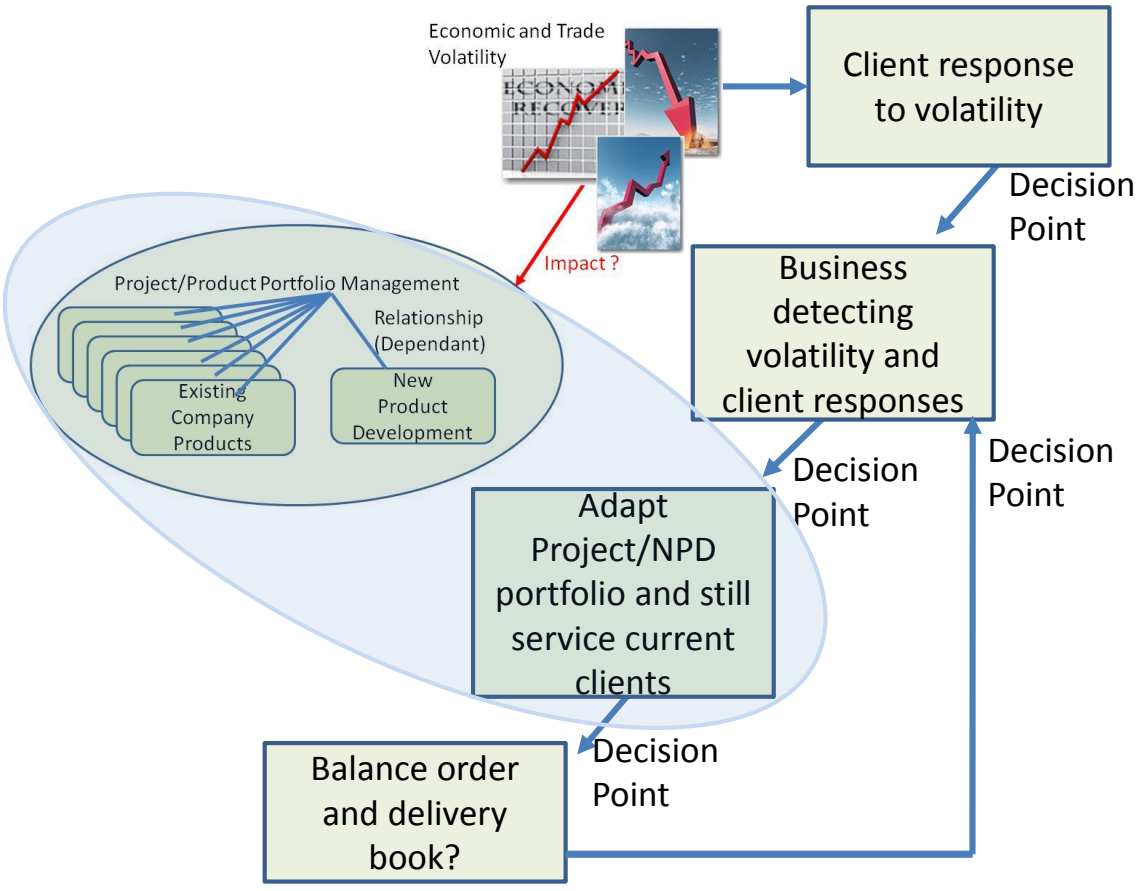

Figure 20: Theories impact on the decision points

The model depicted is a simplification of the complexity in a typical IT business in the IT industry. It is proposed to increase the depth of process impact one level to depict the volatility impact on the different roles in a typical IT business (Figure 21).

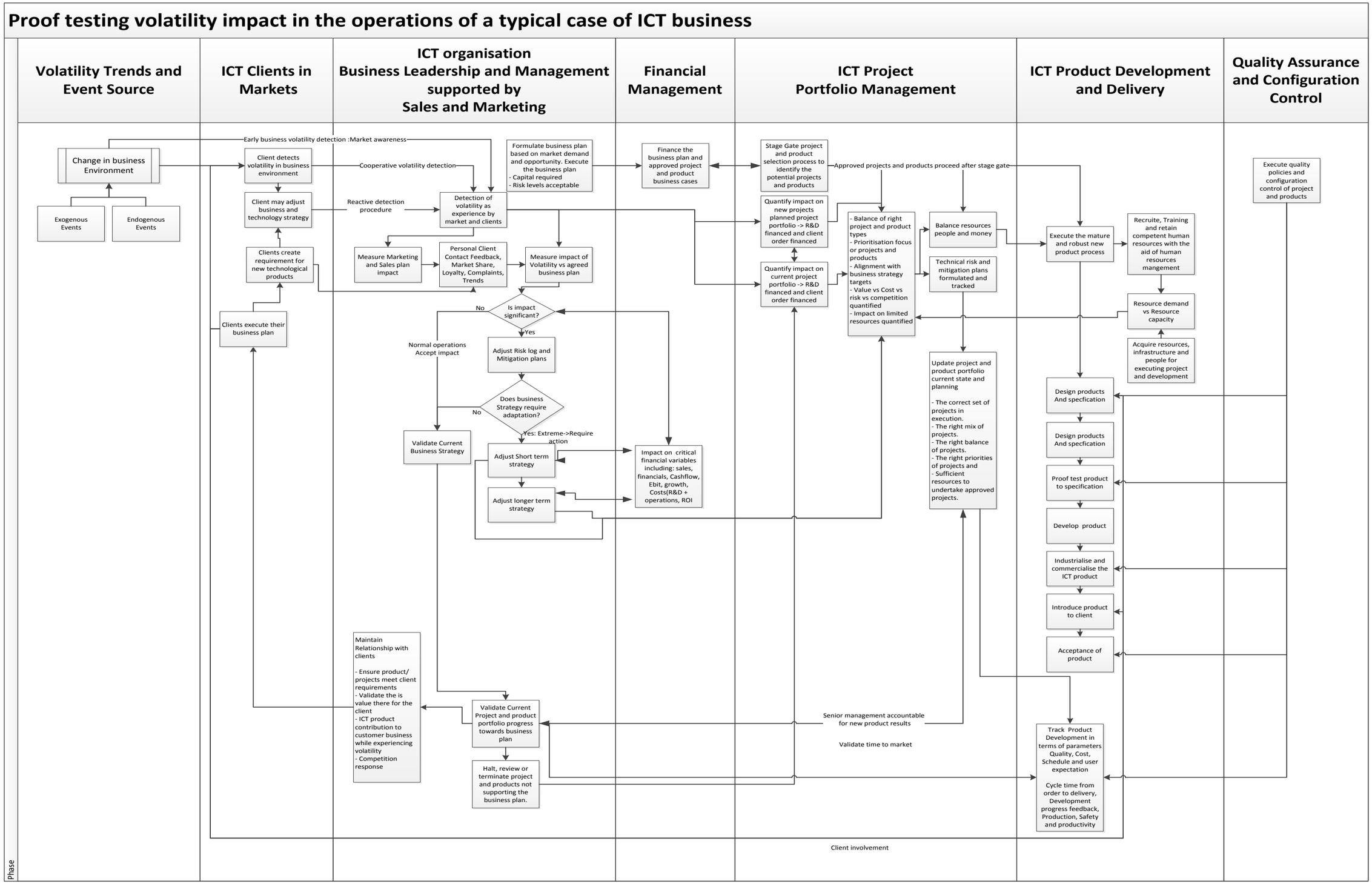

Figure 21: Volatility impact in a model in a typical IT business

As can be seen from Figure 21 there are six roles in the model contributing in the IT business process execution cycle:

- IT clients in markets serviced by the IT industry;
- IT organisational business leadership supported by sales and marketing personnel;
- Financial management that support the business leadership;
- IT project portfolio management;
- IT product development and delivery personnel;
- Quality control and configuration control.

The relationships between the elements proposed theories are embedded in the proposed systems diagram of a business cycle in Figure 21. The horizontal lines crossing the different stakeholder borders as depicted in the systems diagram align with the research questions.

It is foreseen that the questionnaire questions include a level of relevance to the listed business cycle and specifically the crossing points on the areas of responsibility. As a result the study seeks to understand where the business environment volatility has an impact.

To validate some of the constructs in use in the proposed theories it is proposed to formulate hypothesis tests around the key relationships between the elements and predictions in the theories. The elements, relationships and predictions as proposed will also be tested in the research by means of the research questionnaire feedback to test the hypothesis acceptance.

3.3.1.1 The deducted theory of new research hypothesis:

The control of technology and technology-driven decisions are shifting out of the hands of IT organisations. These new forces that are not easily controlled by IT are pushing themselves to the forefront of IT spending. Cearly & Claunch (2012) highlight the top ten strategic technology trends in Figure 19 that have the potential to affect business individuals, businesses and IT organisations. These technology trends occur currently irrespective of volatile business conditions and influence the business strategy as well as supporting IT projects and product development strategies . Some of these trends will radically change the *status quo* in terms of current technology, IT processes or business processes resulting in significant cost and disruption.

Research Hypothesis A

- **H1**: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.

Hypothesis A also relates to the research question: **Research question 1: "**How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology?**"** The

hypothesis focuses on the impact of changes required in response to volatile business conditions internally in the business?"

According to Cooper (2001) the following should be done when presenting a new product / project concept to the customer:

- The customer's interest in the product should be measured.
- Facets of the concept that the customer likes and dislikes should be measured.
- How the customer rates your product against the competition should be measured.
- What the customer expects to pay needs to be ascertained.
- The customer's purchase intent at a specific price needs to be determined.
- Information useful in finalising the positioning strategy should be gathered.

As volatile conditions increase customers may respond differently as their available funds and priorities change. Reviewing the above factors as listed by Cooper (2001) the following questions arise:

- Whether customers will show interest in the product?
- The customer may require different performance from the product (less expensive product with fewer features?).
- Which product features are more important as perceived by the client?
- The customer purchase intent may reduce or increase and the right price should be determined.

Positioning the product in the right markets, at the right price may prove more important when volatile conditions are present.

Hypothesis B relates to the research question 2 since it focuses on the IT client response to volatility shock and IT organisation interaction during business environment volatility: **Research question 2:"** What impact does the resulting client response because of volatility shock have on an IT business project portfolio and new product development?"

Research Hypothesis B

H1: The three elements of a clear understanding of:

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** with IT business IT projects and supporting product development growth.

The basic question of being more customer-centric during volatile periods may assist business realisation. The cost of failure of IT products and services acquisition may be especially higher

during exogenous volatile conditions since success is critically required with every new project execution.

Hypothesis B relates to the research question 2 since it focuses on the IT client's response to business environment volatility.

Song and Swink (2009) published research in the alignment of new product development (NPD) and marketing-manufacturing integration(MMI) and specifically the commercialisation of NPD. According to Gerwin and Barrowman (cited in Song and Swink), Griffen and Hauser(cited in Song and Swink) best practise in new product development dictates cross functional teams integrate knowledge into new products lead to more successful products. Conflicts of different objectives of stakeholders are thus being avoided. This research should attempt to understand where in the NPD processes stakeholders should feed information about volatility.

Cooper and Edgett (2006) suggest that picking the right portfolio of projects is paramount to maximising new product development (NPD). They identified several best practices to aid in the improvement of project portfolio management. These best practices include the view of building periodic portfolio reviews to rank projects, ensuring that the business has

- the correct set of projects in execution,
- the right mix of projects,
- the right balance of projects,
- the right priorities of projects and
- sufficient resources to undertake approved projects.

If the above factors are influenced during periods of volatility there may be a resulting impact on the new products under designs, development, manufacturing or maintenance. The product life cycle decisions may also be affected.

Research Hypothesis C

H1: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility.

(In other words, business strategic and technical innovation decisions are more reliant on market intelligence including client requirements when volatility is present in the business environment.)

Hypothesis C relates to the research questions since it focuses on the IT client's response to business volatility: **Research questions 3:** "Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms?"

From the theory as indicated by Grant (cited in Wu & Lin p.76) businesses should differentiate between short-term actions versus longer term clear direction. It can be suggested that a business should be able to detect client requirement changes as a result of volatility and use the most accurate information as possible to implement changes. The amount of change is debatable when businesses have business and technological project / product strategies already defined.

Research Hypothesis D

> **H1**: There is a **positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

(In other words, volatility improves the technology strategy as changes in project and products need to be calculated and not done without substance)

Hypothesis D relates to the research question 4 since it firstly assesses the volatile business conditions and secondly responds via decision making with the information known. **Research question 4:**" What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?"

Hypothesis D also relates to the research question: "**Research question 2:** What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development? "
The hypothesis does not only focus on the assessment of the volatile business conditions but also uses the information for decision making.

Aizeman and Pinto (2005) suggest that economic volatility is more than the study of business cycles and the composition of economic growth in cyclical and trend components. They suggest **volatility** is allied to risk in that it provides a measure of the variation or movement of a particular economic variable or some function of the variable. Higher volatility has through a growing body of research become more associated with lower rates of economic growth. However, Porter (1998) does suggest that an upgrading economy demands steadily rising levels of technology. Porter (1998) further concludes that technological change in the broadest sense accounts for much of economic growth. It may be concluded that the increased rate of change as a result of volatility can induce growth and change of technology innovation strategy in businesses.

Research Hypothesis E

- **H1**: New high technology product development selection is **more dependent** on project portfolio selection during periods of volatility.

  (In other words, choice of what product to develop is more critical during periods of volatility as the right projects should be selected.)

Hypothesis E relates to the research question: **Research question 5:** "How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?"

The hypothesis focuses on the relationship between project portfolio selection and new product development and secondly on the impact of changes required in response to the volatile business conditions internally in the business.

Hypothesis E also relates in lesser extent to the research question: "Research question 6 and 7: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do they balance their order and delivery books?" The hypothesis also impacts capacity planning in the organisation. It has relevance to research question 4, which also relates to capacity planning in the organisation.
The hypothesis focuses on the impact of changes required in response to volatile business conditions internally in the business.

Cooper and Edgett (2001) indicate five goals of project and product portfolio management:

- Maximise the value of the portfolio via selecting new product projects so as to maximise the sum of the values or commercial worth of all active projects supporting a business objective.
- Seek balance in the portfolio in parameters of short- versus long-term projects, high versus low risk, markets, technologies, product categories, project types.
- The portfolio must be strategically aligned and spending across projects areas, markets *et cetera* must mirror strategic objectives.
- Pick the right number of projects with the limited resources available.
- Ensure the revenue (or profit) goals set out in the product innovation strategy is achievable given the projects currently underway.

Dedee and Vorhies (cited in Wu & Lin p.76) argue that when a downturn arrives, business executives rush to make across-the-board cuts in everything from R&D spending to employee headcounts. When signs of recovery appear, businesses turn on the spending to rebuild their strategic orientation. Although these approaches seem reasonable, they can damage long-term

competitive positions and corporate performance. In times of volatility it may be concluded that businesses focus to get more value but still not exceed organisational and supplier capabilities.

Research Hypothesis F

- **H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment,
  (In other words, whether positive or negative in level, project portfolio changes are stronger related to capacity planning during periods of volatility)

Hypothesis F also relates to the research question: **Research question 6:** "How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions?"

Cooper and Kleinschmidt (2007:6) investigated the critical factors in product development that drive performance at business unit level. They found nine factors which distinguished better performing businesses:

- A high quality new product process;
- A defined new product strategy for the business unit;
- Adequate resources of people and money;
- Research and development spending for new product development;
- High quality new product project teams;
- Senior management committed to and involved in new products;
- An innovative climate and culture;
- The use of cross functional project teams;
- Senior management accountability for new product results.

Businesses can implement these changes to improve performance. In times of volatility this may prove challenging since the business needs to delivery products to clients whilst implementing changes.

Research Hypothesis G

- **H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.
  Hypothesis G also relates to the research question: **Research question 7:** "How do IT businesses balance the order and delivery books during periods of volatility?"

The hypothesis impacts on the balancing of internal organisational capacity with external client requirements. The impact of volatile business conditions on the level capacity planning process in the business is of specific concern.

The research hypothesis being based on deductions of the research construct propositions should be aligned to the research questions and practical IT model business cycle impacts. See hypothesis and associations of research variables in Figure 22. The research questions and the research hypothesis will be tested for acceptance to see if it holds value in practice.

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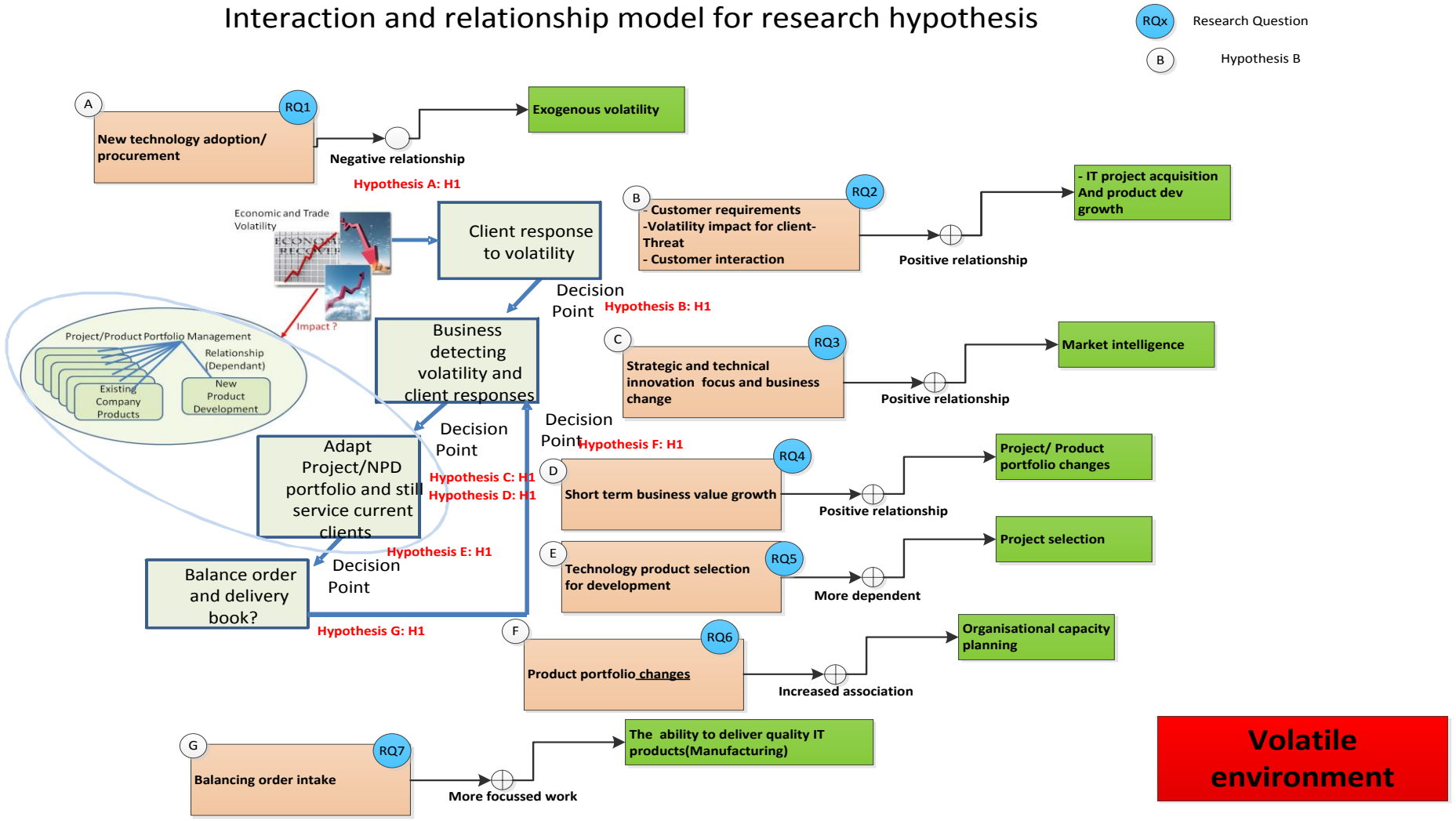

Figure 22: Overall diagram understand the link of research questions vs. research hypotheses vs. original impact model.

3.4 CONCLUSION

The basic approach for the research process has progressed in this chapter as per Figure 23:

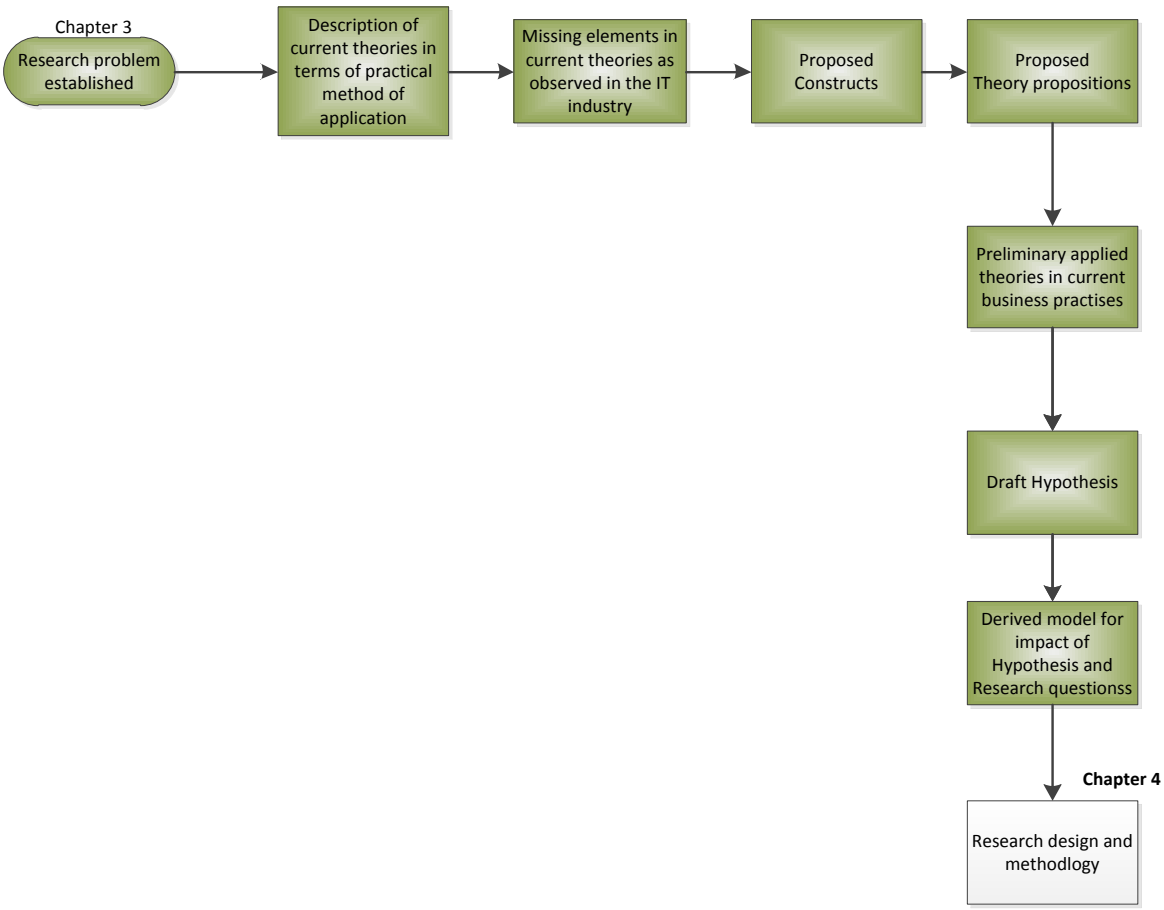

Figure 23: Research concept and process progress

The application of current theories around volatility has been applied to the IT industry practices and it was concluded that the IT industry may be prone to similar forces, requirements and practices as in other service and product industries.

Missing concepts as perceived to be present in the IT industry have been highlighted with subsequent constructs being formed for the research.

Four theories were derived including:

Theory 1: **Changing consumer behaviour amidst volatility**

Theory 2: **Volatility impact on project / product development**

Theory 3: **Risk and impact of volatile conditions**

Theory 4: **Volatility and new technological products in the IT market or industry**

The elements and relationships between the four theories were applied in a typical high level IT business execution process model to see if they are of practical value. The model serves as input for the research hypothesis. See Figure 22 for details.

.

The research questions have been specifically linked to the hypothesis and to the operational model as reported during action research and feedback from IT industry participants.

Seven hypothesis statements are proposed and need to be tested with practical feedback from the IT industry practitioners to see if they are accepted or rejected.

The hypothesis statements are linked to the research questions in section 3.3.1.1.

In conclusion the research should address a key aspect as highlighted by Navarro (2009),

“Recession teaches businesses to be prepared even during the good times, because a recession is like a battle - When you are in it, it is almost too late start training for it; if you are no prepared for it, you will pay for it!”

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4. CHAPTER IV - RESEARCH DESIGN AND METHODOLOGY

4.1 THE TYPE OF RESEARCH

The research type conforms to exploratory, hypothesis testing as well as theory testing focussed research (Page & Meyer, 2006).

- From an exploratory research type the research seeks a measure of association between volatility and project portfolio as well as new product development. The research problem contains several association estimation questions. The research hypothesis is still broad but “hunches” may be possible based on practical feedback from knowledgeable and contributing business and technology managers in the IT industry. This research project is aimed identify the patterns or themes and creating hypotheses to be tested as well as building theory and refining the research hypotheses during the process.
- From a hypothesis-testing perspective, statistical techniques were used to test whether research findings do or do not, support the seven predictions arising from the theory at a statistically significant level. The hypothesis testing assisted in formulating theory to clearly relate the impact of volatile business conditions with project portfolio management and new product development.

RQ1 RQ2 = Research questions 1 and 2
How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response because of volatility shock have on IT business project portfolios and new product development?

RQ3 RQ4 = Research question 3 and 4
Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?

RQ5 = Research question 5
How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?

RQ6 RQ7 = Research question 6 and 7
How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions?
How do IT businesses balance the order and delivery books during periods of volatility?

A consistency matrix is used to indicate the relationship between research problems, research questions, hypotheses and structure of data collection in Table 19:

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Research Consistency Matrix					
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Source of research data**	**Type of Data**	**Type of analysis on data**
The market demanding new technology and subsequent client responses to volatility require **clients to change their adoption/procurement of technology during negative periods.**	Cearly & Claunch (2012)	**Research Hypothesis A in relation to RQ1** **H1**: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.	Questionnaire: Structured and unstructured questions.	Ordinal + Likert	Quantitative + Qualitative • Numerical • Descriptive analysis • Hypothesis testing
IT clients in the formal corporate sector are also in the same business environment as IT businesses and **they experience the same shocks** as a result of volatility. They, change their short-and long-term business strategies as well as requirements for IT systems, products and services. Projects may be	Cooper 2001 Navarro (2009)	**Research Hypothesis B in relation to RQ2** **H1**: The three elements of a clear understanding of: • customer requirements; • customer operational impact as a result volatility as well as • one-on-one customer interaction activities have a **positive association** with IT	Questionnaire: Structured and unstructured questions	Ordinal + Likert	Quantitative + Qualitative • Numerical • Descriptive analysis • Hypothesis testing

Research Consistency Matrix					
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Source of research data**	**Type of Data**	**Type of analysis on data**
halted as a result of budget constraints and ROI required with available IT funding.		business IT projects and supporting product development growth.			
The IT business adapts its business strategy to adopt for the changing economic and trade conditions. Although businesses attempt to understand their industry and technology products they can potentially not have sufficient **detection mechanisms** for volatile conditions and respond too late with too little!	Grant (cited in Wu & Lin p.76) Nocco and Stulz (2006) Weeks (2009) Burton et al (2009)	**Research Hypothesis C in relation to RQ3** **H1**: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility	Questionnaire: Structured and unstructured questions	Nominal + Ordinal + Likert	Quantitative + Qualitative • Numerical • Descriptive analysis • Hypothesis testing
When business strategy changes it impacts the project and product portfolio selection. Changes in the output of	Aizeman and Pinto (2005) Porter (1998) Ulrich and Eppinger (2008)	**Research Hypothesis D in relation to RQ4** **H1**: There is a **positive association** between business	Questionnaire: Structured and unstructured questions	Ordinal	Quantitative + Qualitative • Numerical • Descriptive analysis

Research Consistency Matrix					
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Source of research data**	**Type of Data**	**Type of analysis on data**
new product conceptualisation, design, development, production and delivery processes will be required in response to changes in project/production portfolio selection. The changed project/product portfolio should be done whilst business operations are being executed. Thus businesses **need to change and still get current products to clients**. The transitional change state requires detailed planning for internal process changes and remains risky.		value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.			• Hypothesis testing
Businesses do struggle to	Cooper and	**Research Hypothesis E in**	Questionnaire:	Ordinal + Nominal	Quantitative +

Research Consistency Matrix					
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Source of research data**	**Type of Data**	**Type of analysis on data**
cope with **project changes** as a result of volatility while executing current business operations.	Edgett (2006) Le (2004)	**relation to RQ5** **H1**: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility.	Structured and unstructured questions		Qualitative • Numerical • Descriptive analysis • Hypothesis testing
The selection of **products** that must be built for **project** deliveries to clients while the business environment is changing as a result of volatility leads to uncertainties in the business and technology strategy.	Cooper and Kleinschmidt (2007:6) Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43) Navarro (2009)	**Research Hypothesis F in relation to RQ6** **H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment	Questionnaire: Structured and unstructured questions	Ordinal + Nominal	Quantitative + Qualitative • Numerical • Descriptive analysis • Hypothesis testing
In high technology product/project environments products	Cooper and Edgett (2001) Cooper and	**Research Hypothesis G in relation to RQ7**	Questionnaire: Structured and unstructured	Ordinal + Nominal	Quantitative + Qualitative • Numerical

Research Consistency Matrix					
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Source of research data**	**Type of Data**	**Type of analysis on data**
may already be ordered before they exist. The IT business orders will be affected by changing economic conditions and this means the business needs to adapt their resource allocation and utilisation. **Balancing the product/project order book with the limited organisational resources is a constant risk for businesses.**	Kleinschmidt (2007:6)	**H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.	questions		• Descriptive analysis • Hypothesis testing

Table 19: Consistency matrix table

The aim is to add to the body of knowledge by means of accepting or rejecting the hypothesis being tested.

- From a **theory testing** type of research viewpoint the research is critically assessing theory and best practices in use by business and concluding if these theories are accepted or rejected. The theory available currently is more broad- product development area focused and does not clearly depict the relationship between volatility and IT project portfolio management/new product development. As previously noted there is, however, some level of commonality between practices used in the IT industry and other service related industries. However, some changing economic and volatile conditions may create changes in business strategy, project portfolio management and new product development. The responses from businesses are connected in a logical way to sustain business operations. We wish to understand "Why" in the assertion of the hypothesis. It is foreseen that some comparative work needs to be performed to validate output from the existing theory with the practical responses from business. The key focus is, however, the formulation of new theory based on feedback from the IT industry as well as accepting the hypothesis with substantiated data. The feedback can assist in answering the "Why" of a relationship/no relationship is observed between the elements of the theory.
- Since the study will also evaluate previous research's impact in the IT industry practice for example, the applicability of resiliency management (Weeks, 2009) and pattern-based management (Burton et al, 2009). A **level of extension study** is present. The testing of the research questions in section 3.2.2 and acceptance/rejection of the hypothesis statements with data gathered from the IT industry will, however, extend the results to be more IT industry tested and turned practically for use age in actual business processes.

It is foreseen that the research falls within the **management research domain** (Page and Meyer, 2006) since the optimisation of business and behaviour of people for greater efficiency, effectiveness and productivity do form part of the research. The research also touches on **business research** since the research does measure the performance impact of volatility and response to the volatility. A challenge is that the research is not focused on one organisation specifically but on industry or IT organisations, but focused to a large extent on internal operations but sensitive to client input as a result of volatility. From a consumer perspective of IT the study needs to include several industry consumers of IT spanning several types of industries.

As the research impacts on several functional departments in IT organisations there may be more costs associated with implementing the research findings. **These findings will be identified for further research. IT organisations should, however, measure the clear business value derived from the cost of changed strategy, functions, people and processes**.

4.2 PROPOSED APPROACH FOR PERFORMING THE RESEARCH AND RESULTING MILESTONES

The initial research objective includes a review of literature in the following key areas:

- Volatility conditions
- Project management
- New product development
- IT industry

The literature review provides a base for forming firstly research questions. Research variables are derived and these research variables' data is collected from the IT industry by means of structured (quantitative) and unstructured questions (qualitative) feedback. The questionnaires are used for empirical field work.

Once the literature and field data have been collated, cleaned and analysed, answers are sought for the research questions posed in section 1.2.1. Page and Meyer (2006) suggest that the research should be focused more narrowly on important research questions to accommodate planned research time tables and level of study.

- Milestone 1: Formulation of research proposal and acceptance for further study- Completed
    - Discussion with several business and technical managers in the field of study to understand basic problems, applied practical cases and what strategy of business applies as a result. (external to the current business)
    - Formulation of research hypothesis and research questions
- Milestone 2: Research plan and acceptance (see Figure 24)
    - Build on the research proposal with an exhaustive review of previous literature on the subject area.
    - Formulation of missing theory gap (proposed concepts), proposed constructs, proposed theories to be applied in an IT business model for the research.
    - Refinement of research hypothesis, research questions and measurable variables
    - Formulation of a structured questionnaire for quantitative data analysis as well as semi-structured interviews for qualitative insight into structured questionnaire responses.
    - First round OECD (Business for economic co-operation and development) data analysis proved unsuccessful for the South Africa context. Data from Business Monitor (2011) as well as Statistics South Africa may prove more useable when creating the questions for the questionnaire.

- Milestone 3: Research execution and acceptance of results.
    - E-mail based questionnaire for focused areas of interest, and direct telephonic interviews.
    - Data analysis and iterative testing of data with independent/dependent regression variables.
- Milestone 4: Writing of thesis and acceptance sought.
- Milestone 5: Dissemination of results and acceptance sought.

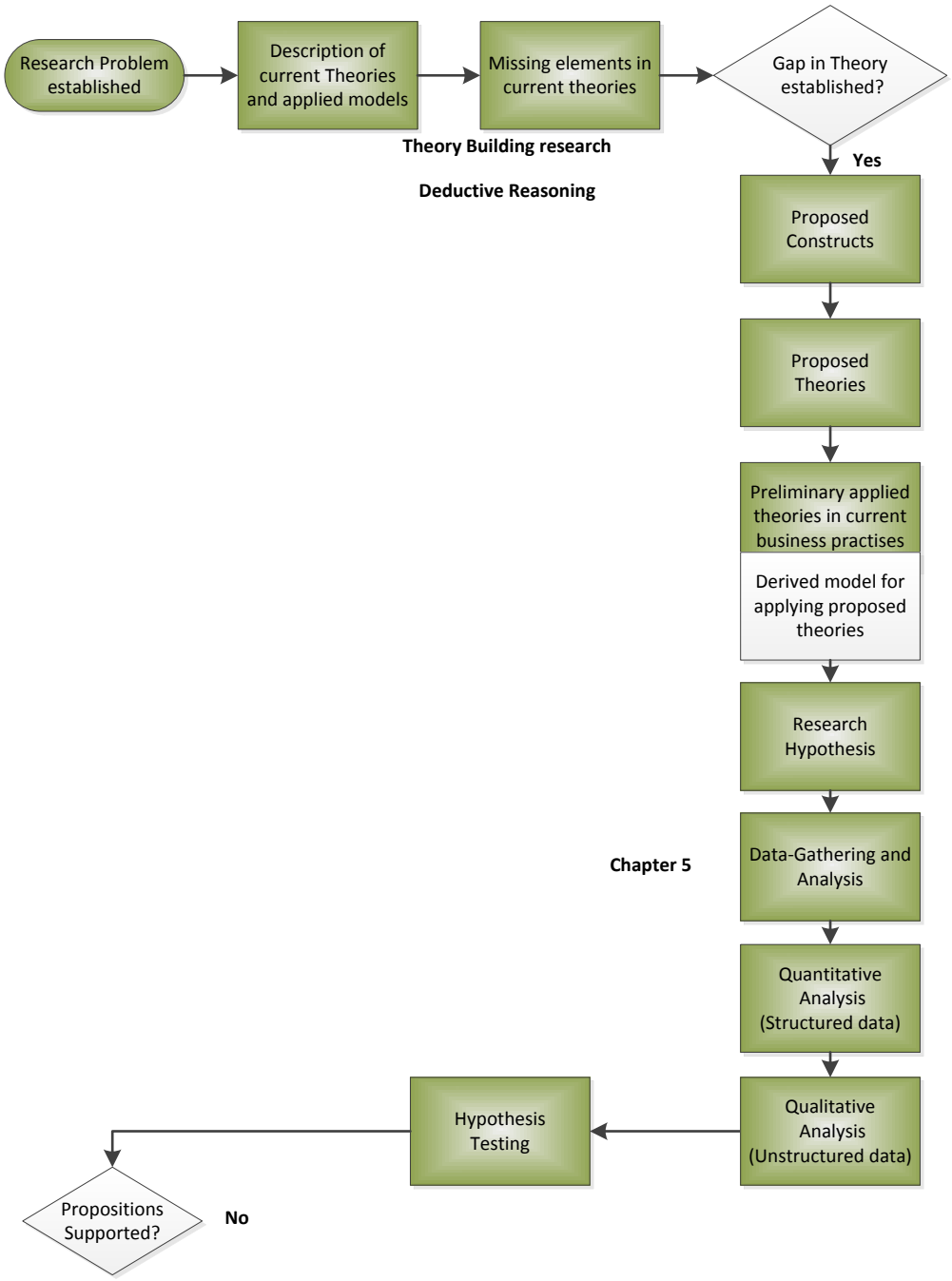

Figure 24: The research roadmap followed

4.2.1 The Design template followed for the research is based on:

- **Research Design:**
  - The planned research should result in scientific value as well as practical value for business.
- **Linkage to Theory:**
  - The study combines both exploratory research and theory building research to derive new theories' models and methods.
- **Type of study:**
  - Elements of hypothesis and exploratory research types are present in the research.
- **Data acquisition techniques to be used:**
  - Data is primarily collected from survey questionnaires with structured and unstructured commentary feedback from respondents.
- **Data analysis techniques to be used:**
  - Data classification and analysis techniques
    - Ordinal/Nominal and Likert scale data.
  - Statistical data analysis techniques including:
    - Graphical data analysis (Univariate Analysis)
    - Measures of centre and spread
    - Bivariate analysis, association tests and research hypothesis testing
    - Tests for significance
      - Chi-squared tests
  - Qualitative data analysis on more frequently occurring key words, concepts and families of data.

4.3 PROPOSED RESEARCH INSTRUMENTS, METHODS OF DATA COLLECTION AND ANALYSIS

Primary data was to be collected from -

- Interactive data collection where survey sample questionnaires were tested with sample groups leading towards:
- Non-Interactive data collection mechanisms via newly defined surveys (email and web based using commercially available online commercial business network service "www.linkedin.com").

Secondary data was collected and analysed from databases such as the Business Monitor (2011), report and Statistics South Africa. The primary data used for analysis was derived from the structured survey questionnaires and used to evaluate the research hypothesis significance.

The methods are **justified** in that they support:

- Real life events such as economic down/up turn and the experiences of business personnel should be collected via questionnaires.
- The purpose is to uncover facts, relationships and causations in a **quantitative** focus.
- Some unstructured questions will also be **qualitative** to obtain unforeseen IT industry specific factors significantly relevant to the research and not present in the initial research scope.
- Unbiased data from secondary sources which are useful for formulating questions for unstructured feedback.

It is foreseen that the interview questionnaire and survey questionnaires be designed with the following actions in mind:

- Step 1: Create the conceptual model and refine the derived model as depicted in Figure 8 into a systems model diagram.
    - Define the research problem;
    - Define the purpose of the research;
    - Define the research design;
    - Define the research variables and hypothesis;
    - Define the measures of the variables;
    - Define the intended population and plans for data analysis.
- Step 2: Produce the questionnaire.
    - Write the introduction;
    - Write the statement of informed consent;
    - Write the questions and response criteria;
    - Define the “look and feel format”.
- Step 3: Pre-test the questionnaire with a small group of respondents.

The questionnaires included both structured and unstructured questions. The unstructured questions were purely included for perception-based measurements to obtain unforeseen IT industry specific factors significantly relevant to the research and not present in the initial research scope.

Research Population:

The businesses selected to participate in the questionnaire were either IT suppliers or IT consumers with a typical portfolio of technology products for local and international markets. The

business selection was not limited to a specific geographical area in South Africa but rather attempted to include multiple business sector participation for example banking/financial sector vs. mining sector vs. IT consulting (part of IT industry).
The research problems analysed are scientifically and practically actual around the world. The research results are likely to be of use for other country IT businesses as well since IT products tend to be global in nature.

The structure of the questionnaire was aligned to the research questions which support research variables which in turn supported research hypothesis. The proposed questionnaire used for the survey can be found in Annexure A.

4.3.1 Proposed research variables in support of the research questions:

The research questions are listed again:

- **RQ1/RQ2: Research questions 1/2:** How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolios and new product development?
- **RQ3/RQ4: Research questions 3/4:** Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?
- **RQ5: Research question 5**: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions?
- **RQ6/RQ7: Research questions 6/7:** How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility? How do IT businesses balance the order and delivery books during periods of volatility?

The research hypotheses are listed again:
See section 3.3.1.1 for a detail description on how the hypotheses support the research questions.

- **Research Hypothesis A in relation to RQ1**
  H1: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.
- **Research Hypothesis B in relation to RQ2**

H1: The three elements of a clear understanding of

- customer requirements
- customer operational impact as a result of volatility as well as
- one-on-one customer interaction activities

have a **positive association** with IT business IT projects and supporting product development growth.

- **Research Hypothesis C in relation to RQ3**

  H1: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility

- **Research Hypothesis D in relation to RQ4**

  H1: There is a **positive association** between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

- **Research Hypothesis E in relation to RQ5**

  H1: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility.

  The "ability to deliver products to clients" is regarded as a moderating variable as it influences the projects chosen by the IT business for execution as well as the eventual products being developed. The moderating variable takes the form of an indicator variable (1="no", 2="yes")

- **Research Hypothesis F in relation to RQ6**

  H1: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment

- **Research Hypothesis G in relation to RQ7**

  H1: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

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Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
1 Q1	ExogVolatility	**Exogenous volatility** derives from sources of volatility that are outside of control of both households and policy makers in the short term for example Commodity prices, interest rates and skills shortages.	Independent variable Variable Type = Ordinal 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis A Research Question 1	Do IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term? Structured question /answer feedback + General commentary area for unstructured perception feedback.
2 Q2/Q3	NewTechAdoptProca NewTechAdoptProcb	Impact on clients adopting and procuring new IT technology.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Clients adopt/ procure far fewer IT projects/products 2 = Clients adopt/ procure	Research Hypothesis A Research Question 1	a) What is the level of impact on the adoption/procurement of new IT technology in negative conducive volatile periods?

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
			somewhat fewer IT projects/products 3 = Clients adopt/ procure the same level IT projects/products 4 = Clients adopt/ procure somewhat more IT projects/products 5 = Clients adopt/ procure significantly more IT projects/products		b) What is the level of impact on the adoption/procurement of new IT technology in positive conducive volatile periods? Structured question /answer feedback + General commentary area for unstructured perception feedback.
3 Q4	CustomerReq	Level of impact of understanding customer requirements during periods of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does a clearer understanding of customer requirements during periods of volatility assist in growing project portfolio and supporting product development? Structured question

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					/answer feedback + General commentary area for unstructured perception feedback. List and discuss what techniques are used to obtain customer requirements.
4 Q5	CustomerOpImpact	Level of the impact of volatility on customer operations.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does an understanding of the impact of volatility on customer operations assist in growing an IT business project portfolio and supporting product development? Structured question /answer feedback + General commentary area for unstructured perception feedback.

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					List and discuss what type of operational impact do customers experience as a result of volatility?
5 Q6	CustomerIntAct	Level of the impact of one-on-one customer interaction assists growth of an IT project and supporting product development.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does one-on-one interaction with clients during periods of volatility assist in growing project portfolio and supporting product development? Structured question /answer feedback + General commentary area for unstructured perception feedback.
6 Q7	ITProjProdGrowth	Business IT project and product development levels.	Dependent variable Variable Type = Ordinal Structured scale:	Research Hypothesis B Research Question 2	Has client response to volatility impacted IT business project

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
			1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact		development and supporting product development? Structured question /answer feedback + General commentary area for unstructured perception feedback.
7 Q8	CustomerReq_ CustomerOpImpact_ CustomerIntAct_VS_ ITProjProdGrowth	The collective impact of an understanding of customer requirements, impact of volatility on customer operations and one-on-one interaction have on growth of an IT project and supporting product development.	Variable Type = Likert scale variable: Association perception views from respondents. Structured scale: 1 = Strongly disagree 2 = Disagree somewhat 3 = Neutral 4 = Agree somewhat 5 = Strongly disagree	Research Hypothesis B Research Question 2	Does the combined impact of an understanding of customer requirements, the impact of volatility on customer operations and one-on-one interaction have a more positive affect on growing an IT project and supporting product development during the presence of volatility?

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					Structured question /answer feedback + General commentary area for unstructured perception feedback.
8 Q9	BusStratChange	Change level in IT business for period of volatility. Retain focus on business objectives vs. short term/longer term survival.	Dependent variable Variable type = Nominal 1 = Shorter Term IT changes 2 = Longer term IT planning 3 = Both short and longer term changes 4 = Remain with original IT planning in support of business changes irrespective of short and longer term.	Research Hypothesis C Research Questions 3	Does IT Business gather market intelligence for shorter or longer term strategy changes during periods of volatility? Structured question /answer feedback + General commentary area for unstructured perception feedback. List techniques used to gather market

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					intelligence about clients that leads to IT business strategy changes.
9 Q10	MarketIntel	Determine level of increase of market intelligence during periods of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Increase 2 = Low increase 3 = Medium increase 4 = High Increase 5 = Very High Increase	Research Hypothesis C Research Question 3	Do businesses increase their collection of market intelligence during periods of volatility? Structured question /answer feedback + General commentary area for unstructured perception feedback.
10 Q11	BusStratChange_vs_ MarketIntel	Level of agreement as to changes in IT business strategy as a result of volatile business environment.	Variable Type = Likert scale variable: Association perception views from respondents. Structured scale: 1 = Strongly disagree	Research Hypothesis C Research Question 3	Do businesses adapt their IT business /IT strategy during periods of volatility based on market intelligence for short term benefit?

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
			2 = Disagree somewhat 3 = Neutral 4 = Agree somewhat 5 = Strongly disagree		Structured question /answer feedback + General commentary area for unstructured perception feedback.
11 Q12	ShortLongStratDef	Level of change in IT businesses in short-term technology strategy to induce business value growth as a result of using market intelligence of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Changes 2 = Minimal Changes 3 = Medium Changes 4 = High amount of changes 5 = Very High levels of changes	Research Hypothesis D Research Question 4	To what extent do IT businesses adapt their short term technology strategy as a result of using market intelligence on volatility? Structured question /answer feedback + General commentary area for unstructured perception feedback.
12 Q13	ProjectProductExecChange	Level of increase in project and product portfolio adaptations as a result of IT changes in business	Dependent variable Variable Type = Ordinal Structured scale: 1 = No Changes	Research Hypothesis D Research Question 4	When the IT business/technology strategy is adapted for volatile reasons, are

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
		strategy/ technology strategy for volatility.	2 = Minimal Changes 3 = Medium Changes 4=High amount of changes 5 = Very High levels of changes		major adaptations required in the project portfolio and supporting product development? Structured question /answer feedback + General commentary area for unstructured perception feedback.
13 Q14	ShortLongStratDef_vs_ ProjectProductExecChange	Level of impact of short-term technology strategy definition on project/product portfolio changes during periods of volatility.	Variable Type = Ordinal Association perception views from respondents Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis D Research Question 4	What is the resulting impact these market intelligence mechanisms have on technology strategy (in terms of project and product development in the short vs. longer term)? Structured question

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					/answer feedback + General commentary area for unstructured perception feedback.
14 Q15	HighTechProdSelect	New high technology product selection impact for development during volatile periods.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis E Research Question 5	Is the selection of sellable products to be developed by IT business of more importance during volatile periods? Structured question /answer feedback + General commentary area for unstructured perception feedback.
15 Q16	ProjectPortfSlect	New high technology project selection impact from clients for execution during volatile periods	Independent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance	Research Hypothesis E Research Question 5	Is the selection of projects for the IT business as offered by clients to execute of more importance during

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
			3 = Medium Importance 4 = High Importance 5 = Very High Importance		volatile periods than non-volatile periods? Structured question /answer feedback + General commentary area for unstructured perception feedback.
16 Q17	AbiliDeliverProdClient	Importance of an IT business having the organisational capacity (people, infrastructure, financial resources) and technology to deliver contracted products/services taken on for delivery.	Moderating Variable Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis E Research Question 5	Do IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects? Structured question /answer feedback + General commentary area for unstructured perception feedback.

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
17 Q18	HighTechProdSelect_vs_ ProjectPortfSlect	Importance of the right product portfolio selection during periods of volatility.	Association perception views from respondents Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis E Research Question 5	Is the formulation of the right product portfolio in support of potential projects to clients more critical during periods of volatility than in periods of less volatility? Structured question /answer feedback + General commentary area for unstructured perception feedback. List mechanisms used by IT businesses to adapt project/product portfolio changes in scope/timing/features and still maintain the ability to deliver projects to clients.

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					Do IT businesses succeed in their ability to deliver projects on time, with agreed scope and budget during periods of volatility?
18 Q19	ProdProjChanges	Impact of project changes on product development	Independent variable Variable Type = Ordinal Structured scale: 1 = No Risk 2 = Low Risk 3 = Medium Risk 4 = High Risk 5 = Very High Risk	Research Hypothesis f Research Question 6	Is their increased risk in product development as a result of changes in project execution for clients when volatility is present? Structured question /answer feedback + General commentary area for unstructured perception feedback. List mechanisms used by IT business's to

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					balance project and product development.
19 Q20	CapacityPlanDelivery	Importance of capacity planning for project execution during volatile periods.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis f Research Question 6	Do IT businesses increase focus in capacity planning for project execution during volatile periods? Structured question /answer feedback + General commentary area for unstructured perception feedback. List common mechanisms used for project capacity planning in an IT business.
20 Q21	ProdProjChanges_vs_ CapacityPlanDelivery	Is there increased focus in capacity planning and product portfolio changes to	Association perception views from respondents	Research Hypothesis for Research Question 6	Is there an increased focus in capacity planning and product

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
		support project execution during periods of volatility?	Variable Type = Nominal Structured scale: 1 = No 2 = Yes		portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility? Structured question /answer feedback + General commentary area for unstructured perception feedback.
21 Q22	OrderIntake	Level of importance of focus on the order book for IT businesses.	Independent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis G Research Question 7	How important is it for an IT business to increase focus on their order book as a result of volatility? Structured question /answer feedback + General commentary

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					area for unstructured perception feedback.
22 Q23	BalanceAblilityDelivery	Level of importance of focus delivery of projects for IT businesses.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis G Research Question 7	Do IT businesses increase focus on delivery of projects successfully as a result of volatility? Structured question /answer feedback + General commentary area for unstructured perception feedback.
23 Q24	OrderIntake_vs_ BalanceAblilityDelivery	Do IT businesses balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade?	Association perception views from respondents Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis G Research Question 7	Do IT businesses balance their order intake with ability to deliver focused work during periods of volatility more often than in stable periods of

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
					trade? Structured question /answer feedback + What techniques do IT business use to execute the 1) forecast of order intake ? 2) to understand available capacity in the organisation to service orders? 3) balance the order and delivery book?

Table 20: Research variable deduction

4.3.2 Data Analysis of questionnaire results

The question and associated responses in the study lend themselves to both quantitative and qualitative types of data. This is visible in the proposed questionnaire.

The **non-compulsory** qualitative data supports the exploratory theory forming but it does lend itself to be more perceptual hence it is used for qualitative analysis and only supports the quantitative purposes. **It is important to note that the qualitative data is connected to the quantitative data as it extends the structured feedback with unstructured comments. It will then of course be in support of the structured quantitative feedback and only provide reasoning or new ideas to be taken into consideration.**

Since the questionnaire was quite lengthy with 24 subject questions, all with commentary and some with a list of fields on questions, it was expected that less commentary information was provided later in the questionnaire. Questions were not presented in random order, rather sequentially to obtain a logical flow of thinking (without content guidance) from the respondent in relation to the research questions.

During hypothesis testing (Page & Meyer, 2006) tests included Chi-squared tests for discrete variables having distinct categories.

The data analysis included at least the following steps:

- Coding of data for each research variable.
- Capturing of data in Microsoft Excel® spread sheets or web sites. Porting of the data from web collection platforms to Excel® for data analysis.
- Definition of the measurement scale for each variable.
- Checking of data and correction of errors (unbiased).
- Descriptive Statistics:
    - Univariate tests;
        - Graphical analysis;
        - Measures of centre and spread.
    - Bivariate tests;
        - Graphical and tabular analysis;
        - Measures of association;
        - Hypothesis testing;
        - Tests for significance.
- Qualitative data analysis including coding of data, families of data and inductive counting of most prominent concepts in data. The inductive approach as indicated by Thomas (2003) is used to count and summarise predominant concepts/key words.

- Qualitative data in support or rejection of quantitative findings.

The comprehensive statistical data analysis capability Microsoft Excel® 2010® and advanced analysis capabilities of Palisade Stattools were used for:

- Statistical Analysis including numerical data analysis.
- Classification and association analysis for quantitative data.
- Hypothesis testing of quantitative data.

The capability for data analysis in Microsoft Excel® was cross-checked with Stattools® and in some cases the Stattools® p-value Hypothesis test results were used as end product. Chi-Squared values correlated between Microsoft Excel® and Stattools® to ensure calculation accuracy.

Bivariate Data Analysis was based on constructing a data matrix worksheet in Microsoft Excel®. Each research variable occupied one column and every questionnaire feedback provided one row of data for the worksheet (a primary document). Only data was captured that conformed to the pre-defined data coding standard.

Textual data as provided in the list of tools and mechanisms were recorded and analysed using a qualitative tool Atlas.ti®.

As depicted in Figure 25 the tool supports the locating, coding and annotation of findings in primary data material collected. The findings of the data are weighted, evaluated for importance and relevance to the research questions. Complex relationships were visualised between the findings in the qualitative data.

Descriptive analysis for qualitative data was conducted with the qualitative tool Atlas.ti®. Inductive reasoning and counting of recurring concepts was performed to obtain views on supporting or rejecting quantitative findings.

Results of significance were listed and the research hypothesis rejected or accepted.

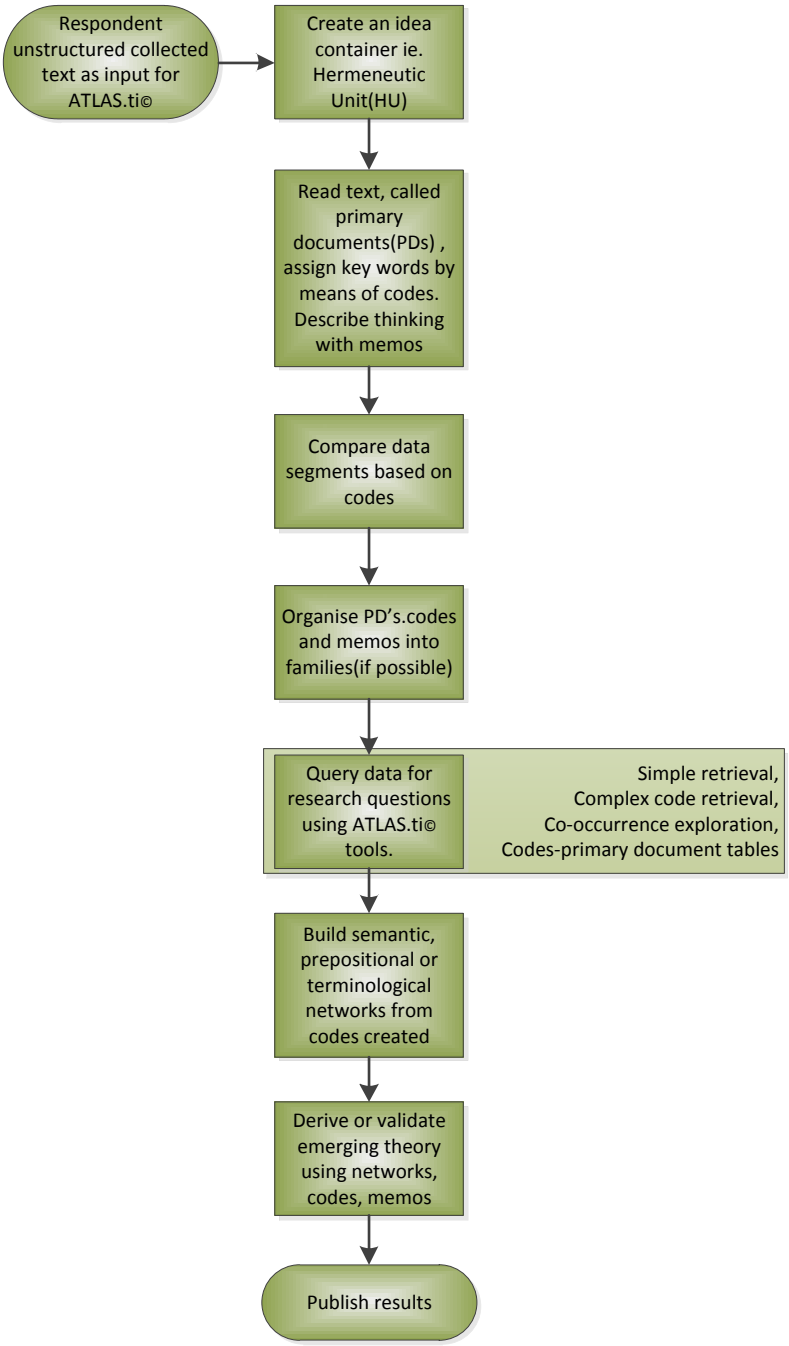

Figure 25: Altas.ti® process flow for qualitative data analysis

4.4 CONCLUSION

The research design and methodology in Chapter Four aimed to address the logical steps in Figure 26.

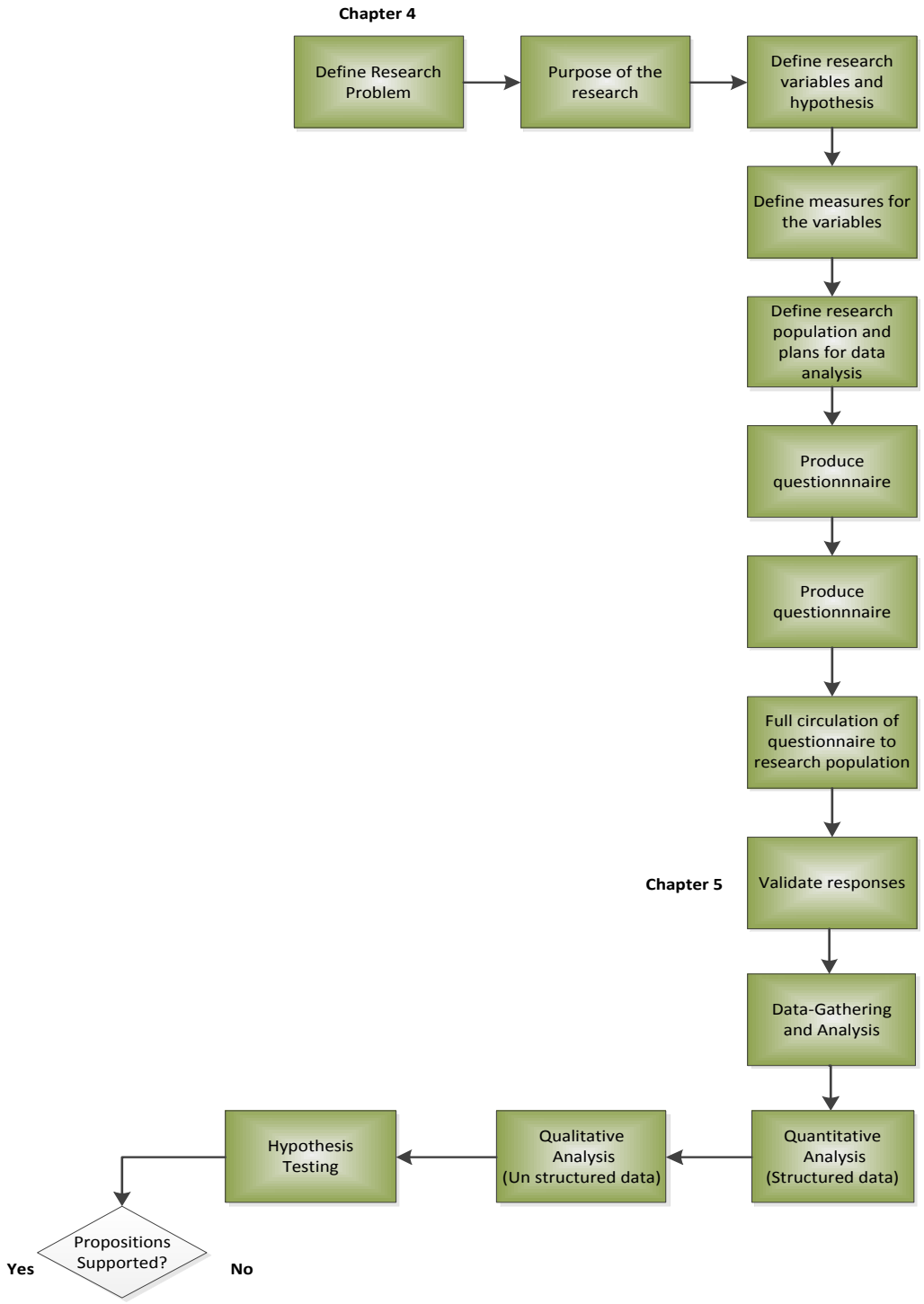

Figure 26: Research design and methodology

The derived questionnaire in Annexure A is more comprehensively structured to not only include the quantitative structured variables but also several qualitative questions to obtain lists of mechanisms used as well as opinion in general comments

As part of the research design several research variables were defined in Table 20 to clearly relate the questionnaire variables to the seven research hypotheses statements in support of the seven research questions.

Quantitative and qualitative data analysis techniques were planned to firstly analyse the structured data variables which are of ordinal and nominal type.

Secondly, the unstructured data comments were related back to the structured data findings to see if descriptive conclusions for the structured data findings could be achieved.

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5. CHAPTER V – RESULTS: DATA GATHERED AND ANALYSIS

Chapter Five focused on the collected research and analysed results. Starting off with the research population and how the data was collected, a detailed questionnaire is listed in Annexure A.

The results obtained via the questionnaire were analysed for each of the seven hypotheses in steps using both quantitative and qualitative techniques. The data was first analysed on a single variable case for each of the 24 questions in the questionnaire and then all qualitative data related to the questions for hypotheses are analysed as a unit to obtain an overall view for the hypothesis concerned.

Each of the seven hypothesis were analysed using bivariate techniques to determine visual associations in data, the strength of the association and ultimately if the Null hypothesis was accepted or rejected.

The approach followed during the data analysis is depicted in Figure 27.

Obtained results were summarised and significant results highlighted. The obtained results are compared to the research questions and related to the original research problems.

For ease of relating the research analysis to the hypotheses, a section reference is listed in Table 21

Hypothesis	Questionnaire questions	Qualitative Univariate analysis section reference	Qualitative analysis section reference	Bivariate analysis section
A	1 2 3	5.2.1.1 5.2.1.2 5.2.1.3	5.2.1.4	5.3
B	4 5 6 7 8	5.2.2.1 5.2.2.2 5.2.2.3 5.2.2.4 5.2.2.5	5.2.2.6	5.3.2
C	9 10 11	5.2.3.1 5.2.3.2 5.2.3.3	5.2.3.4	5.3.3

Hypothesis	Questionnaire questions	Qualitative Univariate analysis section reference	Qualitative analysis section reference	Bivariate analysis section
D	12 13 14	5.2.4.1 5.2.4.2 5.2.4.3	5.2.4.4	5.3.4
E	15 16 17 18	5.2.5.1 5.2.5.2 5.2.5.3 5.2.5.4	5.2.5.5	5.3.5
F	19 20 21	5.2.6.1 5.2.6.2 5.2.6.3	5.2.6.4	5.3.6
G	22 23 24	5.2.7.1 5.2.7.2 5.2.7.3	5.2.7.4	5.3.7

Table 21: Section reference table for each hypothesis

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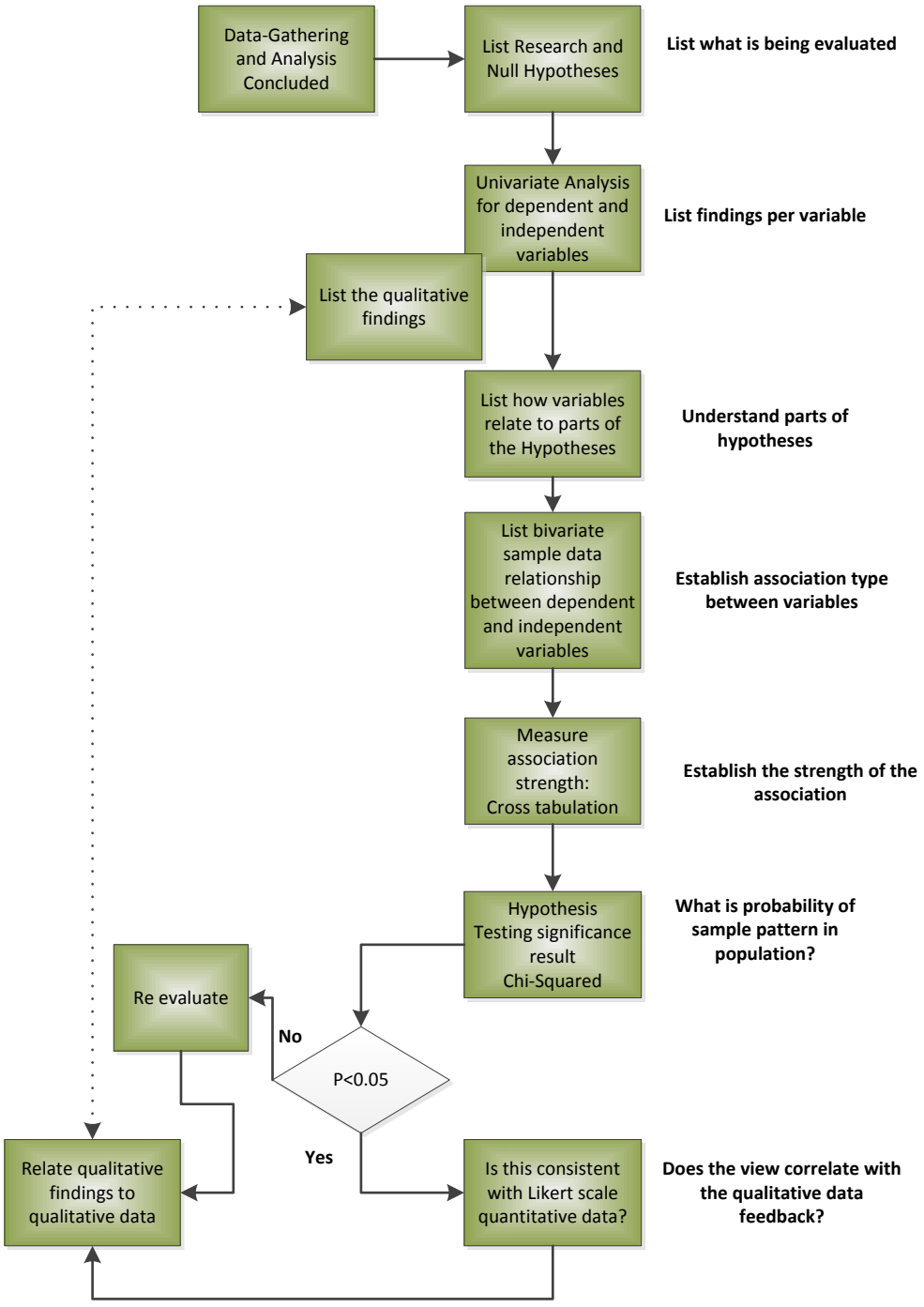

Figure 27: Process for combining analysis results to obtain hypothesis significance

5.1 OVERVIEW OF RESEARCH DATA AND INFORMATION COLLECTED

5.1.1 The research population

The research population included both consumers and creators of IT products/systems but having several years of experience in the IT industry. From a consumer focus perspective the research population needed to interact with IT product, project and services providers to create product demand for the IT industry.

A smaller group of seven respondents were requested to complete the first release of the questionnaire. This proved helpful to:

- Make the questions understandable for the target audience;
- Ensure that the research variables as used in the hypothesis support the research questions adequately;
- Create a first-level data analysis review to see if the answers make sense;
- Address security concerns for personal data of respondents.

A final questionnaire was compiled and after review published in several stages using Survey Monkey® (www.surveymonkey.com) commercial service. See Annexure A for details on the questionnaire.
During the period February 2013 until end of June 2013 a total of 1165 knowledgeable IT professionals were approached either by direct e-mail or via “LinkedIn” commercial service to participate in the study. Linkedin® (www.linkedin.com) is a globally reachable business networking web site based in California in the United States of America for professional IT members. It is mainly used for professional networking with more than 225 million users in 200 countries.

An **unsolicited** request for participation was submitted to the potential respondents to complete the questionnaire with structured and unstructured questions. The respondents were chosen at random based on having several years of applied IT experience as well as having formal IT training qualifications.

Formal settings such as conferences or training sessions where respondents might be subjected to concept discussions or training were explicitly not targeted as it might induce team association or biased answers in the answer list.

5.1.2 The collected data

As can be seen from Table 22 the questionnaire was executed in five phases with a clear cut off in respondent feedback. Since the invitations were of a completely unsolicited nature i.e. people were

targeted at random without prior information of briefing of the study, a low yield on successful feedback was expected.

			Total amount of answer sheets received	Not Useful	Useful	
Test Group			16	6	10	
Second Round			27	6	21	
Third Round			20	7	13	
Fourth Round			82	38	44	
Fifth Round			45	18	27	
	Sum		190	75	115	
Total amount of individuals targeted(Traceable record)					1165	
Percentage success on overall targeted vs eventual useful responses					9.871	%
Percentage success of "Useful" responses					60.526	%
Percentage fail of "Not Useful" responses					39.474	%

Table 22: Questionnaire target list and successful responses

A post-review was held with some of the respondents who provided uncompleted answer sheets. The main reasons for not completing some of the questions included:

- Electronic e-mail (from unknown sources) that was not accepted by the respondents since business spam and malware filters do classify mail as malware and the e-mail are blocked before reaching respondents (82% of cases).
- Questionnaire was too long i.e. too many questions to complete in one session. The Survey Monkey product does terminate user sessions of questionnaire feedback if users do not complete feedback in a limited time period.
- LinkedIn profiles were outdated and not serviced by the profile owners. This lead to e-mail being sent to un serviced or non-existing e-mail boxes.
- Personal time management challenges. Professionals may not have sufficient time to complete the questionnaire.
- Industrial espionage views from respondents limiting them to fill in the questionnaires. In some cases business regulations limit potential respondents from providing business information which could support viewpoints.

Answer sheets received were quality checked for completeness only and answer sheets without a full answer list to all questions were not used in the study. The majority of unused answer sheets were of an incomplete nature where users only filled in a view answers at the beginning of the list of questions and did then not complete the full list.

It needs to be stated that as expected a very low yield on requests for participation was experienced. A total of 9.87% answer sheets of the eventual targeted audience of **1165** were eventually used with a list of 115 resulting answer sheets. A total of 60.53% of the received answer sheets were successfully qualified and used in the analysis of results.

Very few respondents required additional information. The structured as well as commentary (unstructured) fields provided sufficient room for feedback as required by the respondents. Several questions were also included whereby respondents were asked to list typical techniques used in certain practices. These lists of questions were intentionally placed in the questionnaire to stimulate the respondent to think about the feedback on the related commentary questions. The eventual qualitative data analysis excludes these lists of techniques as many of them are organisation and client industry domain specific.

Several rounds of publishing the same questionnaire to different individuals followed and time limits for publication were defined to ensure that the respondents did advance to completion stage of their answers. No interaction between any respondents was encouraged nor detected in the data analysis for commentary feedback.

The unsolicited responses received were analysed using Altas.ti® qualitative data analysis tool to obtain a view on the industry representation of the respondents.
Since the questionnaire was supplied to suppliers / producers and consumers of IT a diverse supplier industry representation was expected with potentially more suppliers of IT projects / products. A total of 57 of the 115 respondents function on the supply side of IT as can be seen in Figure 28. A total of 58 respondents function from the consumer side of IT usage. The split of supplier and consumer of IT was obtained directly without interference on the qualified respondents' answer sheets. The achieved balance provided for a reasonably representative view on the questionnaire answers between the IT supplier industry and consumer industries.

The banking and financial industry in South Africa is an information technology user on a large scale with significant numbers of personnel appointed to IT functions, running into thousands of personnel in some cases. Discussions with several of the respondents indicated more of the respondents do stay in the Johannesburg area due to availability of employment in the banking and financial businesses that centralise the IT functions in Johannesburg. This could be indicative of the larger consumer representation (18 of the 115) of respondents for the banking and financial industry.

The presence of professional services businesses which delivers IT in end-user systems for clients were also present in the respondent list of answers (9 out of 115). The professional services businesses typically operate with consultants and they also act as consumers of IT in the execution of their advisory and service deliveries. To a large extent they are not primary producers of IT but formulate client useable systems and infrastructure as a result of projects being executed using procured primary IT products. Within the context of this study they serve to build a project portfolio using IT products. The development of the project portfolio of services is relevant since this is their core business.

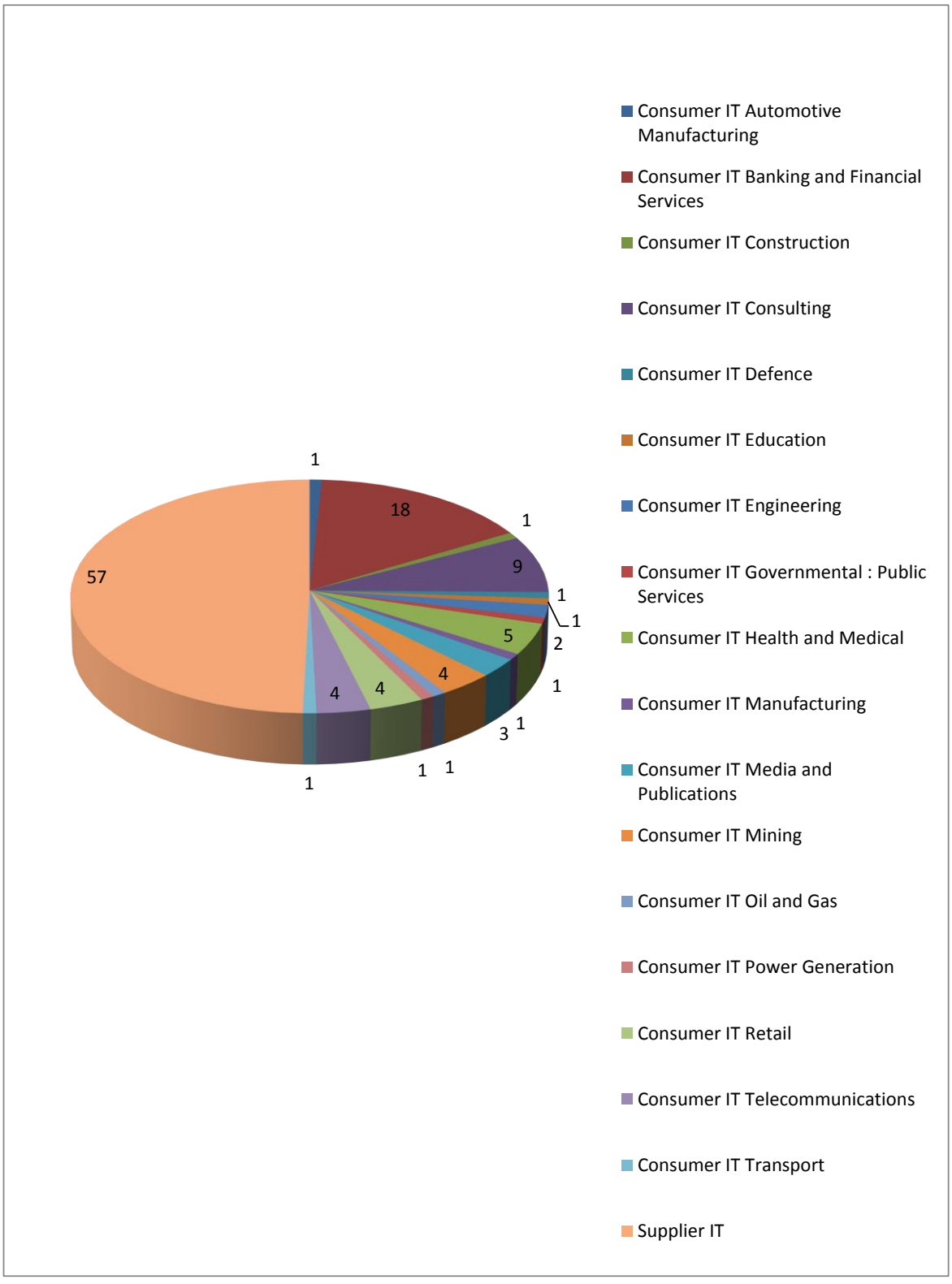

Figure 28: Industry representation of respondents

As can be seen from Figure 29 the functional roles of the respondents varied significantly. This was to the benefit of the study as the respondent answer sheets are not bound to specific roles of respondents. Since decision making is part of the study where organisations need to respond to changing IT client behaviours as a result of volatility, it is to be expected that respondents to the questionnaires need to be in decision-making roles.

The executives who make up 55 of the 115 respondents formulate the project and product portfolio decisions in response to the business environment. The positions include the roles of:

- Chief executive officers
- Chief information manager
- Chief technical officers
- Executive managers
- Directors
- Senior managers
- Managers
- Sales directors

The implementation of the changes for projects and products is typically executed on the delivery side by:

- Business Analysts
- Business Process Re-engineering Leads
- Consultants
- Development Managers
- Procurement Managers
- Programme Managers
- Project Managers
- Solutions Architects
- Systems Engineers

A total of 57 of the 115 respondents function on the delivery side of formulated decisions for projects and supporting IT products.
Overall a good balance on strategy decision makers and subsequent strategy implementation views were obtained with the respondent feedback.

The data appears scattered across multiple job functions and the data is not group in a level based approach since a wider representation was seeked. As an alternative data can be grouped in less groups of titles but this may also induce biasing as the research would need to group data without a clear understanding of the exact role in the organisation ie development manager may/may not be same as programme manager. Future research could be done with a group based categorisation to reduce categories and link to industry sectors.

Some categories are also small compared to other categories and data analysis would be more meaningful for the larger count categories.

Ensuring the respondent selection and resulting questionnaire responses can be applied in the industry in general if it was to be retested, was a key focus of the study to ensure integrity in the results obtained. The study should be repeatable and leading to a similar unbiased result list if executed again.
The study was also executed **completely externally** to the organisation where the researcher is employed to ensure external organisational validity as well as independent views and subsequently general validity in the IT industry.

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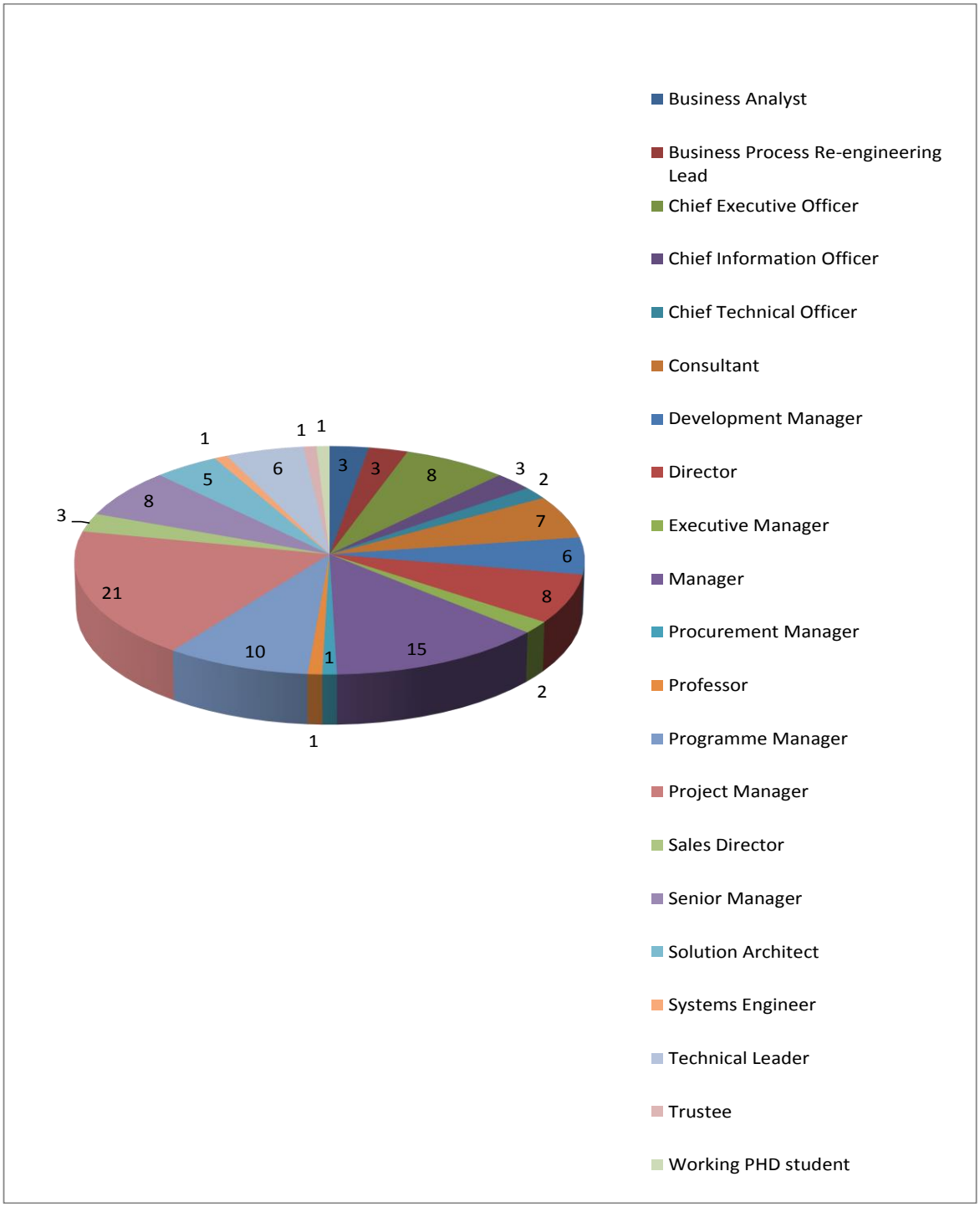

Figure 29: Organisational function/appointment of respondent

5.2 SINGLE VARIABLE ANALYSIS OF DATA AND INFORMATION COLLECTED

The Univariate data analysis of each of the twenty-four questions is used as base to determine the distribution of the sample data received form the questionnaire respondents.

In general analysis values on single variable data analysis are rounded off to two decimal places including percentage calculations.

5.2.1 Questions for Hypothesis A: Univariate Data Analysis and Qualitative analysis

5.2.1.1 Question 1, Variable ExogVolatility: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
1 Q1	ExogVolatility	**Exogenous volatility** derives from sources of volatility that are outside the control of both households and policy makers in the short term for example commodity prices, interest rates and skills shortages.	Independent variable Variable Type = Ordinal 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis A Research Question 1	Do IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts on their business in the longer term?

Table 23: Review questionnaire question 1 detail

The ordinal answer data feedback for the question in Table 23 is analysed by means of a graphical analysis as per Figure 30. The data analysis result is derived from the combined sample data of structured 115 answers and shown in relation to the research hypothesis.

The ExogVolatility variable functions as independent variable for the Hypothesis A.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 30 57 of the 115 respondents (49.57%) indicated that exogenous volatility has a high impact on their business. The second highest category was 36 out of the 115 respondents (31.30%). Together this creates a significant 80.57% of respondent feedback.
- The nature of the distribution is middle to predominantly medium to higher impact level since the centre is at a mean of 3.67 and median of 4 as well as a spread which with a low skew factor of 0.33.
- The median value of 4 is as a measure of location also indicates the skewed distribution towards high impact.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium impact level indicating the majority of respondent feedback for exogenous volatility has a medium impact on businesses.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to high impact level indicating the majority of respondent feedback for exogenous volatility has a high impact on businesses.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high impact level indicating the majority of respondent feedback for exogenous volatility has a high impact on businesses.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term on a **high impact level**.

The sample data is associated to the second part of the Hypothesis A and may provide support for the underlined part only.

> **H1**: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.

The addition of the unstructured qualitative data feedback in section 5.2.1.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.

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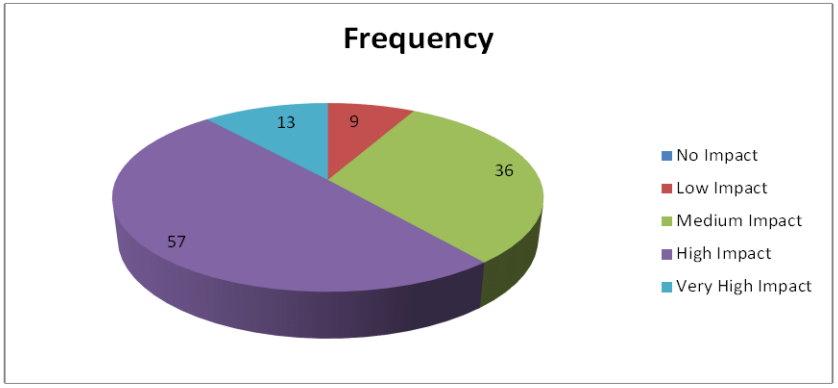
Univariate Data Analysis:

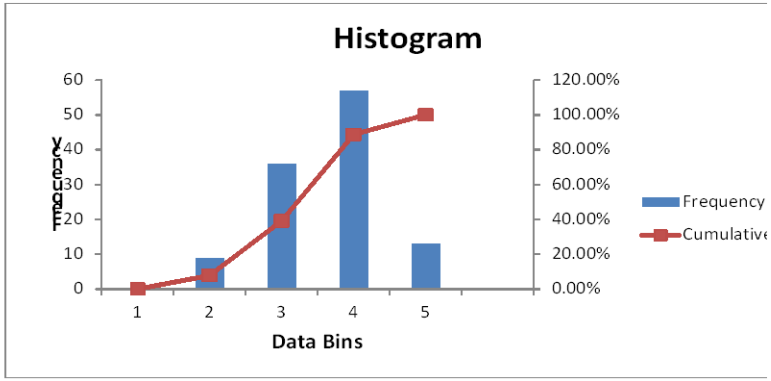
Variable 1: ExogVolatility
Variable Context: Independent
Variable Type: Ordinal

Data Bin Description	*Data Bins*	*ExogVolatility Frequency*	*Cumulative %*
No Impact	1	0	0.00%
Low Impact	2	9	7.83%
Medium Impact	3	36	39.13%
High Impact	4	57	88.70%
Very High Impact	5	13	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	**1**		
Mean =	**3.670454545**	**Rounded(2 decimal)**	**3.67**
Median = middle value of range of numbers	**4**		
Mode = Number most repeated	**4**		
Range = Largest minus smallest	**4**		
25th Percentile	**3**		
50th Percentile	**4**		
75th Percentile	**4**		
Interquantile range(75th - 25th percentile):	**1**		
Skew(difference between median and mean):	**0.329545455**	**Rounded(2 decimal)**	**0.33**

Figure 30: Univariate data analysis of variable ExogVolatility

5.2.1.2 Question 2, Variable NewTechAdoptProca: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
2a Q2	NewTechAdoptProca	Impact on clients adopting and procuring new IT technology.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Clients adopt/ procure far less IT projects/products 2 = Clients adopt/ procure somewhat less IT projects/products 3 = Clients adopt/ procure the same level IT projects/products 4 = Clients adopt/ procure somewhat more IT projects/products 5 = Clients adopt/ procure significantly more IT projects/products	Research Hypothesis A Research Question 1	a) What is the level of impact on the adoption/procurement of new IT technology in **negative** conducive volatile periods?

Table 24: Review questionnaire question 2 detail

The ordinal answer data feedback for the question in Table 24 is analysed by means of a graphical analysis as per Figure 31. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The NewTechAdopProcA variable functions as dependent variable for the Hypothesis A.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 31 a total of 55 of the 115 respondents (47.83%) indicated that business adopt/procure somewhat less IT/projects during periods of negative volatility. The second highest category being 40 out of the 115 respondents (34.78%) where clients adopt/procure far less IT projects/products. Together this creates a significant 82.61% of respondent feedback.
- The nature of the distribution is middle to predominantly somewhat less level since the centre is at a mean of 1.90 and median of 2 as well as a spread which with a low skew factor of 0.10.
- The median value of 2 is as a measure of location also indicating the skewed distribution towards a somewhat less adoption/procurement of IT projects/products.
- The 25th percentile value of 1 is indicative of the 25 per cent of respondent answers being smaller than or equal to far less adoption/procurement levels suggesting the respondent feedback is for far less adoption/procurement of IT projects/products.
- The 50th percentile value of 1 is indicative of the 50 per cent of respondent answers being smaller than or equal to somewhat less adoption/procurement levels suggesting the respondent feedback is for somewhat less adoption/procurement of IT projects/products.
- The 75th percentile value of 1 is indicative of the 75 per cent of respondent answers being smaller than or equal to somewhat less adoption/procurement level suggesting the respondent feedback is for somewhat less adoption/procurement of IT projects/products.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, clients adopt/procure **somewhat less** IT projects/products during negative conducive volatile periods.

The sample data is associated to the first part of the Hypothesis A and may provide support for the underlined part only. The impact of positive conducive volatile periods should, however, also be taken into account.

> **H1**: There is **a negative association** between <u>new technology adoption/procurement</u> and periods of exogenous volatility in the business environment.

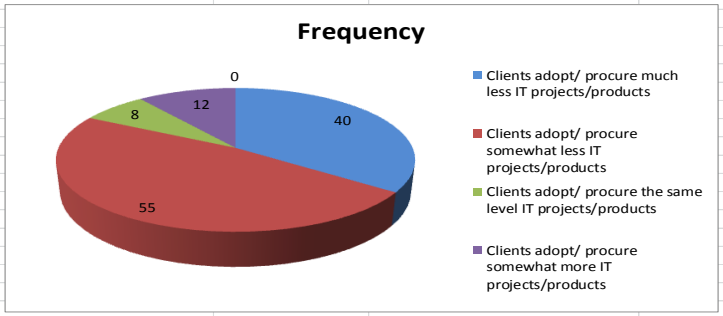
The addition of the unstructured qualitative data feedback in section 5.2.1.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.

Univariate Data Analysis:

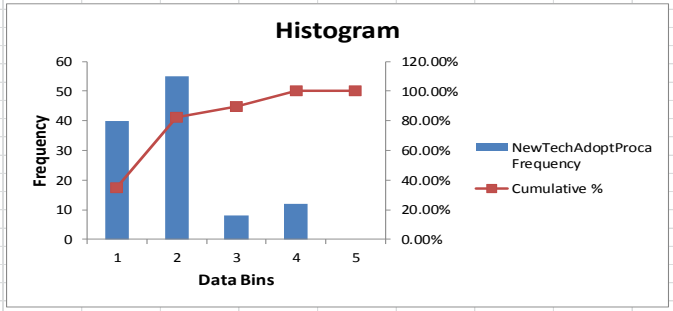
Variable 2a:	NewTechAdoptProca
Variable Context:	Dependent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*NewTechAdoptProca Frequency*	*Cumulative %*
Clients adopt/ procure much less IT projects/products	1	40	34.78%
Clients adopt/ procure somewhat less IT projects/products	2	55	82.61%
Clients adopt/ procure the same level IT projects/products	3	8	89.57%
Clients adopt/ procure somewhat more IT projects/products	4	12	100.00%
Clients adopt/ procure significantly more IT projects/products	5	0	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1 over category 1 and 2		
Mean =	1.897727273	Rounded(2 decimal)	1.9
Median = middle value of range of number	2		
Mode = Number most repeated	2		
Range = Largest minus smallest	4		
25th Percentile	1		
50th Percentile	2		
75th Percentile	2		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	0.102272727	Rounded(2 decimal)	0.1

Figure 31: Univariate data analysis of variable NewTechAdoptProca

5.2.1.3 Question 3, Variable NewTechAdoptProcb: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
2b Q3	NewTechAdoptProcb	Impact on clients adopting and procuring new IT technology.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Clients adopt/ procure far less IT projects/products 2 = Clients adopt/ procure somewhat less IT projects/products 3 = Clients adopt/ procure the same level IT projects/products 4 = Clients adopt/ procure somewhat more IT projects/products 5 = Clients adopt/ procure significantly more IT projects/products	Research Hypothesis A Research Question 1	b) What is the level of impact on the adoption/procurement of new IT technology in **positive** conducive volatile periods?

Table 25: Review questionnaire question 3 detail

The ordinal answer data feedback for the question Table 25 is analysed by means of a graphical analysis as per Figure 32. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The NewTechAdopProcB variable functions as dependent variable for the Hypothesis A.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 32 a total of 69 of the 115 respondents (60 per cent) indicated that businesses adopt/procure somewhat more IT/projects during periods of positive volatility. The second highest category being 20 out of the 115 respondents (17.39 per cent) where clients adopt/procure significantly more IT projects/products. Together this creates a significant 77.39 per cent of respondent feedback.
- The nature of the distribution is middle to predominantly somewhat more level since the centre is at a mean of 3.84 and median of 4 as well as a spread with a low skew factor of 0.16.
- The median value of 4 as a measure of location also indicates the skewed distribution towards somewhat greater adoption/procurement of IT projects/products during periods of positive volatility.
- The 25th percentile value of 4 is indicative of the 25 per cent of respondent answers being smaller than or equal to somewhat more adoption/procurement levels suggesting the respondent feedback is for somewhat adoption/procurement of IT projects/products.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to somewhat more adoption/procurement levels suggesting the respondent feedback is for somewhat adoption/procurement of IT projects/products.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to somewhat more adoption/procurement levels suggesting the respondent feedback is for somewhat adoption/procurement of IT projects/products.

Thus it may be concluded according to the structured question, based on the sample data scope only and highest category; IT clients adopt/procure **somewhat more** IT projects/products during positively conducive volatile periods.
The sample data is associated to the first part of the Hypothesis A and may provide support for the first part only.

> **H1**: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.

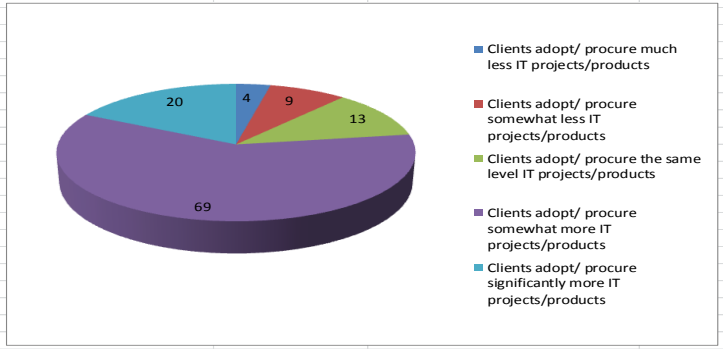
The addition of the unstructured qualitative data feedback in section 5.2.1.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.

Univariate Data Analysis:

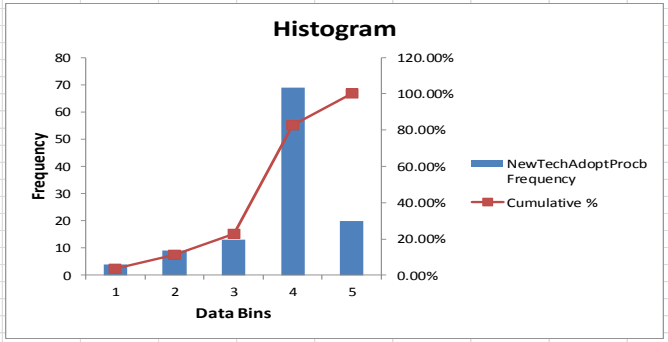
Variable 2b:	NewTechAdoptProcb
Variable Context:	Dependent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*NewTechAdoptProcb Frequency*	*Cumulative %*
Clients adopt/ procure much less IT projects/products	1	4	3.48%
Clients adopt/ procure somewhat less IT projects/products	2	9	11.30%
Clients adopt/ procure the same level IT projects/products	3	13	22.61%
Clients adopt/ procure somewhat more IT projects/products	4	69	82.61%
Clients adopt/ procure significantly more IT projects/products	5	20	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:		1 over category 4 and 5	
Mean =	3.840909091	Rounded(2 decimal)	3.84
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	4		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	0		
Skew(difference between median and mean):	0.159090909	Rounded(2 decimal)	0.16

Figure 32: Univariate data analysis of variable NewTechAdoptProcb

5.2.1.4 Inductive qualitative data analysis for Hypothesis A

The commentary data for research questions1,2 and 3 were grouped together using Altas.ti to:

- Determine key words that describe concepts in the 3 questions.
- Be able to group key data words into families of similar meaning (see Table 27); and
- Derive relationships between the key words to understand the causal relationships possible between independent and dependent variable questions. The findings must be related to existing and or new theory in relation to the hypothesis and research question.
- Bold text indicates predominant concepts and keywords in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.1.4.1 Key words and family concepts of data

Using the Co-occurrence tables, and codes to primary documents with query capabilities of Altas.ti® majority keyword/concepts were extracted and depicted in Table 27:

Question	Question detail	Dominant keywords and concepts (families) of data
1	Do IT clients experience volatility as a result of interest rates, commodity costs, skills shortage in their business environment which impacts on their business in the longer term? *(51 responses received)*	• **Skills shortage** was listed as a significant factor. External recruitment of personnel remains under pressure with less than expected availability of resources in the market. • **Training and up-skilling** is seen as a risk due to turnover of personnel. • **Cost of doing business** increasing significantly with regard to commodities like energy, communications and the regulatory aspects of compliance. • **Exchange rates volatility** makes planning, execution and delivery difficult since many IT products are imported. • **Time to market** of products is reduced in general. • Business strategy followed by different **sizes of businesses** makes the business more or less susceptible to influences of skills, interest rates and exchange rates.

Question	Question detail	Dominant keywords and concepts (families) of data
2	What is the level of impact on the adoption/procurement of new IT technology in negative conducive volatile periods? (*49 responses received*)	• **Industry specific factors** do have an influence in terms of impact of adoption/procurement of new IT. • **New market required technologies in** the market require IT clients to upgrade product/projects even when negative volatility is present since they should remain efficient in delivery of their products and services. • IT is seen as an enabler and is used to reduce cost and improve productivity; hence during negative volatility focused expenditure for **valued based return is more required due to limited funding**. • IT clients reduce project and product development investment in line with business strategy of lower OPEX funding for IT. They then **catch up** when more funding is available. • IT clients put a significant focus on their product growth and **use IT to identify the growth areas**. IT investment is then carefully directed at these areas.
3	What is the level of impact on the adoption/procurement of new IT technology in positively conducive volatile periods? *(40 Responses received)*	• The business and technology strategy dictates the focus and priorities for investment. During positively volatile periods more funding is generally available to **improve IT investments** and directed to further investment in growth areas. Clients do remain conservative on IT spending. • Provided the **business case is viable** and accepted there is increased expenditure in the IT project portfolio and product development. • IT project/product portfolio is typically more upgraded during these positive periods to **be current and competitive**. • **Value derived from IT** investment remains the deciding factor for expenditure. • IT industry refocuses as a result **major**

Question	Question detail	Dominant keywords and concepts (families) of data
		technology shifts like mobile IT products for users. These shifts may likely motivate more funding from clients as well during periods of positive volatility.

Table 26: Prominent keywords in questions feedback related to Hypothesis A

5.2.1.4.2 Relation to univariate quantitative data findings

- Survey question 1 quantitative finding (independent variable): IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts on their business in the longer term on a **high impact level.**

  The qualitative data received supports the quantitative view of a high impact of volatility as a result of interest rates, commodity process skills shortage in the client business environment.

- Survey question 2 quantitative finding (dependent variable): Clients adopt/procure **somewhat less** IT projects/products during negative conducive volatile periods.

  The qualitative data received supports the quantitative view of clients adopting somewhat fewer IT projects/products during negative conducive volatile periods. Focused expenditure in terms of operational efficiency remains a focus to ensure optimal value from investment to sustain business.

- Survey question 3 quantitative finding (dependent variable): Clients adopt/procure **somewhat more** IT projects/products during positively conducive volatile periods.

  The qualitative data received supports the quantitative view of clients adopting somewhat more IT projects/products during positively conducive volatile periods. Focused expenditure remains a focus to ensure optimal value from investments whilst supporting trends in the market.

5.2.1.4.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Atlas.ti to indicate

- the cause of certain volatility factors,

- the market demands changes as a result of the volatility
- And response from clients as well as IT business required.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 33 the theory then becomes apparent that clients do respond to exogenous volatility and as a result IT business do alter their business strategy in response to the client focus. In the reviewing the relationship with the research hypothesis A, the periods of positive volatility (main question 3 in the diagram) will not adversely impact on the level of IT adoption/procurement. Whilst periods of negative volatility (main question 2 in the diagram) may, but will not always, adversely impact on the levels of IT adoption/procurement.

This leads potentially to a refocusing in IT project portfolio and product development.

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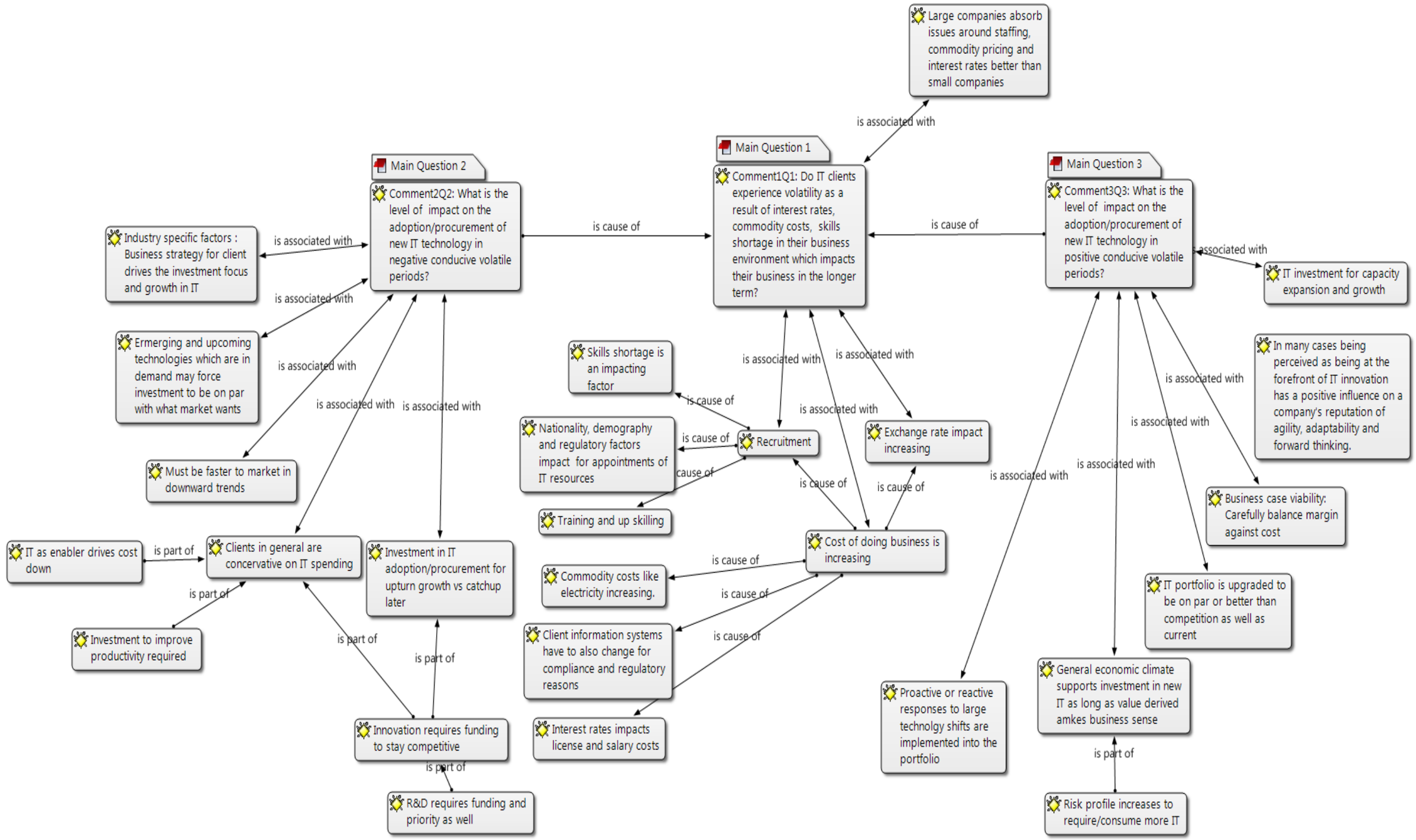


Figure 33: High level network diagram for qualitative nodes of questions 1,2 and 3

5.2.2 Questions for Hypothesis B: Univariate Data Analysis and Qualitative analysis

5.2.2.1 Question 4, Variable CustomerReq: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
3 Q4	CustomerReq	Level of impact of understanding customer requirements during periods of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does a clearer understanding of customer requirements during periods of volatility assist in growing project portfolio and supporting product development?

Table 27: Review questionnaire question 4 detail

The ordinal answer data feedback for the question Table 27 is analysed by means of a graphical analysis as in Figure 34. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The CustomerReq variable functions as independent variable for the Hypothesis B.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 34, 50 of the 115 respondents (43.48 per cent) indicated that understanding of customer requirements have a high impact on growing the project portfolio and supporting product development. The second highest category being 29 out of the 115 respondents (25.22 per cent). Together this creates a significant 68.7 per cent of respondent feedback.
- The nature of the distribution is middle to predominantly medium to higher impact level since the centre is at a mean of 3.61 and median of 4 as well as a spread which with a medium skew factor of 0.39.

- The median value of 4 is as a measure of location also indicating the skewed distribution towards high impact.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to a medium impact level suggesting respondent feedback for a clearer understanding of client requirements during volatility has a medium impact on growing the project portfolio and product development.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to a high impact level suggesting respondent feedback for a clearer understanding of client requirements during volatility has a high impact on growing the project portfolio and product development.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to a high impact level suggesting respondent feedback for a clearer understanding of client requirements during volatility has a high impact on growing the project portfolio and product development.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, having a clearer understanding of IT client requirements has a **high impact** on assisting in growing the project portfolio and supporting product development.

The sample data is associated to the first part of the Hypothesis B and may provide support for the underlined part only.

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business, IT projects and supporting product development growth.

The addition the unstructured qualitative data feedback in section 5.2.2.6 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

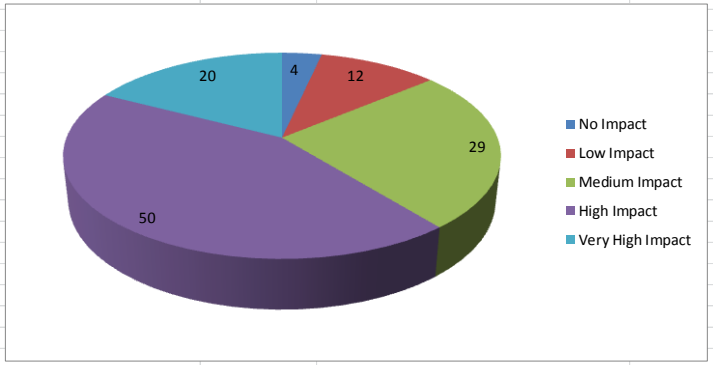
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.2.

Univariate Data Analysis:

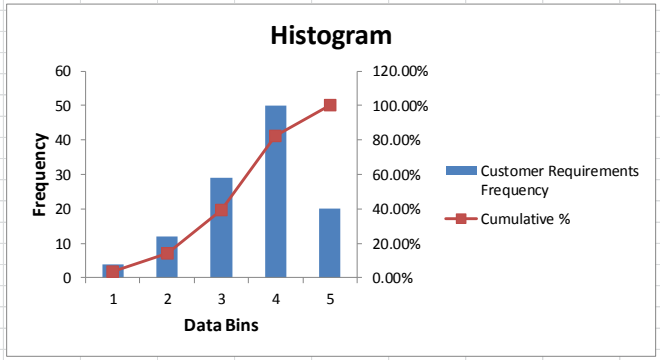
Variable 3:	CustomerReq
Variable Context:	Independent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Customer Requirements Frequency*	*Cumulative %*
No Impact	1	4	3.48%
Low Impact	2	12	13.91%
Medium Impact	3	29	39.13%
High Impact	4	50	82.61%
Very High Impact	5	20	100.00%

Sample Data Distributior Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.613636364	Rounded(2 decimal)	3.61
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean)	0.386363636	Rounded(2 decimal)	0.39

Figure 34: Univariate data analysis of variable CustomerReq

5.2.2.2 Question 5, Variable CustomerOpImpact: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
4 Q5	CustomerOpImpact	Level of the impact of volatility on customer operations.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does an understanding of the impact of volatility on customer operations assist in growing IT business project portfolios and supporting product development?

Table 28: Review questionnaire question 5 detail

The ordinal answer data feedback for the question in Table 28 is analysed by means of a graphical analysis as in Figure 35. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The CustomerOpImpact variable functions as independent variable for the Hypothesis B.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 35, 46 of the 115 respondents (40 per cent) indicated an understanding of the impact of volatility on customer operations assisting in growing IT business project portfolios (medium impact) being 36 out of the 115 respondents (31.30 per cent). Together this creates a significant 71.3 per cent of respondent feedback.
- The nature of the distribution is middle to predominantly medium to high impact level since the centre is at a mean of 3.58 and median of 4 as well as a spread which with a medium skew factor of 0.4204.
- The median value of 4 is as a measure of location also indicating the skewed distribution towards high impact.
- The 25th percentile value of 4 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium level suggesting the respondent feedback for a clearer

understanding of the impact of volatility on client operations during volatility has a medium impact on growing the project portfolio and product development.

- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to high impact level suggesting the respondent feedback for a clearer understanding of the impact of volatility on client operations during volatility has a high impact on growing the project portfolio and product development.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high level suggesting the respondent feedback for a clearer understanding of the impact of volatility on client operations during volatility has a high impact on growing the project portfolio and product development.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, having a clearer understanding of the impact that volatility has on client operations has a **high impact** on assisting in growing the project portfolio and supporting product development.

The sample data is associated to the second part of the Hypothesis B and may provide support for the underlined part only.

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business, IT projects and supporting product development growth.

The addition of the unstructured qualitative data feedback in section 5.2.2.6 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

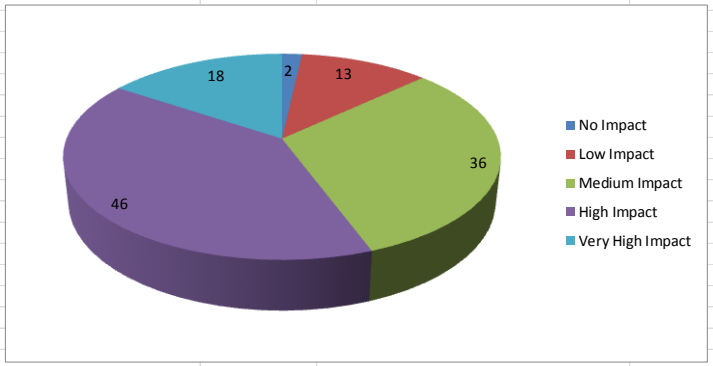
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.2.

Univariate Data Analysis:

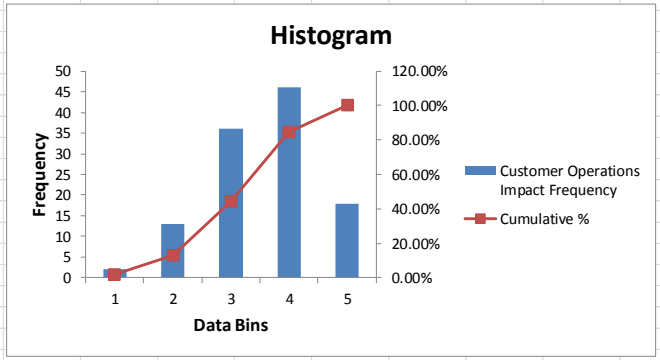
Variable 4:	CustomerOpImpact
Variable Context:	Independent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Customer Operations Impact Frequency*	*Cumulative %*
No Impact	1	2	1.74%
Low Impact	2	13	13.04%
Medium Impact	3	36	44.35%
High Impact	4	46	84.35%
Very High Impact	5	18	100.00%

Sample Data Distributior Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.579545455	Rounded(2 decimal)	3.58
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean)	0.420454545	Rounded(2 decimal)	0.42

Figure 35: Univariate data analysis of variable CustomerOpImpact

5.2.2.3 Question 6, Variable CustomerIntAct: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
5 Q6	CustomerIntAct	Level of the impact of one-on-one customer interaction assists growth of IT projects and supporting product development.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does one-on-one interaction with clients during periods of volatility assist in growing project portfolios and supporting product development?

Table 29: Review questionnaire question 6 detail

The ordinal answer data feedback for the question Table 29 is analysed by means of a graphical analysis as in Figure 36. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The CustomerIntAct variable functions as independent variable for the Hypothesis B.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 36, 43 of the 115 respondents (37.39 per cent) indicated that one on one interaction with clients during periods of volatility has a high impact on growing of IT projects and supporting product development. At medium impact level being 27 out of the 115 respondents (23.48 per cent) and at very high impact level being 27 out of the 115 respondents (23.48 per cent).Together this creates a significant 84.35 per cent of respondent feedback.
- The nature of the distribution is middle to predominantly high impact level since the centre is at a mean of 3.75 and median of 4 as well as a spread which with a medium skew factor of 0.25.
- The median value of 4 is as a measure of location also indicating the skewed distribution towards high impact.

- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium impact level suggesting the respondent feedback favours that one-on-one interaction with clients during periods of volatility assists on medium level in growing the IT s and supporting product development.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to high impact level suggesting the respondent feedback favours that one-on-one interaction with clients during periods of volatility assists on high level in growing the IT projects and supporting product development.
- The 75th percentile value of 4 is indicative of the 75per cent of respondent answers being smaller than or equal to high impact level suggesting the respondent feedback favours that one-on-one interaction with clients during periods of volatility assists on high level in growing the IT project and supporting product development.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, having one-on-one interaction with clients has a **high impact** on growing the IT project and supporting product development during periods of volatility.

The sample data is associated to the third part of the Hypothesis B and may provide support for the underlined part only.

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business IT projects and supporting product development growth.

The addition of the unstructured qualitative data feedback in section 5.2.2.6 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

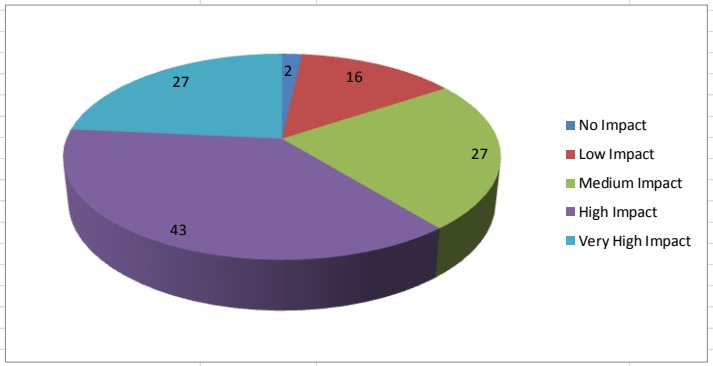
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.2.

Univariate Data Analysis:

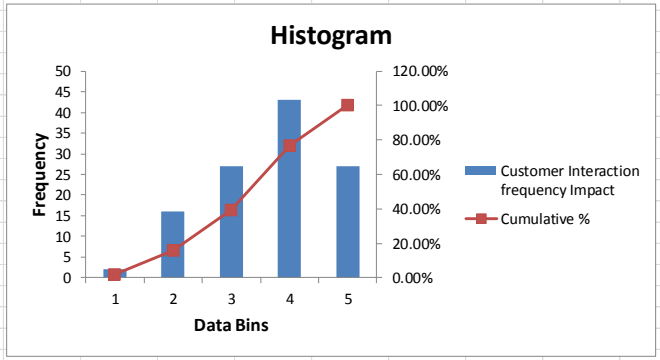
Variable 5:	CustomerIntAct
Variable Context:	Independent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Customer Interaction frequency Impact*	*Cumulative %*
No Impact	1	2	1.74%
Low Impact	2	16	15.65%
Medium Impact	3	27	39.13%
High Impact	4	43	76.52%
Very High Impact	5	27	100.00%

Sample Data Distributior Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.75	Rounded(2 decimal)	3.75
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean)	0.25	Rounded(2 decimal)	0.25

Figure 36: Univariate data analysis of variable CustomerIntAct

5.2.2.4 Question 7, Variable ITProjGrowth: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
6 Q7	ITProjProdGrowth	Business IT project and product development levels.	Dependent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Have client responses to volatility impacted on IT business project development and supporting product development growth?

Table 30: Review questionnaire question 7 detail

The ordinal answer data feedback for the question Table 30 is analysed by means of a graphical analysis as in Figure 37. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The ITProjProdGrowth variable functions as dependent variable for the Hypothesis B.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 37, 49 of the 115 respondents (42.61per cent) indicated that client responses as a result of volatility has a high impact on IT projects and supporting product development. At medium impact level being 33 out of the 115 respondents (28.70 per cent). Together this creates a significant 71.31 per cent of respondent feedback.
- The nature of the distribution is medium to high impact level since the centre is at a mean of 3.70 and median of 4 as well as a spread which with a medium skew factor of 0.34.
- The median value of 4 is as a measure of location also indicating the skewed distribution towards high impact.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium impact level suggesting the respondent feedback favours

that client responses during periods of volatility impact on IT projects and supporting product development at a medium level.

- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to high impact level suggesting the respondent feedback favours that client responses during periods of volatility impact on IT projects and supporting product development at a high level.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high impact level suggesting the respondent feedback favours that client responses during periods of volatility impact on IT projects and supporting product development at a high level.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that IT client response during volatility has a **high impact** on IT projects and supporting product development.

The sample data is associated to the last part of the Hypothesis B and may provide support for the underlined part only.

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business, IT projects and supporting product development growth.

The addition of the unstructured qualitative data feedback in section 5.2.2.6 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

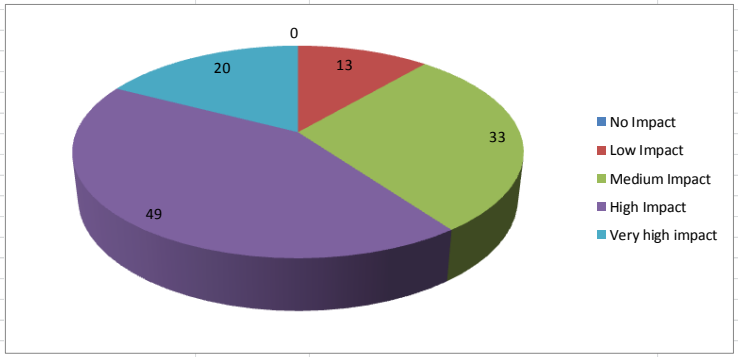
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.2.

Univariate Data Analysis:

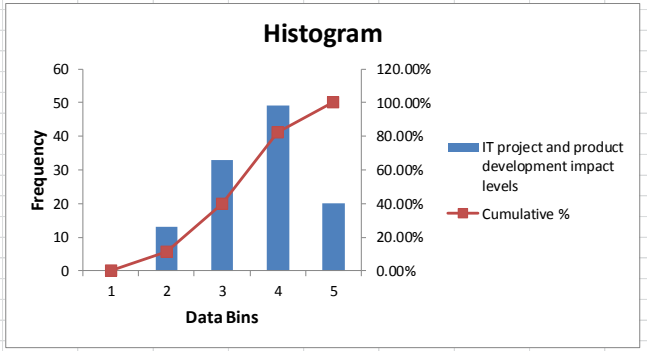
Variable 6:	ITProjProdGrowth
Variable Context:	Dependant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*IT project and product development impact levels*	*Cumulative %*
No Impact	1	0	0.00%
Low Impact	2	13	11.30%
Medium Impact	3	33	40.00%
High Impact	4	49	82.61%
Very high impact	5	20	100.00%

Sample Data Distributior Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.659090909	Rounded(2 decimal)	3.66
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean)	0.340909091	Rounded(2 decimal)	0.34

Figure 37: Univariate data analysis of variable ITProjProdGrowth

5.2.2.5 Question 8, Variable CustomerReq_CustomerOpImpact_CustomerIntAct_VS_ITProjProdGrowth: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
7 Q8	CustomerReq_ CustomerOpImpact_ CustomerIntAct_VS_ ITProjProdGrowth	The collective impact of an understanding of customer requirements, impact of volatility on customer operations and one-on-one interaction have on the growth of IT projects and supporting product development.	Variable Type = Likert scale variable: Association perception views from respondents. Structured scale: 1 = Strongly disagree 2 = Disagree somewhat 3 = Neutral 4 = Agree somewhat 5 = Strongly disagree	Research Hypothesis B Research Question 2	Does the combined impact of an understanding of customer requirements, impact of volatility on customer operations and one-on-one interaction have a more positive impact on growing IT projects and supporting product development during the presence of volatility?

Table 31: Review questionnaire question 8 detail

The ordinal answer data feedback for the question in Table 31 is analysed by means of a graphical analysis as in Figure 38. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The CustomerReq_CustomerOpImpact_CustomerIntAct_VS_ITProjProdGrowth variable functions as a Likert scale variable for the Hypothesis B combining both the independent and dependent variables in one question and represents the combined responses from respondents.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 38, 51 of the 115 respondents (44.35 per cent) indicated that there is strong agreement as to the combined impact of the independent variables on the dependent variable. At somewhat agreement level were 48 out of the 115 respondents (41.74 per cent).Together this creates a significant 86.09 per cent of respondent feedback.
- The nature of the distribution is middle to predominantly somewhat agreement level since the centre is at a mean of 4.27 and median of 4 as well as a spread which with a medium skew factor of -0.27.
- The median value of 4 is as a measure of location also indicating the skewed distribution towards somewhat and strong agreement.
- From a variability perspective the standard deviation of the sample is ±0.75 which is indicative of the majority of the values being close to the mean value of 4.27.
- The 25th percentile value of 4 is indicative of the 25 per cent of respondent answers being smaller than or equal to somewhat agreement level suggesting the respondent feedback favours somewhat agreement impact of the independent variables (customer requirements, customer operational impact as a result volatility as well as one-on-one customer interaction activities) on the dependent variable (IT business IT projects and supporting product development growth).
- The 50th percentile value of 5 is indicative of the 50 per cent of respondent answers being smaller than or equal to strong agreement level suggesting the respondent feedback favours strong agreement impact of the independent variables (customer requirements, customer operational impact as a result volatility as well as one-on-one customer interaction activities) on the dependent variable (IT business IT projects and supporting product development growth).
- The 75th percentile value of 5 is indicative of the 75 per cent of respondent answers being smaller than or equal to somewhat agreement level suggesting the respondent feedback favours strong agreement impact of the independent variables (customer requirements, customer operational impact as a result volatility as well as one-on-one customer interaction activities) on the dependent variable (IT business, IT projects and supporting product development growth).

Thus it can be concluded according to the structured question and based on the sample data scope only and highest category, that the category of **strongly agreement** categorises the positive impact of the independent variables (customer requirements, customer operational impact

as a result volatility as well as one-on-one customer interaction activities) have on the dependent variable (IT business, IT projects and supporting product development growth).

The sample data is associated to the full part of the Hypothesis B and may provide support for the full hypothesis.

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business, IT projects and supporting product development growth.

There is risk in the Likert scale (Page and Meyer, 2006) as respondents might have differences in the meaning of what a response category entails.

The addition of the unstructured qualitative data feedback in section 5.2.2.6 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in 5.3.2.

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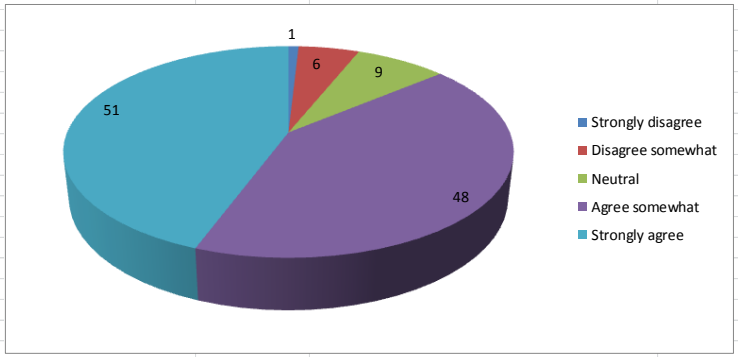
Univariate Data Analysis:

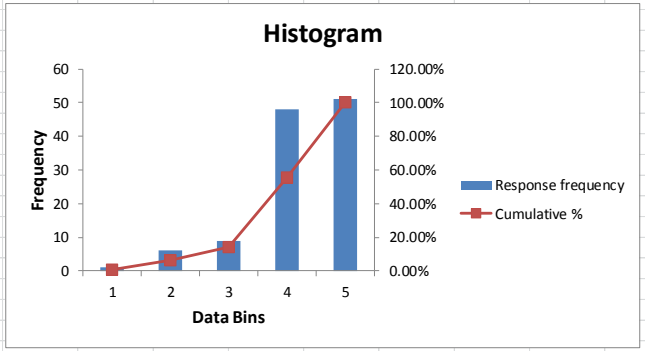
Variable 7:	CustomerReq_ CustomerOpImpact_ CustomerIntAct_VS_ ITProjProdGrowth
Variable Context:	Combined Context of dependant and independent variables
Variable Type:	Likert scale(Special Case of Ordinal data)

Data Bin Description	*Data Bins*	*Response frequency*	*Cumulative %*
Strongly disagree	1	1	0.87%
Disagree somewhat	2	6	6.09%
Neutral	3	9	13.91%
Agree somewhat	4	48	55.65%
Strongly agree	5	51	100.00%

Sample Data Distributior Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	2		
Mean =	4.272727273	Rounded(2 decimal)	4.27
Median = middle value of range of number	4		
Mode = Number most repeated	5		
Range = Largest minus smallest	4		
25th Percentile	4	Measure of spread	
50th Percentile	4	Measure of spread	
75th Percentile	5	Measure of spread	
Interquantile range(75th - 25th percentile):	1	6	
Skew(difference between median and mean)	-0.272727273	Rounded(2 decimal)	-0.27
Conclusions for variability			
Standard Deviation	0.867381748	Rounded(2 decimal)	0.87

Figure 38: Univariate data analysis of variable CustomerReq_CustomerOpImpact_CustomerIntAct_VS_ITProjProdGrowth

5.2.2.6 Inductive qualitative data analysis for Hypothesis B

The commentary data for research questions 4, 5, 6, 7, 8 was grouped together using Altas.ti to:

- Determine key words that describe concepts in the 5 questions
- Be able to group key data words into families of similar meaning (see Table 32), and
- Derive relationships between the key words/concepts to understand the causal relationships possible between independent and dependent variable questions. The findings must be related to existing and or new theory in relation to the hypothesis and research question. The research questions are used as main categories (Thomas, 2003), and Atlas.ti® commentary feedback from respondents are linked to the categories.
- Bold text indicates predominant concepts and keyword in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.2.6.1 Key words and family concepts of data

Using the Co-occurrency tables, and codes to primary documents with query capabilities of Altas.ti® majority keyword/concepts were extracted and depicted in Table 32:

Question	Question detail	Dominant keywords and concepts (families) of data
4	Does a clearer understanding of customer requirements during periods of volatility assist in growing project portfolios and supporting product development? *(45 responses received)*	• **Client business goals** need to translate to requirements to be serviced by the IT businesses with project and product portfolio even more **flexible** during volatile periods. • **Understanding client operations and impact of volatility** can be used to promote project and supporting product features during proposal stage. • Client requirements translate the **application of IT products** via projects to **improve operational processes (and cost)** during volatile periods and is not the reason to create products. • IT business must be focused at client **centric innovation and delivering growth focused**

Question	Question detail	Dominant keywords and concepts (families) of data
		products/projects and not purely at integration of systems which increase running costs for the client. • Knowing customers and their requirements during volatile periods implies that the IT business portfolio of projects and products should lead to a **customer centric culture and systems base.**
5	Does an understanding of the impact of volatility on customer operations assist in growing an IT business's project portfolio and supporting product development? *(36 responses received)*	• IT business should understand the **pain areas** of IT clients to assist them in identifying **sweet spot areas** where IT projects and products can make a difference in their business. • Customers are **seeking return on investment (ROI) improvement** during volatile periods with a refocus on IT budgets in support of the ROI optimisation. The already defined product suite can be **optimised and stage validated to be aligned** to client requirements via project-based applications. • Products should be **operationally matured** for client requirements and the **strategic intent of the product suite optimised with product road mapping for future focus.** • During negative volatile periods clients **will slow down or halt higher risk IT projects**. The IT business should realise this can happen and proactively seek concurrent business with more customers to ensure the project/product portfolio does not stagnate when projects are halted. • **Well-defined business cases** for IT projects are subject to volatile conditions but may still grow the project/product portfolio if the focus is retained to realise promised value from executing the business case (p**rice vs. quality vs. competitive advantage**). • Clients focus on **internal process**

Question	Question detail	Dominant keywords and concepts (families) of data
		optimisation more frequently during volatile periods and IT should support process optimisation **without inducing and increasing running costs' overheads.**
6	Does one-on-one interaction with clients during periods of volatility assist in growing project portfolio and supporting product development*?* *(55 Responses received)*	• **Communications and mutual understanding** between IT client and IT business is a pre requisite for expectation management leading to successful project and product development. • **Know your customer, know your product, know your market and know competitive pricing for a suitable IT projects/products portfolio.** • Turning the IT proposal to the client into a successful sale very often **requires close co-operation with the customer to refine** scope, pricing/budgeting, quality requirements, commercial conditions and operational requirements. This creates the demand for the project and the product portfolio to grow. • **Joint decisions and fulfilment on the decisions with the customer** leads to operational risk reduction and acceptance of new products which improve performance. • **Slow response speed kills IT.** The communications with the client identifies IT project/product opportunities or existing risks which should be solved timeously by focused IT projects and product development.
7	Have client responses to volatility impacted on IT business project development and supporting product development? *(46 Responses received)*	• **Yes,** IT client response during volatility has a high impact on IT projects and supporting product development. • **Projects are halted** leading to reductions in IT project/product development. • Focus is shifted to **high ROI IT projects/product.** • **Customers focus on pain points in**

Question	Question detail	Dominant keywords and concepts (families) of data
		processes and not gearing for growth opportunities of new IT projects/products if they are a small business. • IT businesses see a reduction during negative volatility or orders; they then **relate this to client budgets/operational priorities** and reassess their project and product portfolio focus.
8	Does the combined impact of an understanding of customer requirements, impact on the volatility of customer operations and does one-on-one interaction have a more positive impact on growing an IT project and supporting product development during the presence of volatility? *(34 Responses received)*	• **Yes,** the combined impact has an impact on IT projects and supporting product development growth. • Focus in project and product development is **optimised to client requirement applications**, feedback and general business environment volatility conditions. • Customers know what they **receive** and IT businesses know what IT projects/products should be **supplied**. • **New requirements from the market** for innovative IT products (like mobile portable IT devices) are discussed with clients, **refined for their processes** and this may likely realise in new innovative IT applications. Together IT business and clients **unlock competitive opportunities**. • IT clients also need to provide a service and satisfy their clients' needs. The interaction capabilities of new technologies such as social media, e-mail, voice over Internet protocol (VOIP) products unlock opportunities **to link back end systems with client interaction**. This can grow the IT project/product portfolio irrespective of volatility.

Table 32: Prominent keywords in questions feedback related to Hypothesis B

5.2.2.6.2 Relation to univariate quantitative data findings

- Survey question 4 quantitative finding (independent variable): It was concluded according to the structured question, based on the sample data scope only and highest category, that having a clearer understanding of client requirements has a **high impact** on assisting in growing the project portfolio and supporting product development. The relationship between the qualitative and quantitative data is important to provide more descriptive information for the quantitative findings.

  The qualitative data received supports the quantitative view that having an understanding of client requirements has a **high impact** on assisting in growing the project portfolio and supporting product development. The requirements should support the business goals of the IT client to be able to realise the business goals.

- Survey question 5 quantitative finding (independent variable): It was concluded according to the structured question, based on the sample data scope only and highest category, having a clearer understanding of the impact volatility on client operations has a **high impact** on assisting in growing the project portfolio and supporting product development.

  The qualitative data received supports the quantitative view of a clearer understanding of the impact volatility has on client operations and has a **high impact** on assisting in growing the project portfolio and supporting product development. Understanding the customer strategy, processes and **pain areas** unlocks opportunities that should lead to quick action on the part of the IT business supplier.

- Survey question 6 quantitative finding (independent variable): Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, having one-on-one interaction with clients has a **high impact** on growing the IT project and supporting product development during periods of volatility.

  The qualitative data received supports the quantitative view that having one-on-one interaction with clients has a **high impact** on growing the IT project and supporting product development during periods of volatility. From the qualitative data the view is clear: know your customer, know your product, know your market and know competitive pricing for a suitable IT projects/products portfolio to grow.

- Survey question 7 quantitative finding (dependent variable): It was concluded, according to the structured question, based on the sample data scope only and highest category, that client response during volatility has a **high impact** on IT projects and supporting product development.

The qualitative data received supports the quantitative view that client response during volatility has a **high impact** on IT projects and supporting product development. Projects are halted leading to reductions in IT project/product development and focus is shifted to high ROI IT projects/products. This makes the formulation of the viable, growing project and product portfolio even more critical.

Survey question 8 quantitative finding (Likert variable): It was concluded according to the structured question and based on the sample data scope only and highest category, that the category of **strong agreement** categorises the positive impact of the independent variables on the dependent variable. The 3 elements of a clear understanding of -

- customer requirements
- customer operational impact as a result volatility, as well as
- one-on-one customer interaction activities

has a **positive association** on IT business IT projects and supporting product development growth.

The qualitative data received supports the quantitative view of The 3 elements of a clear understanding of -

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

has a **positive association** on IT business, IT projects and supporting product development growth. New requirements from the market for innovative IT products (like mobile portable IT devices) are discussed with clients, refined for their processes and this may likely realise in new innovative IT applications. Together IT business and clients unlock competitive opportunities

5.2.2.6.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Altlas.ti to indicate -

- How data is grouped to support question 4 to 7
- Understand the interaction between the 4 questions on high level only. The diagram is used more to group and associate data in accordance to the 4 questions. Question 8 is more the combined effect of the other 4 questions. Using Atlas.ti® the main associations for a main question are combined and predominant concepts/keywords linked towards the main question 8.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they directly relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 39 it is apparent that clients detect volatility and they do respond with appropriate action. The qualitative data does provide some level of support for the view that the combined impact of an understanding of customer requirements, impact of volatility on customer operations and one-on-one interaction have a more positive impact on growing IT projects and supporting product development during the presence of volatility (Hypothesis B). The qualitative data listed in Figure 39 supports on concept level the main questions that underlie the main questions for the research hypothesis B.

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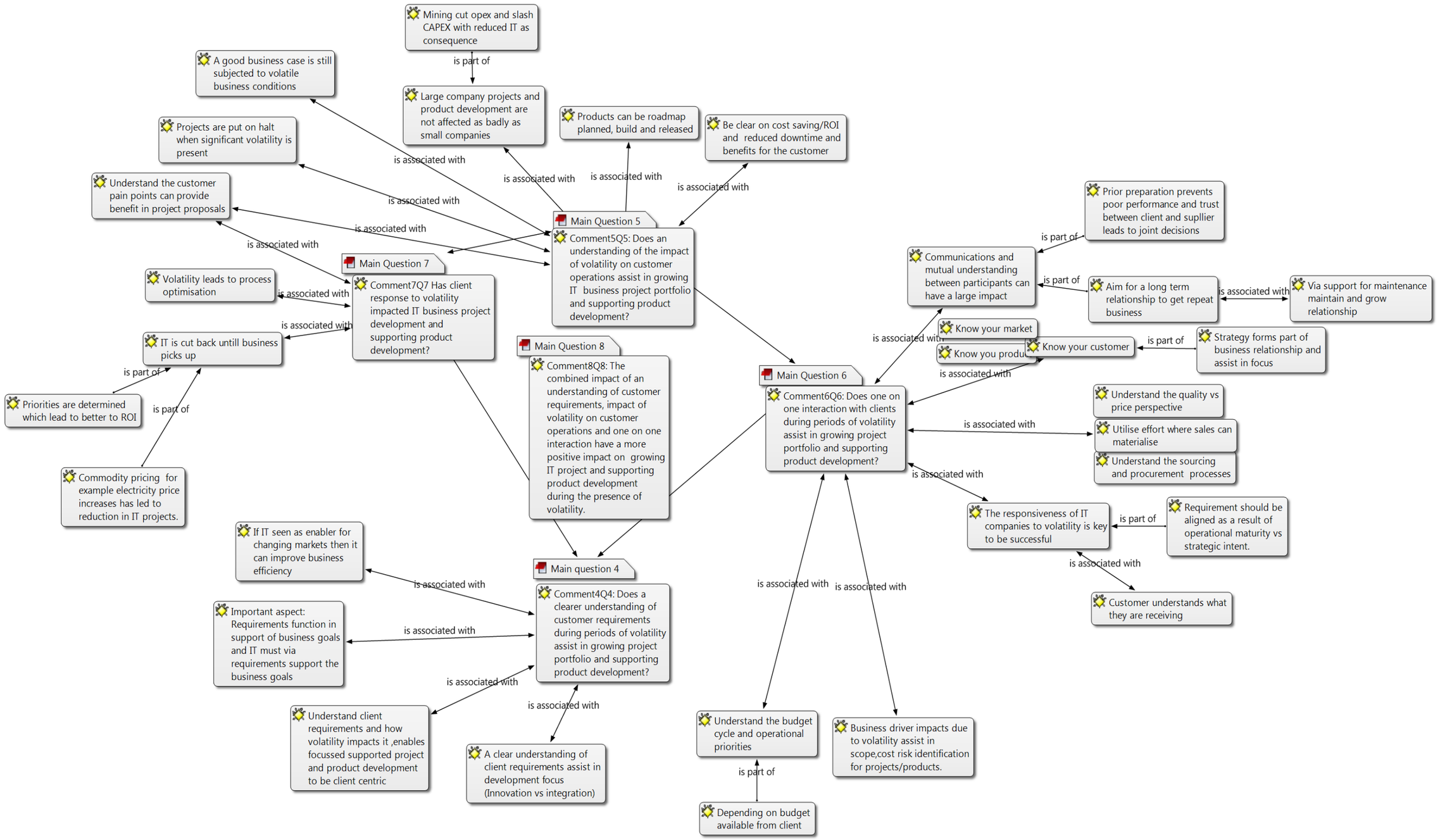

Figure 39::High level network diagram for qualitative nodes in questions 4,5,6,7

5.2.3 Questions for Hypothesis C: Univariate Data Analysis and Qualitative analysis

5.2.3.1 Question 9, Variable BusStratChange: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
8 Q9	BusStratChange	Change level in IT business for period of volatility. Retain focus on business objectives vs. short term/longer term survival.	Dependent variable Variable type = Nominal 1 = Shorter Term IT changes 2 = Longer term IT planning 3 = Both short and longer term changes 4 = Remain with original IT planning in support of business changes irrespective of short and longer term.	Research Hypothesis C Research Questions 3	Does IT business gather market intelligence for shorter or longer term strategy changes during periods of volatility?

Table 33: Review questionnaire question 9 detail

The nominal answer data feedback for the question Table 33 is analysed by means of a graphical analysis as in Figure 40. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The BusStratChange variable functions as dependent variable for the Hypothesis C.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 40, 63 of the 115 respondents (54.78 per cent) indicated IT business still focuses on obtaining market intelligence for short- and long-term strategy changes. Furthermore, more market intelligence is gathered for short-term strategy changes (25 respondents) than market intelligence for longer term strategy (10 respondents) changes. This can be indicative of making short-term changes but still understand short-term as well as longer term strategy changes.
- The nature of the distribution is short and longer terms changes since the centre is at a mean of 2.60 and median of 3 as well as a spread which with a medium skew factor of 0.40.
- The median value of 3 as a measure of location also is indicating the skewed distribution towards the larger category of both short and longer changes.
- The 25th percentile value of 2 is indicative of the 25 per cent of respondent answers being smaller than or equal to longer term level suggesting the respondent feedback favours a gathering of market intelligence for both longer term strategy changes.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to short and longer term level suggesting the respondent feedback favours a gathering of market intelligence for both short and longer term strategy changes.
- The 75th percentile value of 3 is indicative of the 75 per cent of respondent answers being smaller than or equal to short and longer term level suggesting the respondent feedback favours a gathering of market intelligence for both short and longer term strategy changes.

Thus it can be concluded according to the structured question and based on the sample data scope only, that business response during volatility is still focused on obtaining market intelligence that can lead to **short and longer term strategy changes.**

The sample data is associated to the first part of the Hypothesis C and may provide support for the underlined part only.

> **H1**: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility
> (i.e. business strategic and technical innovation decisions are more reliant on market intelligence including client requirements when volatility is present in the business environment.)

The addition of the unstructured qualitative data feedback in section 5.2.3.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.3.

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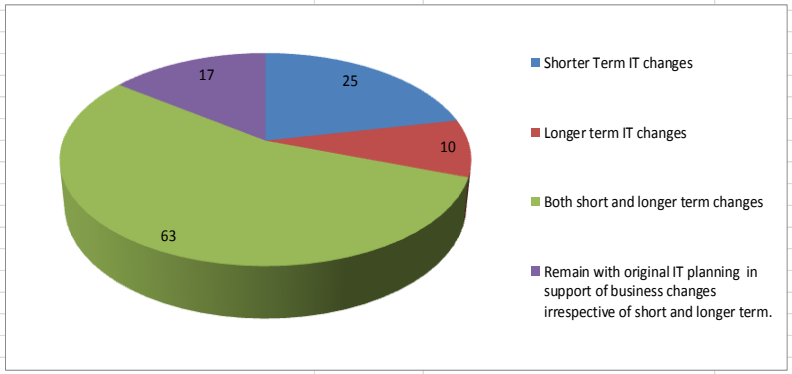
Univariate Data Analysis:

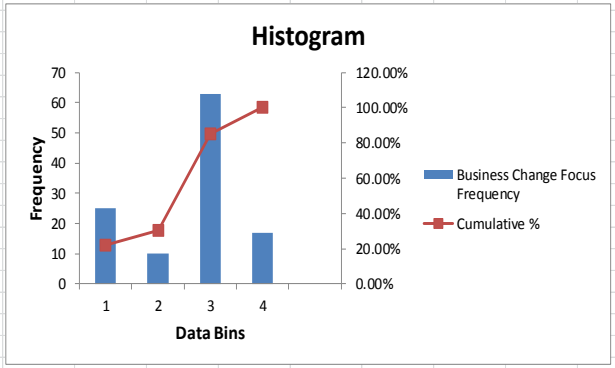
Variable 8:	BusStratChange
Variable Context:	Dependant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Business Change Focus Frequency*	*Cumulative %*
Shorter Term IT changes	1	25	21.74%
Longer term IT changes	2	10	30.43%
Both short and longer term changes	3	63	85.22%
Remain with original IT planning in support of business changes irrespective of short and longer term.	4	17	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	2.602272727	Rounded(2 decimal)	2.6
Median = middle value of range of number	3		
Mode = Number most repeated	3		
Range = Largest minus smallest	3		
25th Percentile	2		
50th Percentile	3		
75th Percentile	3		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	0.397727273	Rounded(2 decimal)	0.4

Figure 40: Univariate data analysis of variable BusStratChange

5.2.3.2 Question 10, Variable MarketIntel: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
9 Q10	MarketIntel	Determine level of increase of market intelligence during periods of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Increase 2 = Low increase 3 = Medium increase 4 = High Increase 5 = Very High Increase	Research Hypothesis C Research Question 3	Do IT businesses increase their collection of market intelligence during periods of volatility?

Table 34: Review questionnaire question 10 detail

The ordinal answer data feedback for the question Table 34 is analysed by means of a graphical analysis as in Figure 40. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The MarketIntel variable functions as an independent variable for the Hypothesis C.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 41, 40 of the 115 respondents (34.78per cent) indicated there is a medium increase in the gathering of market intelligence during periods of volatility. There seems to be a spread of higher increase (32 respondents) as well. This can be indicative of a wider opinion as respondents answers are distributed between predominantly medium increase and high increase for gathering market intelligence.
- The nature of the distribution is medium increase since the centre is at a mean of 2.84 and median of 3 as well as a spread with a very small skew factor of 0.16.
- The median value of 3 as a measure of location also is indicating a smaller skewed distribution towards the category of medium increase.
- The 50th percentile with a value of 3 is indicative of the fact that close to 50 per cent of values are smaller or equal to the medium increase category. The 75th percentile with a

value of 4 is indicative of the fact that close to 75 per cent of values are smaller or equal to the high increase category. There seems to be a spread of values, however, across low, medium and high increases.

- The 25th percentile value of 2 is indicative of the 25 per cent of respondent answers being smaller than or equal to low increase level suggesting the respondent feedback there is a low increase in the gathering of market intelligence during periods of volatility.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to medium increase level suggesting the respondent feedback there is a medium increase in the gathering of market intelligence during periods of volatility.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high increase level suggesting the respondent feedback there is a high increase in the gathering of market intelligence during periods of volatility.

Thus it can be concluded according to the structured question and based on the sample data scope only, that business response during volatility is to increase their collection market intelligence at predominantly a **medium level (category wise).** The high increase categories should not be ignored, however, as respondents did offer wider spreading opinions.

The sample data is associated to the last part of the Hypothesis C and may provide support for the underlined part only.

> **H1**: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility
> (i.e. business strategic and technical innovation decisions are more reliant on market intelligence including client requirements when volatility is present in the business environment.)

The addition of the unstructured qualitative data feedback in section 5.2.3.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

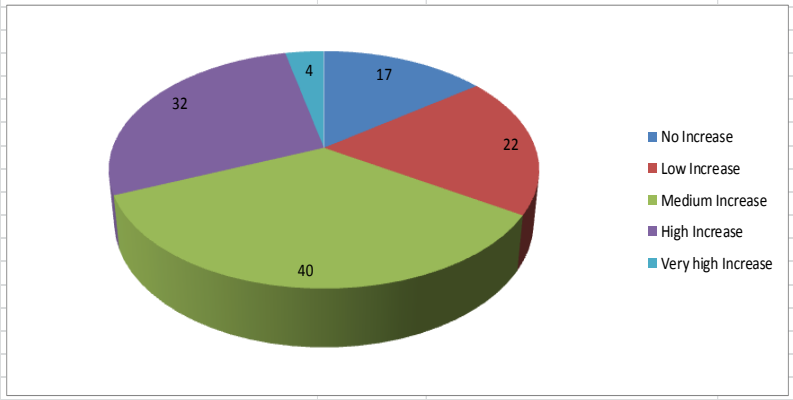
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.3.

Univariate Data Analysis:

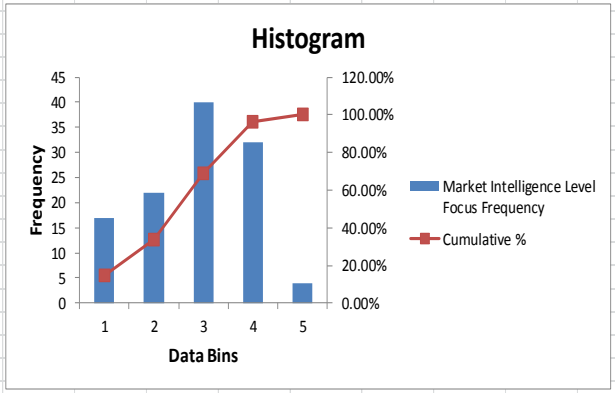
Variable 9:	MarketIntel
Variable Context:	Independent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Market Intelligence Level Focus Frequency*	*Cumulative %*
No Increase	1	17	14.78%
Low Increase	2	22	33.91%
Medium Increase	3	40	68.70%
High Increase	4	32	96.52%
Very high Increase	5	4	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1	(2 other populations are smaller in comparison)	
Mean =	2.840909091	Rounded(2 decimal)	2.84
Median = middle value of range of number	3		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	2		
50th Percentile	3		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	2		
Skew(difference between median and mean):	0.159090909	Rounded(2 decimal)	0.16

Figure 41: Univariate data analysis of variable MarketIntel

5.2.3.3 Question 11, Variable BusStratChange_vs_MarketIntel: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
10 Q11	BusStratChange_vs_ MarketIntel	Level of agreement as to changes in IT business strategy as a result of volatile business environment.	Variable Type = Likert scale variable: Association perception views from respondents. Structured scale: 1 = Strongly disagree 2 = Disagree somewhat 3 = Neutral 4 = Agree somewhat 5 = Strongly disagree	Research Hypothesis C Research Question 3	Do businesses adapt their IT business /IT strategy during periods of volatility based on market intelligence for short-term benefit?

Table 35: Review questionnaire question 11 detail

The ordinal answer data feedback for the question Table 35 is analysed by means of a graphical analysis as in Figure 42. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The BusStratChange_vs_MarketIntel variable functions as a Likert scale variable for the Hypothesis C combining both the independent and dependant variables in one question and represents the combined responses from respondents.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 42, 48 of the 115 respondents (41.74 per cent) indicated that there is only somewhat agreement that businesses adapt their IT strategy for short-term benefit. The impact of the independent variable is not as strong on the dependent variable. At neutral agreement level 33 out of the 115

respondents (28.70 per cent).Together this creates a significant 70.44% of respondent feedback.

- The nature of the distribution is in the neutral agreement level since the centre is at a mean of 2.84 and median of 3 as well as a spread with a small skew factor of 0.16.
- The median value of 3 is as a measure of location also indicating the skewed distribution tow*ards* neutral agreement only.
- *The* 75th percentile is in the somewhat agreement level category indicating the majority of respondent feedback favours equal or lower values to the somewhat agreement level only impact of the independent variable on the dependent variable.
- The 25th percentile value of 2 is indicative of the 25 per cent of respondent answers being smaller than or equal to disagree somewhat level suggesting the respondent feedback favours disagree somewhat on the impact of the independent variable on the dependent variable.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to neutral level suggesting the respondent feedback favours neutrality on the impact of the independent variable on the dependent variable.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to agree somewhat level suggesting the respondent feedback favours agree somewhat on the impact of the independent variable on the dependent variable.

Thus it can be concluded according to the structured question and based on the sample data scope only, that category of somewhat agreement is the largest category of impact of the independent variables (market intelligence) on the dependent variable (a business's strategic focus towards change).

The sample data is associated to the full parts of the Hypothesis C and may provide support for the full hypothesis.

> **H1**: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility
> (i.e. business strategic and technical innovation decisions are more reliant on market intelligence including client requirements when volatility is present in the business environment.)

There is risk in the Likert scale (Page and Meyer, 2006) as respondents might have differences in the meaning of what a response category means. The implication may be that the balance between neutral to somewhat agreement may change slightly.

From a variability perspective the standard deviation of the sample is ±1.11 which is indicative of the majority of the values being close to the mean value of 2.84.

The addition of the unstructured qualitative data feedback in section 5.2.3.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.3

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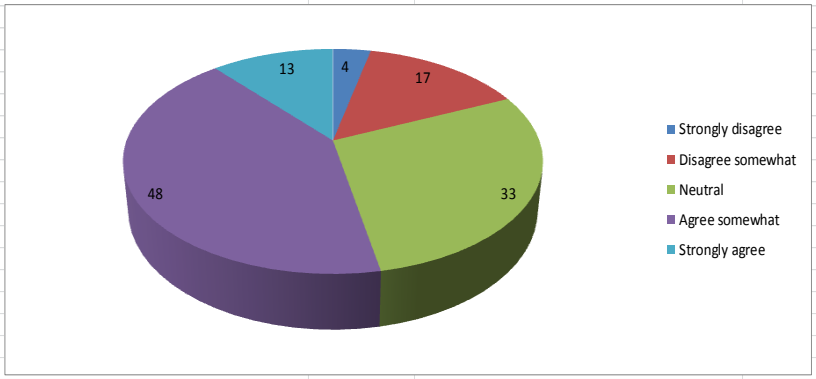
Univariate Data Analysis:

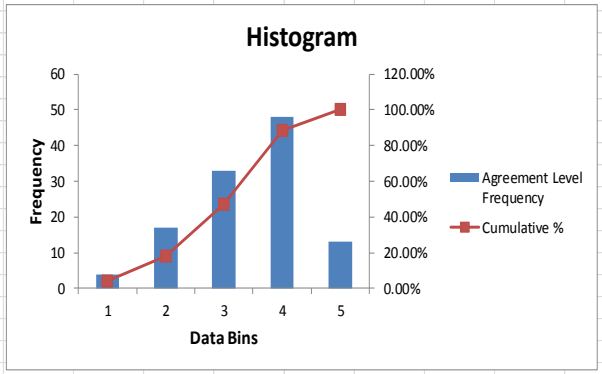
Variable 10:	BusStratChange_vs_ MarketIntel
Variable Context:	Combined Context of dependant and independent variables
Variable Type:	Likert

Data Bin Description	*Data Bins*	*Agreement Level Frequency*	*Cumulative %*
Strongly disagree	1	4	3.92%
Disagree somewhat	2	17	18.26%
Neutral	3	33	46.96%
Agree somewhat	4	48	88.70%
Strongly agree	5	13	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	2.840909091	Rounded(2 decimal)	2.84
Median = middle value of range of number	3		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	2		
50th Percentile	3		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	2		
Skew(difference between median and mean):	0.159090909	Rounded(2 decimal)	0.16
Conclusions for variability			
Standard Deviation	1.112999093	Rounded(2 decimal)	1.11

Figure 42: Univariate data analysis of variable BusStratChange_vs_MarketIntel

5.2.3.4 Inductive qualitative data analysis for Hypothesis C

The commentary data for research questions 9, 10, 11 were grouped together using Altas.ti to:

- Determine key words that describe concepts in the 3 questions
- Be able to group key data words into families of similar meaning (see Table 36), and
- Derive relationships between the key words to understand the causal relationships possible between independent and dependent variable questions. The findings must be related to existing and or new theory in relation to the hypothesis and research question.
- Bold text indicates predominant concepts and keywords in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.3.4.1 Keywords and family concepts of data

Using the Co-occurrence tables, and codes to primary documents with query capabilities of Altas.ti® majority keyword/concepts were extracted and depicted in Table 36:

Question	Question detail	Dominant keywords and concepts (families) of data
9	Does IT business gather market intelligence for shorter or longer term strategy changes during periods of volatility? *(39 responses received)*	• **Short-term collection for crisis/threat management** and **longer term collection for strategic intent and growth.** • **Understanding customer responses** to volatility requires constant collection and analysis of market intelligence. • **Proactive opportunities** identified during volatile periods should be capitalised on over the short and longer terms — Look beyond volatility. • **Business size, financial position, order book level and status in project/product development** will also determine collection of market intelligence frequency. • Businesses utilise market intelligence as part of formal **risk plans for time periods** immediate, one year, three years or five years. • Business can be **innovative/evolving** or **stable/reliable** and this requires different types and frequencies of market intelligence.

Question	Question detail	Dominant keywords and concepts (families) of data
10	Do businesses increase their collection of market intelligence during periods of volatility? *(29 responses received)*	• Yes, business increases focus on **short term survival (d**ue to insecurity/threats) and management of the business variables influenced by volatility. • Business uses increased market intelligence to **plan strategy and increase action for post volatility cycles of downturn or upturn**. • Business increases market **intelligence to obtain information on how to stabilise itself operationally** in the short- and mid-term. • Business increases market intelligence at medium level also to understand **volatility impact for clients**. • Being **flexible in approach** to do business implies the use of accurate market intelligence collected constantly to be able to adapt to changing customer behaviour as a result of volatility.
11	Do Businesses adapt their IT business /IT strategy during periods of volatility based on market intelligence for short term benefit? *(32 Responses received)*	• **Somewhat agreement,** as business makes **informed decisions on strategy** as a result of volatility it has **operational focus changes and budget constraints which both impact on IT strategy**. • Proactive opportunities identified as a result of **market intelligence** during volatility may demand **quicker innovative responses** from IT implementations. • IT strategies in larger businesses are set annually and **not frequently adapted** to ensure reaching planned IT scope is achieved and business cases promises realised. (typical key performance indicator approach to management). • Many businesses focus on **core business during volatility** which requires stable working IT functions without operational risk of changes in the short term.

Question	Question detail	Dominant keywords and concepts (families) of data
		• Market intelligence indicating **customer operational IT/business changes**, requires potential short term changes in own IT project/products. This is done to **improve delivery of services, communications and engagement**.

Table 36: Prominent keywords in questions feedback related to Hypothesis C

5.2.3.4.2 Relation to univariate quantitative data findings

- Survey question 9 quantitative finding (dependent variable): It was concluded according to the structured question and based on the sample data scope only, that business response during volatility is still focused at obtaining market intelligence that can lead to **short and longer term strategy changes**.

  The qualitative data received supports the quantitative view of that business response during volatility is still focused on obtaining market intelligence that can lead to **short and longer term strategy changes**. Short threats and crisis must be managed yet a longer term view for strategic direction, growth and intent is important.

- Survey question 10 quantitative finding (independent variable): It was concluded according to the structured question and based on the sample data scope only, that business response during volatility is to increase their collection market intelligence at predominantly a **medium level (category wise).** The high increase categories should not be ignored, however, as respondents did offer wider spreading opinions.

  The qualitative data received supports the quantitative view of businesses' response during volatility is to increase their collection market intelligence at predominantly a **medium level (category wise).** Business typically wishes to stabilise itself amongst volatile conditions to enable itself to retain focus and stick to strategic objectives.

- Survey question 11 quantitative finding (Likert variable): Thus it can be concluded according to the structured question and based on the sample data scope only, that the category of **somewhat agreement** is the largest category of impact of the independent variables on the dependent variable.

  The qualitative data received supports the quantitative view of a business's strategic focus towards change is **positively associated** with its market intelligence (client requirements)

at the time of significant volatility. There is **somewhat agreement** that the business strategic and technical innovation decisions are more reliant on market intelligence including client requirements when volatility is present in the business environment.

5.2.3.4.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Atlas.ti to indicate

- How data is grouped to support question 9 to 11
- Understand the interaction between the 3 questions.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 43 it is apparent that market intelligence plays an important role in IT project/product innovation and development as it influences business strategy. The qualitative data is suggesting that a business's strategic focus towards change is positively associated with its market intelligence (client requirements) at the time of significant volatility (Hypothesis C). This is derived from the various qualitative data concepts listed in support of the commentary fields for the quantitative question 9 where key aspects require increased marketing intelligence during periods of volatility:

- Understand volatility impact on customers
- For projects to be viable more market intelligence is required
- Business updated one- and three-year risk analysis plans based also on market information about the volatility.

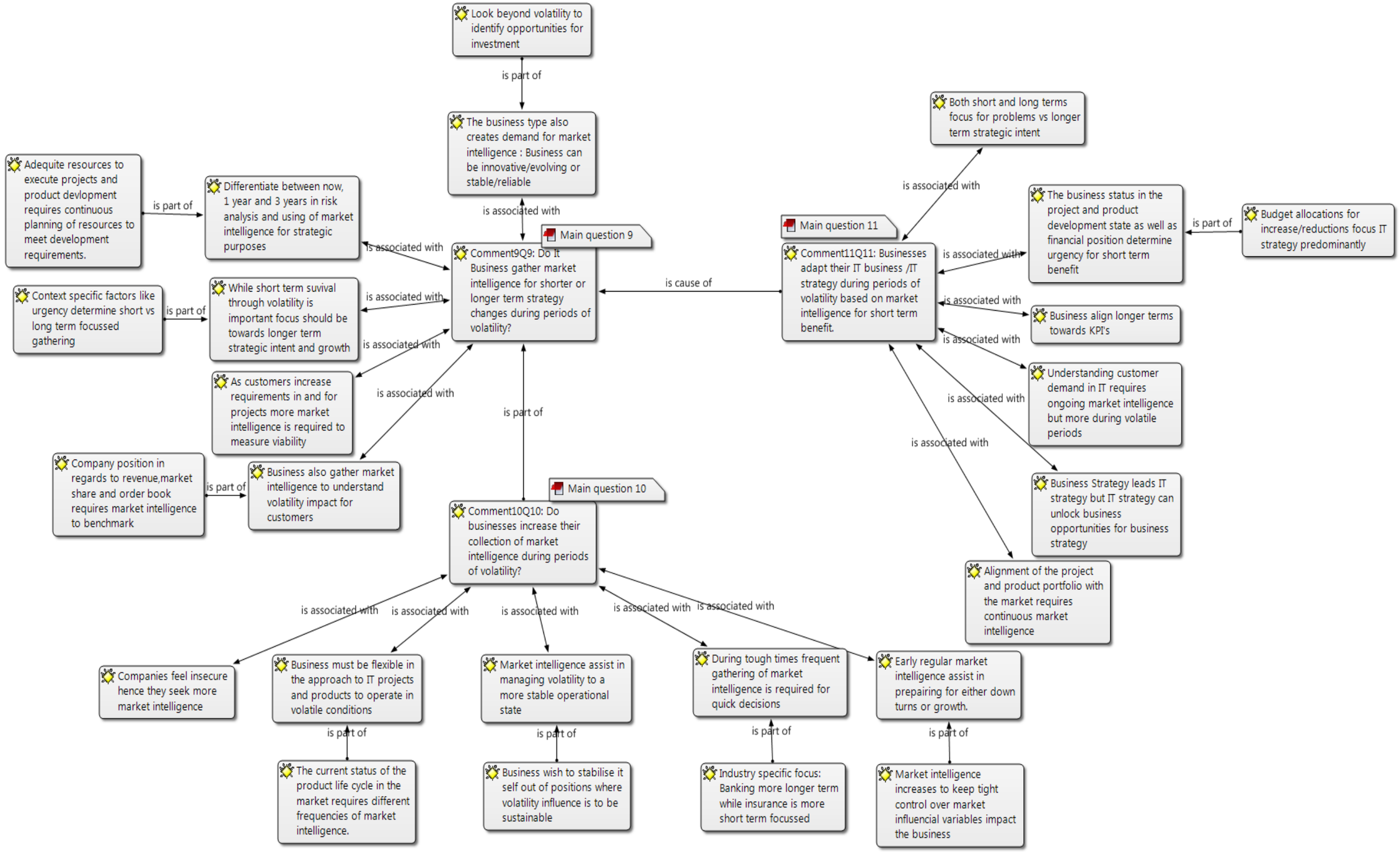


Figure 43: High level network diagram for qualitative nodes in questions 9,10,11

5.2.4 Questions for Hypothesis D: Univariate Data Analysis and Qualitative analysis

5.2.4.1 Question 12, Variable ShortLongStratDef: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
11 Q12	ShortLongStratDef	Level of change in IT businesses in short-term technology strategy to induce business value growth as a result of using market intelligence of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Changes 2 = Minimal Changes 3 = Medium Changes 4 = High amount of changes 5 = Very High levels of changes	Research Hypothesis D Research Question 4	To what extent do IT businesses adapt their short-term technology strategy to induce business value growth as a result of using market intelligence of volatility?

Table 37: Review questionnaire question 12 detail

The ordinal answer data feedback for the question Table 37 is analysed by means of a graphical analysis as in Figure 44. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The ShortLongStratDef variable functions as independent variable for the Hypothesis D.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 44, a majority of 56 of the 115 respondents (48.70 per cent) indicated that IT businesses adapt their short-term technology strategy to induce business value growth with medium level changes as a

result of using market intelligence. Furthermore, almost the same levels of changes at minimal level or high amounts occur with 26 and 27 respondents respectively.

- The nature of the distribution is in the medium-level changes category since the centre is at a mean of 2.99 and median of 3 as well as a spread with a very small skew factor of 0.01..
- The median value of 3 as a measure of location also is indicating the almost no skewed distribution towards the middle category of medium changes.
- The 25th percentile value of 2 is indicative of the 25 per cent of respondent answers being smaller than or equal to minimal changes in short-term technology strategy to induce business value growth as a result of market intelligence indicating the presence of volatility.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to medium changes in short-term technology strategy to induce business value growth as a result of market intelligence indicating the presence of volatility.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high amounts of changes in the short-term technology strategy for business value growth as a result of market intelligence indicating the presence of volatility.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that IT businesses adapt their short term technology strategy at predominantly **medium levels** as a result of market intelligence indicating the presence of volatility in the business environment.

The sample data is associated with the first part of the Hypothesis D and may provide support for the underlined part only.

> **H1**: There is a **positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

The addition of the unstructured qualitative data feedback in section 5.2.4.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

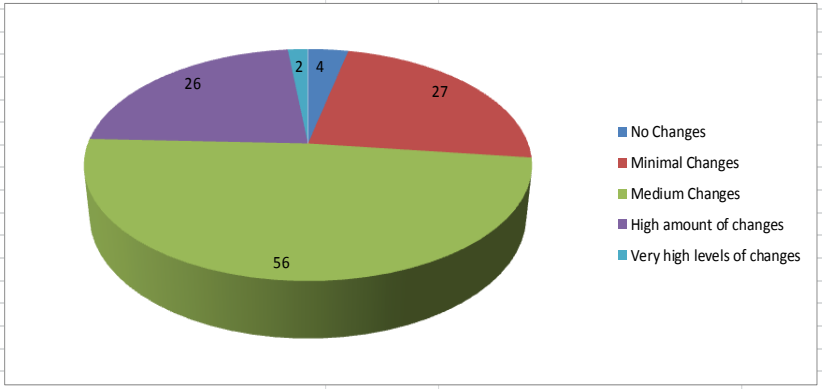
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.4.

Univariate Data Analysis:

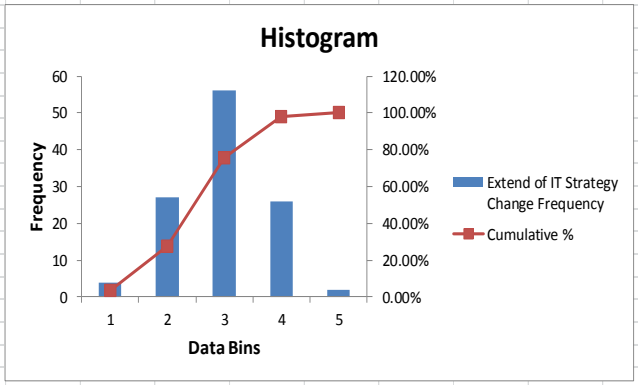
Variable 11:	ShortLongStratDef
Variable Context:	Independant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Extend of IT Strategy Change Frequency*	*Cumulative %*
No Changes	1	4	3.48%
Minimal Changes	2	27	27.43%
Medium Changes	3	56	75.65%
High amount of changes	4	26	98.26%
Very high levels of changes	5	2	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	2.988636364	Rounded(2 decimal)	2.99
Median = middle value of range of number	3		
Mode = Number most repeated	3		
Range = Largest minus smallest	4		
25th Percentile	2		
50th Percentile	3		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	2		
Skew(difference between median and mean):	0.011363636	Rounded(2 decimal)	0.01

Figure 44: Univariate data analysis of variable ShortLongStratDef

5.2.4.2 Question 13, Variable ProjectProductExecChange: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
12 Q13	ProjectProductExecChange	Level of increase in project and product portfolio adaptations as a result of IT changes in business strategy/ technology strategy for volatility.	Dependent variable Variable Type = Ordinal Structured scale: 1 = No Changes 2 = Minimal Changes 3 = Medium Changes 4 = High amount of changes 5 = Very High levels of changes	Research Hypothesis D Research Question 4	When the IT business / technology strategy is adapted for volatile reasons, are major adaptations required in the project portfolio and supporting product development?

Table 38: Review questionnaire question 13 detail

The ordinal answer data feedback for the question Table 38 is analysed by means of a graphical analysis as in Figure 45. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The ProjectProductExecChange variable functions as dependent variable for the Hypothesis D.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 44, a category majority of 51 of the 115 respondents (44.35 per cent) indicated that when changes are made in the IT business/technology strategy as a result of volatility, the changes on project portfolio and supporting products tend to be of a medium level. Furthermore, when changes are made in the IT business/technology strategy as a result of volatility, the changes to project portfolio and product development at supporting products occur at high levels according to 36 of the 115 respondents.
- The nature of the distribution is at medium level changes category lending substance to medium level changes in IT business. Since the centre is at a mean of 3.14 and median of 3 as well as a spread which with a very small skew factor of -0.14.

- The median value of 3 is as a measure of location also indicating the almost no skewed distribution towards the middle category of medium changes.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium amounts of changes required in the project portfolio and supporting product development as a result of the business/technology strategy being adapted due to volatility.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to medium amounts of changes required in the project portfolio and supporting product development as a result of the business/technology strategy being adapted due to volatility.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high amounts of changes required in the project portfolio and supporting product development as a result of the business/technology strategy being adapted due to volatility.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that change in the business/technology strategy as a result of volatility leads to **medium level** changes in the project portfolio and product development.

The sample data is associated to the second part of the Hypothesis D and may provide support for the underlined part only.

> **H1**: There is a **positive association** between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

The addition of the unstructured qualitative data feedback in section 5.2.4.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

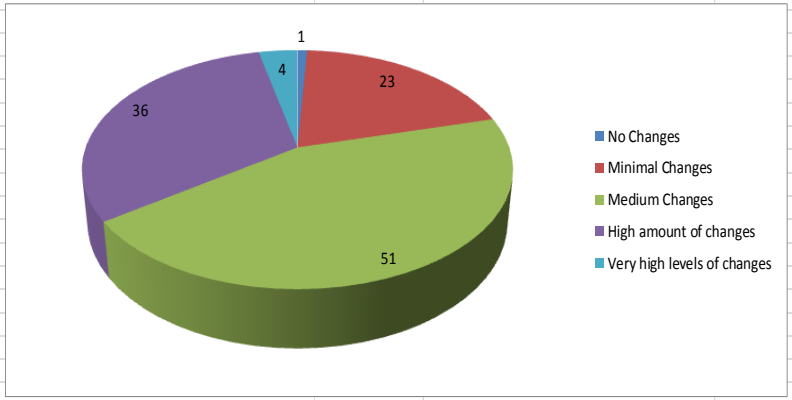
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.4.

Univariate Data Analysis:

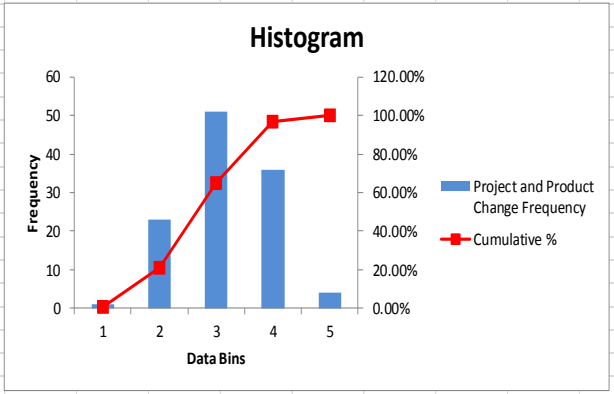
Variable 12:	ProjectProductExecChange
Variable Context:	Dependant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Project and Product Change Frequency*	*Cumulative %*
No Changes	1	1	0.87%
Minimal Changes	2	23	20.87%
Medium Changes	3	51	65.22%
High amount of changes	4	36	96.52%
Very high levels of changes	5	4	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.136363636	Rounded(2 decimal)	3.14
Median = middle value of range of number	3		
Mode = Number most repeated	3		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	3		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	-0.136363636	Rounded(2 decimal)	-0.14

Figure 45: Univariate data analysis of variable ProjectProductExecChange

5.2.4.3 Question 14, Variable ShortLongStratDef_vs_PRojectProductExecChange: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
13 Q14	ShortLongStratDef_vs_ ProjectProductExecChange	Level of impact of short term technology strategy definition on project/product portfolio changes during periods of volatility.	Variable Type = Ordinal Association perception views from respondents Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis D Research Question 4	What is the resulting impact these market intelligence mechanisms have on technology strategy in terms of project and product development in the short vs. longer term?

Table 39: Review questionnaire question 14 detail

The ordinal answer data feedback for the question in Table 39 is analysed by means of a graphical analysis as in Figure 46. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The ShortLongStratDef_vs_ ProjectProductExecChange variable functions as an ordinal scale variable for the Hypothesis D combining both the independent and dependant variables in one question and represents the combined responses from respondents.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 46, 51 of the 115 respondents (44.35 per cent) indicated that there is medium impact of market intelligence mechanisms on technology strategy (in terms of project and product development) in the short vs. longer term.. At low impact level 28 out of the 115 respondents (24.35 per cent) and at high impact level 34 out of 115 respondents (30.43 per cent).Together this creates a

significant 99.13 per cent of respondent feedback. The largest category is the medium impact level but the low impact and high impact categories cannot be ignored.

- The nature of the distribution is in the middle to predominantly medium impact level since the centre is at a mean of 3.07 and median of 3 as well as a spread which with a small skew factor of -0.07.
- The median value of 3 as a measure of location also is indicating the skewed distribution towards medium impact only.
- The 25th percentile value of 2 is indicative of the 25 per cent of respondent answers being smaller than or equal to low impact of market intelligence mechanisms on technology strategy (in terms of project and product development) in the short vs. longer term.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to medium impact of market intelligence mechanisms on technology strategy (in terms of project and product development) in the short vs. longer term.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high impact of market intelligence mechanisms on technology strategy (in terms of project and product development) in the short vs. longer term.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that the category of **medium impact** is the category that categorises the impact of the independent variable (short-term technology strategy definition) on the dependent variable (project/product portfolio execution).
The sample data is associated to the full part of the Hypothesis D and may provide support for the full hypothesis.

> **H1**: There is a **positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

There is risk in the Ordinal scale (Page and Meyer, 2006) as respondents might have differences regarding what a response category means. However, the impact of meaning should be averaged out across the 115 respondent answers.

The addition of the unstructured qualitative data feedback in section 5.2.4.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

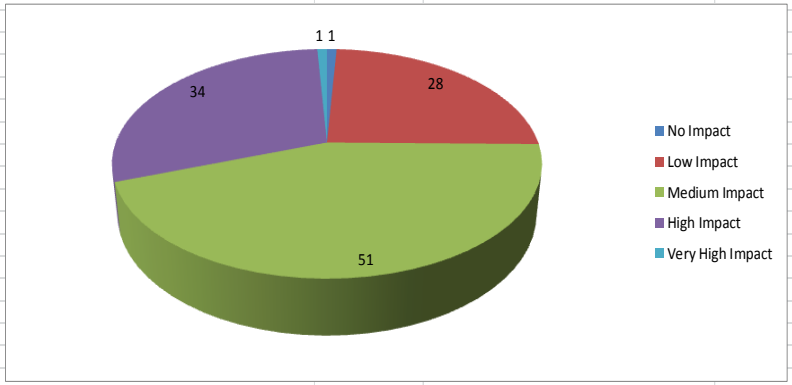
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.4.

Univariate Data Analysis:

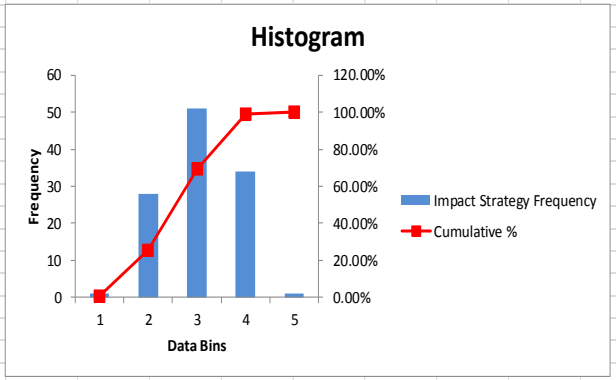
Variable 13:	ShortLongStratDef_vs_ ProjectProductExecChange
Variable Context:	Combined Context of dependant and independent variables
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Impact Strategy Frequency*	*Cumulative %*
No Impact	1	1	0.87%
Low Impact	2	28	25.22%
Medium Impact	3	51	69.57%
High Impact	4	34	99.13%
Very High Impact	5	1	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.068181818	Rounded(2 decimal)	3.07
Median = middle value of range of number	3		
Mode = Number most repeated	3		
Range = Largest minus smallest	4		
25th Percentile	2		
50th Percentile	3		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	2		
Skew(difference between median and mean):	-0.068181818	Rounded(2 decimal)	-0.07

Figure 46: Univariate data analysis of variable ShortLongStratDef_vs_ProjectProductExecChange

5.2.4.4 Inductive qualitative data analysis for Hypothesis D

The commentary data for research questions 12, 13, 14 were grouped together using Altas.ti® to:

- Determine key words that describe concepts in the 3 questions
- Be able to group key data words into families of similar meaning (see Table 40) and
- Derive relationships between the key words to understand the causal relationships possible between independent and dependent variable questions. The findings must be related to existing and or new theory in relation to the hypothesis and research question.
- Bold text indicates predominant concepts and keywords in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.4.4.1 Keywords and family concepts of data

Using the Co-occurrence tables, and codes to primary documents with query capabilities of Altas.ti® majority keyword/concepts were extracted and depicted in Table 40:

Question	Question detail	Dominant keywords and concepts (families) of data
12	To what extend do IT businesses adapt their short-term technology strategy to induce business value growth as a result of using market intelligence of volatility? (34 responses received)	• The technology strategy should **support the changes in IT business strategy** and also **unlock new business value** for the business. • **Changes (medium or drastic) in the technology strategy should have business value** attached to it extending beyond short-term revenue focus to longer term strategic intent. • A **flexible technology strategy (being able to make some changes)** which can create some value for customers with project/product adaptations does go a long way to realise short-term value and business. • The technology strategy must be adaptable with medium level changes for being able to **successfully fulfil many small orders (contract) to make up large amounts**. If a repeatable project/product solution can be delivered at low technical risk and low non-recurring engineering cost, profit can quickly

Question	Question detail	Dominant keywords and concepts (families) of data
		be realised. • The technology strategy t with some changes should phase out technical projects with low margins, low, long-term business potential and high cost. **Apply simple cost of technology vs. business benefit rules**.
13	When the IT business /technology strategy is adapted for volatile reasons, are **major adaptations required in the project portfolio and supporting product development**? *(34 responses received*)	• The answer is **context specific** since the level of change required, the business's ability to consume volatility, budget, competition position and maturity of own project /product portfolio will determine the adaptation level required. In most cases only medium changes are required. • The medium changes in the portfolio are usually split between **short-term benefit** realisation but still having **longer term focus** and strategic intent to grow the portfolio. • The technology strategy should be robust also to facilitate medium changes in technical scope, cost, time required to **mitigate variables induced by volatility** for example release versions based on functional products with interim IT product deliveries. • The **project/product portfolio maturity should be market leading** maturing level to be changed a maximum of medium level, extended and scaled for **flexible deliveries.** For example, clients procuring modular solutions over time via several project phases as budget permits. • **Accelerate changes planned** into technical strategy into the portfolio not to miss new opportunities. Slow reaction speed in IT means lost opportunities.
14	What is the resulting impact these market intelligence mechanisms have on IT	• **New market required technology** will alter the business strategy leading with medium level changes in technology strategy and

Question	Question detail	Dominant keywords and concepts (families) of data
	business/technology strategy **in terms of project and product development in the short vs. longer term**? *(24 responses received)*	subsequent development in the project and supported products. • If market intelligence indicates larger volumes for similar products in the market, **consider lowering pricing** on already developed projects/products to retain volume sales. The product portfolio should include **low risk, already developed products too** with fixed costs for delivery. • The technology strategy should make provision for **roadmap planning** in the project/product portfolio. This should facilitate **short-term extensions** in the project/product portfolio to keep the customer satisfied but also **longer term client- requested larger requirements** into the portfolio. • Market intelligence should be **constantly reviewed** to ensure the business and technology strategy changes are based on best available accurate information about the business environment. • **Competitors' projects/products portfolios** must be continuously assessed and compared to own projects/products portfolio. Required capabilities can be **generically developed** into the portfolio over time or based on **urgency "forced" into the short-term development tracks** for the portfolio.

Table 40: Prominent keywords in questions feedback related to Hypothesis D

5.2.4.4.2 Relation to univariate quantitative data findings

- Survey question 12 quantitative finding (independent variable): It was concluded according to the structured question and based on the sample data scope only, that IT businesses adapt their short term technology strategy at predominantly **medium levels** as a result of market intelligence indicating the presence of volatility in the business environment.

The qualitative data received supports the quantitative view that IT businesses adapt their short term technology strategy at predominantly **medium levels** as a result of market intelligence indicating the presence of volatility in the business environment.
Medium or drastic changes in the project/product portfolio should have business value attached to it extending beyond short term revenue focus to longer term strategic intent.

- Survey question 13 quantitative finding (dependent variable): It was concluded according to the structured question and based on the sample data scope only, that change in the business/technology strategy as a result of volatility leads to **medium level** changes in the project portfolio and product development.

  The qualitative data received supports the quantitative view that change in the business/technology strategy as a result of volatility leads to **medium level** changes in the project portfolio and product development. A clear differentiation needs to be supported in the project/product portfolio between **short term flexibility**/risk management vs. **longer term strategic value** and portfolio maturity. Mature and modular product portfolios enable high **levels of re-use** between clients requiring few product alterations for customers.

- Survey question 14 quantitative finding (ordinal variable): Thus it can be concluded according to the structured question and based on the sample data scope only, that the category of **medium impact** is the category that categorises the impact of the independent variable (business value growth as a result of the short-term technology strategy definition) on the dependent variable (definition and changes on project/product portfolio execution). There is a **positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

  The qualitative data received supports the quantitative view of positive association and medium impact between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility. Competitors' projects/products portfolios must be continuously assessed and compared to own projects/products portfolio. Required capabilities can be generically developed into the portfolio over time or based on urgency "forced" into the short term development tracks for the portfolio.

5.2.4.4.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Atlas.ti to indicate

- How data is grouped to support question 12 to 14
- Understand the interaction between the 3 questions.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 47 it is shown that there are many aspects involved in deciding to update the technology strategy as a result of business strategy changes leading to subsequent project and product development portfolio update (Hypothesis D). Short-term technology strategy updates for the mitigation of significant volatility should be aligned to longer term initiatives to build a re-usable project/product portfolio which is competitive in the market and supports the business strategy. Organisational differences in management style will dictate if visionary leaders adapt to the changing environment embracing change whilst conservative leaders for the fear of failing, avoid risky changes in the technology strategy.

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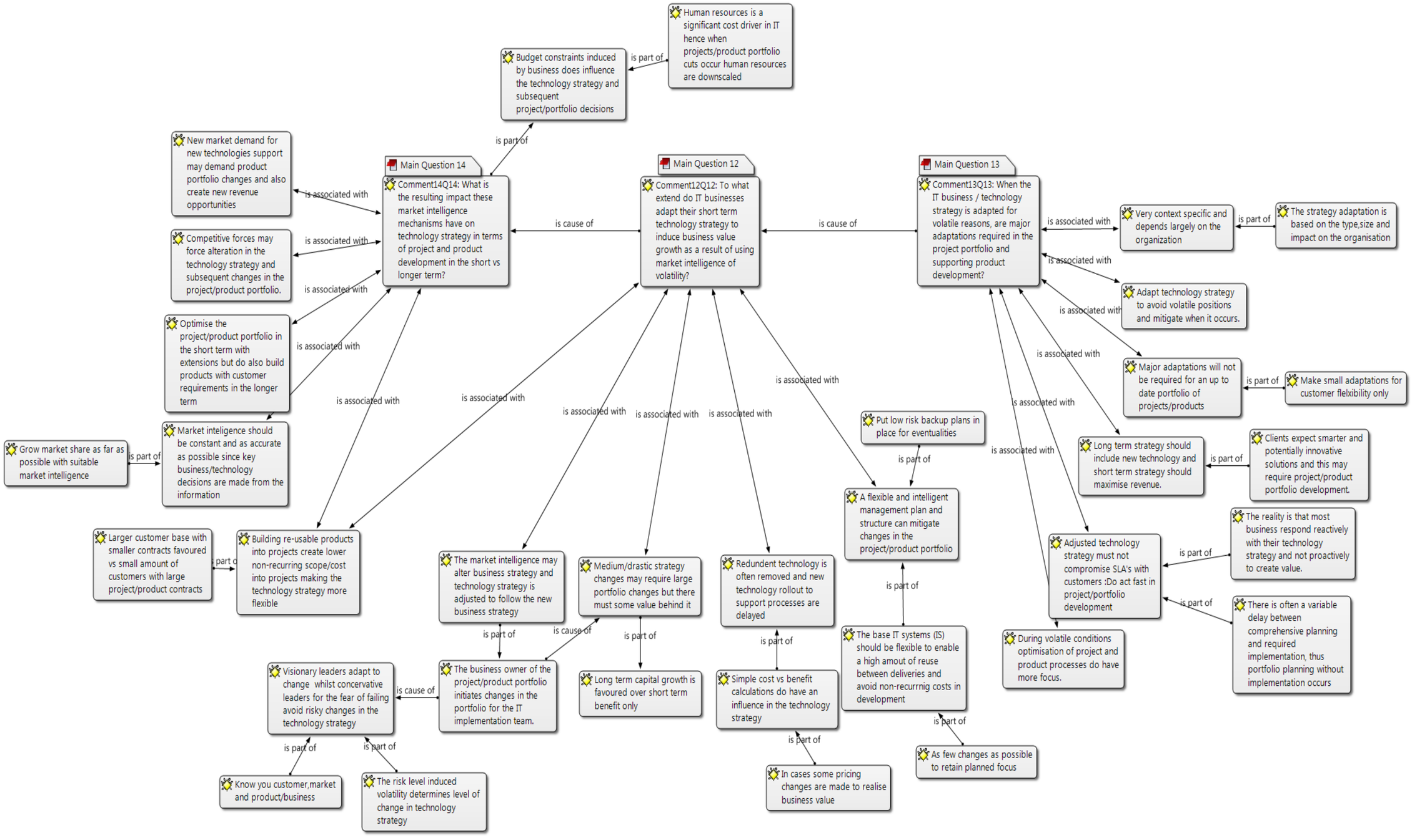


Figure 47: High level network diagram for qualitative nodes in questions 12,13,14

5.2.5 Questions for Hypothesis E: Univariate Data Analysis and Qualitative analysis

5.2.5.1 Question 15, Variable HigTechProdSelect: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
14 Q15	HighTechProdSelect	New high technology product selection impact for development during volatile periods.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis E Research Question 5	Is the selection of sellable products to be developed by IT business of more importance during volatile periods?

Table 41: Review questionnaire question 15 detail

The ordinal answer data feedback for the question in Table 41 is analysed by means of a graphical analysis as in Figure 48. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable HighTechProdSelect functions as dependent variable for the Hypothesis E.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 44, a category majority of 52 of the 115 respondents (45.22 per cent) indicated that the selection of sellable products to be developed by IT business is of higher importance during volatile periods. The remainder of the respondents indicated varying importance levels. The majority category is the high importance category.

- The nature of the distribution is at medium to high importance level category since the centre is at a mean of 3.44 and a median of 4 as well as a spread with a small skew factor of 0.56.
- The median value of 4 as a measure of location also is indicating the medium skewed distribution towards the high importance category of high importance level.
- The 25th percentile value of 2.75 (rounded to the value of 3) is indicative of the 25 per cent of respondent answers being smaller than or equal to medium importance levels of the selection of sellable products to be developed by IT business during volatile periods.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to high importance levels of the selection of sellable products to be developed by IT business during volatile periods.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high importance levels of the selection of sellable products to be developed by IT business during volatile periods.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that the selection of sellable products to be developed by IT business is of **higher importance** during volatile periods.

The sample data is associated to the first part of the Hypothesis E and may provide support for the underlined part only.

> **H1**: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility.

The addition of the unstructured qualitative data feedback in section 5.2.5.5 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

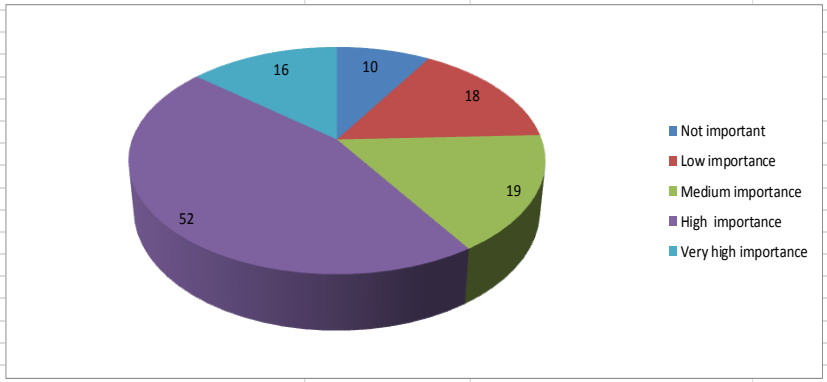
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.5.

Univariate Data Analysis:

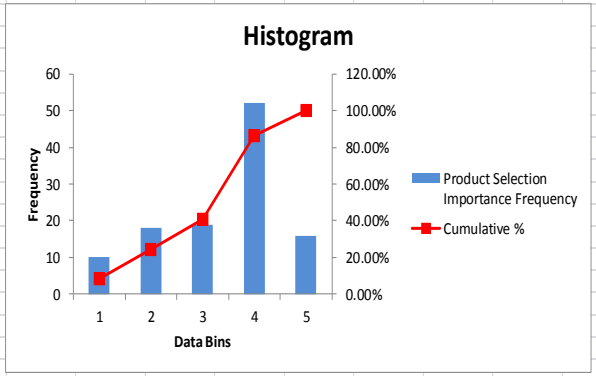
Variable 14:	HighTechProdSelect
Variable Context:	Dependant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Product Selection Importance Frequency*	*Cumulative %*
Not important	1	10	8.70%
Low importance	2	18	24.35%
Medium importance	3	19	40.87%
High importance	4	52	86.09%
Very high importance	5	16	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:		1	
Mean =		3.443181818	Rounded(2 decimal) 3.44
Median = middle value of range of number		4	
Mode = Number most repeated		4	
Range = Largest minus smallest		4	
25th Percentile		2.75	
50th Percentile		4	
75th Percentile		4	
Interquantile range(75th - 25th percentile):		1.25	
Skew(difference between median and mean):		0.556818182	Rounded(2 decimal) 0.56

Figure 48: Univariate data analysis of variable HighTechProdSelect

5.2.5.2 Question 16, Variable ProjectPortfSlect: Univariate quantitative data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
15 Q16	ProjectPortfSlect	New high technology project selection impact from clients for execution during volatile periods	Independent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis E Research Question 5	Is the selection of projects for the IT business as offered by clients to execute of more importance during volatile periods than non-volatile periods?

Table 42: Review questionnaire question 16 detail

The ordinal answer data feedback for the question for Table 42 is analysed by means of a graphical analysis as in Figure 49. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable ProjectPortfSlect functions as independent variable for the hypothesis E.

Interpretation of structured data results:

- As can be seen in the pie chart and bar graph of Figure 49, a category majority of 47 of the 115 respondents (40.87 per cent) indicated that the selection of projects for the IT business as offered by clients to execute is of higher importance during volatile periods than non-volatile periods. A total of 32 out of 115 (27.83 per cent) respondents indicated that the selection of projects for the IT business as offered by clients to execute is of medium importance during volatile periods compared to non-volatile periods. The majority category is the high importance category.
- The nature of the distribution is at high to medium importance level category since the centre is at a mean of 3.42 and median of 4 as well as a spread with a small skew factor of 0.58.

- The median value of 4 is as a measure of location also indicating the medium skewed distribution towards the high importance category of high importance level.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium importance of selection of projects for development during periods of volatility.
- The 50th percentile value of 4 is indicative of the 50% of respondent answers being smaller than or equal to high importance of selection of projects for development during periods of volatility.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high importance of selection of projects for development during periods of volatility.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that the selection of projects for the IT business as offered by clients to execute is of **high importance** during volatile periods rather than non-volatile periods.

The sample data is associated with the second part of the Hypothesis E and may provide support for the underlined part only.

> **H1**: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility.

The addition of the unstructured qualitative data feedback in section 5.2.5.5 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

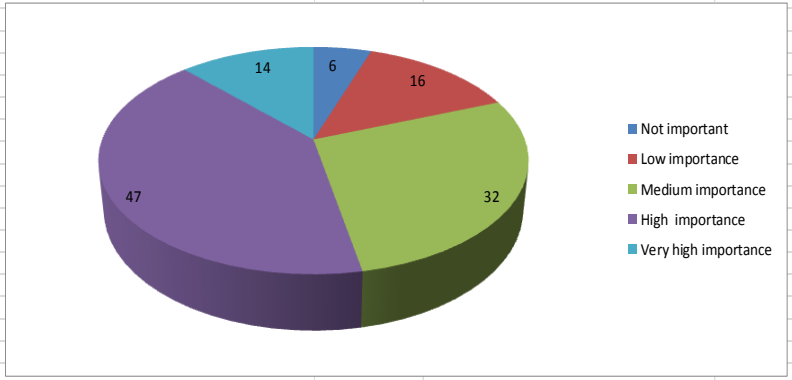
The measure of association between variables and tests for significance of the sample result for validity in the hypothesis and also application in the larger population is tested in section 5.3.5

Univariate Data Analysis:

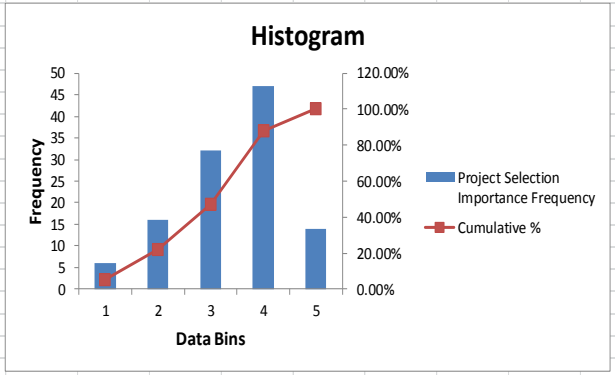
Variable 15:	ProjectPortfSlect
Variable Context:	Independant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Project Selection Importance Frequency*	*Cumulative %*
Not important	1	6	5.22%
Low importance	2	16	21.78%
Medium importance	3	32	46.96%
High importance	4	47	87.83%
Very high importance	5	14	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	3.420454545	Rounded(2 decimal)	3.42
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	0.579545455	Rounded(2 decimal)	0.58

Figure 49: Univariate data analysis of variable ProjectPortfSlect

5.2.5.3 Question 17, Variable AbiliDeliverProdClient: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
16 Q17	AbiliDeliverProdClient	Importance of IT business having the organisational capacity (people, infrastructure, financial resources) and technology to deliver contracted products/services taken on for delivery.	Moderating Variable Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis E Research Question 5	Do IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects?

Table 43: Review questionnaire question 17 detail

The nominal answer data feedback for the question Table 43 is analysed by means of a graphical analysis as in Figure 50. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable AbiliDeliverProdClient functions as **moderating** variable for the Hypothesis E.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 50, a category majority of 74 of the 115 respondents (64.35 per cent) indicated IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects. A total of 41 out of 115 (35.65 per cent respondents indicated that IT businesses do not have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects. The majority category is the “yes” category.

- The mean value of 1.61 lends substance to the “yes” category where the centre rating value rounded is 2.
- The mode of the sample values is clearly 74 out of 115 in favour of the “yes” category.

Thus it may be concluded according to the structured question, based on the sample data scope only and highest category, that IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects.

The sample data impacts the independent variable (ProjectPortfSlect) and dependent variable (HighTechProdSelect) which are both associated to the Hypothesis E:

> **H1**: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility.

The addition of the unstructured qualitative data feedback in section 5.2.5.5 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables, including impact of the moderating variable and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.5.

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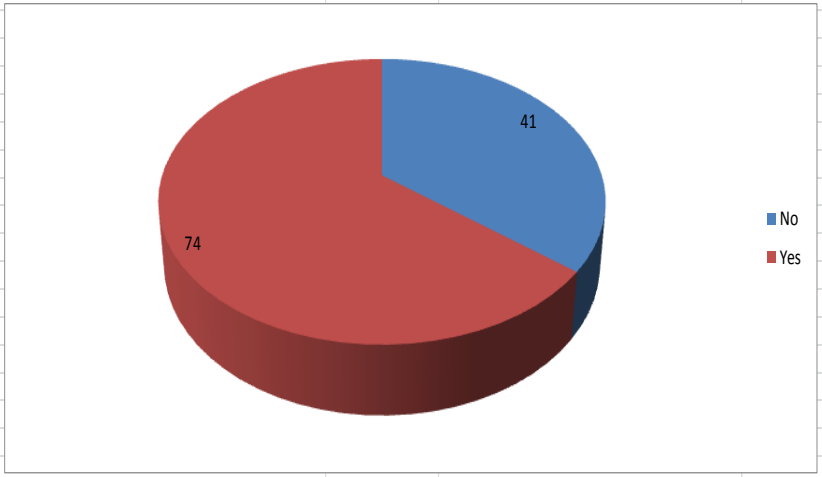
Univariate Data Analysis:

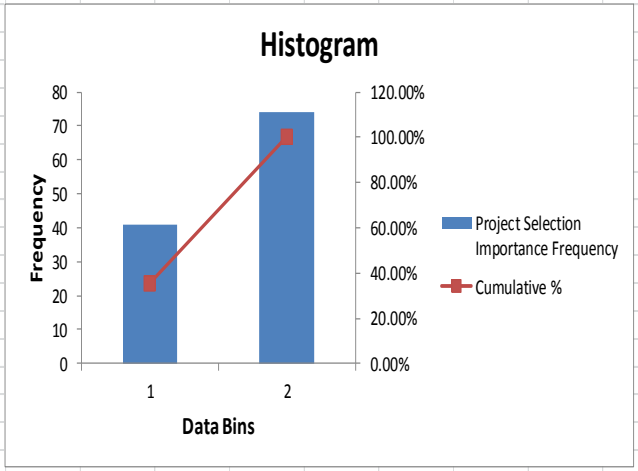
Variable 16:	AbiliDeliverProdClient
Variable Context:	Moderating
Variable Type:	Nominal

Data Bin Description	*Data Bins*	*Project Selection Importance Frequency*	*Cumulative %*
No	1	41	35.65%
Yes	2	74	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	1.613636364	Rounded(2 decimal)	1.61
Mode = Number most repeated	2		

Figure 50: Univariate data analysis of variable AbiliDeliverProdClient

5.2.5.4 Question 18, Variable HighTechProdAelect_vs_ProjectPortfSlect: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
17 Q18	HighTechProdSelect_vs_ ProjectPortfSlect	Importance of the right product portfolio selection during periods of volatility.	Association perception views from respondents Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis E Research Question 5	Is the formulation of the right product portfolio in support of potential projects to clients more critical during periods of volatility than in periods of less volatility?

Table 44: Review questionnaire question 18 detail

The nominal answer data feedback for the question Table 44 is analysed by means of a graphical analysis as in Figure 51. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable HighTechProdSelect_vs_ ProjectPortfSlect functions as a variable for the Hypothesis E since it describes the relationship between the dependent and independent variables as perceived by the respondents.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 51, a category majority of 90 of the 115 respondents (78.26 per cent) indicated the formulation of the right product portfolio in support of potential projects to clients is more critical during periods of volatility than in periods of less volatility. A total of 25 out of 115 (21.74 per cent) respondents indicated that the formulation of the right product portfolio in support of potential projects to clients is not more critical during periods of volatility than in periods of less volatility. The majority category is the “yes” category.

- The mean value of 1.78is lending substance to “yes” category where the centre rating value rounded is 2.
- The mode of the sample values is clearly 90 out of 115 in favour of the “yes” category.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that the formulation of the right product portfolio in support of potential projects to clients is more critical during periods of volatility than in periods of less volatility.

The sample data impacts the independent variable (ProjectPortfSlect) and dependent variable (HighTechProdSelect) which are both associated to the Hypothesis E:

> **H1**: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility.

The addition of the unstructured qualitative data feedback in section 5.2.5.5 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables, including tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.5

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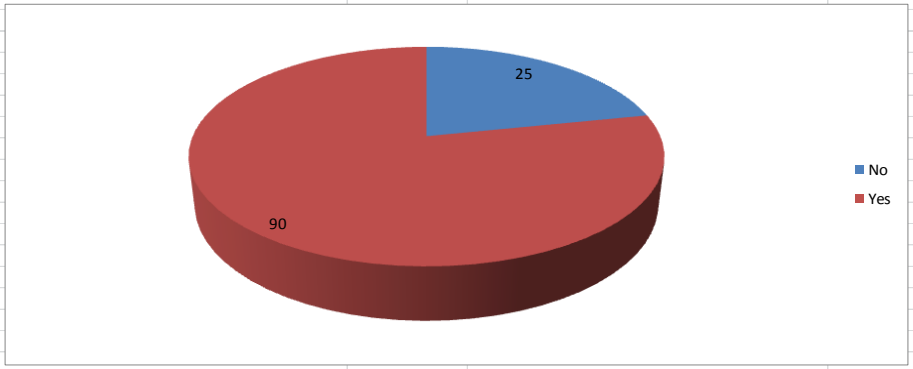
Univariate Data Analysis:

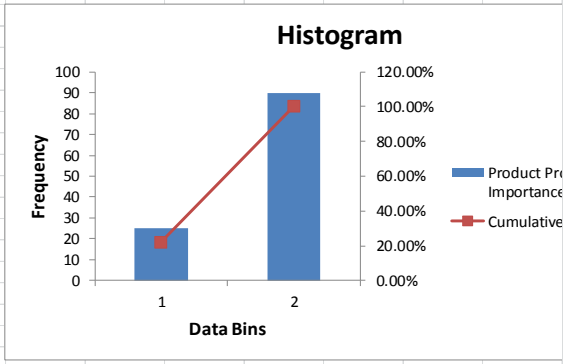
Variable 17:	HighTechProdSelect_vs_ ProjectPortfSlect
Variable Context:	Correlative
Variable Type:	Nominal

Data Bin Description	*Data Bins*	*Product Project Selection Importance Frequency*	*Cumulative %*
No	1	25	21.74%
Yes	2	90	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1		
Mean =	1.784090909	Rounded(2 decimal)	1.78
Mode = Number most repeated	2		

Figure 51: Univariate data analysis of variable HighTechProdSelect_vs_ProjectPortfSlect

5.2.5.5 Inductive qualitative data analysis for Hypothesis E

The commentary data for research questions 15, 16, 17, 18 were grouped together using Atlas.ti to:

- Determine key words that describe concepts in the 4 questions;
- Be able to group key data words into families of similar meaning (see Table 45);
- Derive relationships between the key words to understand the causal relationships possible between independent and dependent variable questions;
- The findings should be related to existing and or new theory in relation to the hypothesis and research question; and
- Bold text indicates predominant concepts and keyword in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.5.5.1 Keywords and family concepts of data

Using the Co-occurrence tables, and codes to primary documents with query capabilities of Altas.ti® majority keyword/concepts were extracted and depicted in Table 45

Question	Question detail	Dominant keywords and concepts (families) of data
15	Is the selection of sellable products to be developed by IT business of more importance during volatile periods? *(39 responses received)*	• **Yes,** the selection of products is very important before and during volatile periods. • The dominant aspect listed by the respondents is that the IT business should have a **diversified product portfolio with lower unit cost, mature and sellable products** that are also available to be sold off the shelf to customers. Not all products should be in the development status of "in progress, but not yet available". • A **proactive product management/planning** (with commercial and sales skill) function must ensure the products have features, functions and prices to be able to be sold in volatile/non-volatile environments. • Be in **close contact with customers where relationship can expose key product**

Question	Question detail	Dominant keywords and concepts (families) of data
		attributes required for the existing and new products. This should focus **limited budgets** at **re-usable, key client requirements and have a competitive edge** to be implemented into product development during volatile periods. • **Return on investment (ROI) in the short term** is important for cash flow yet the product **roadmap also should fit into short time** for delivery to customers.
16	Is the selection of projects for the IT business as offered by clients to execute of more importance during volatile periods than non-volatile periods? *(34 responses received)*	• **Yes, project selection is more important during periods of volatility.** • The dominant concept is that **projects must have value that makes them unique, competitive and have a high ROI with low risk**. • Projects should have a **business case and execution plan to generate ROI early** in the project lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational process efficiencies induced, cost savings, communications, and so forth. Because client **project budgets are tight, IT business should stick to core product features, remove "nice to haves", include some customer required features and remove unnecessary cost drivers**. • Care should be taken not have the client fall into **long-term expensive maintenance financial** traps. Maintenance budgets should rather also provide **new innovative features** during the project delivery to ensure the client gets significant operational value for money. **Longer term contracts even with lower profit** provide project team security and a satisfied customer.

Question	Question detail	Dominant keywords and concepts (families) of data
17	Do IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects? *(43 responses received)*	• **Yes**, on a case-by-case approach where **processes are in place** and being **executed as such**. • **Larger businesses** with more **formal processes** tend to have more formal capacity planning since they execute more project and product development with large but **limited teams** of people and resources. • **Smaller IT businesses** tend to scope capacity on a **per project only** with little excess capacity or overhead plan. • **Budget constraints** have a significant impact on capacity planning since the ideal available resources may often not fit into the budget**.** • Many IT businesses utilise **best practise industry frameworks** like TOGAF®, PRINCE II®, ZACHMAN®, ITIL®, COBIT® and Industry frameworks like eTOM®, EMMMV®, HPUM® for capacity planning and process maturity assessments.
18	Is the formulation of the right product portfolio in support of potential projects to clients more critical during periods of volatility than in periods of less volatility? *(24 responses received)*	• **Yes**, the right project and product portfolio strategy is more required during volatile periods as there is **potentially less funding available from IT clients.** • The technology strategy that manages the **project and product portfolio must be benchmarked/aligned to the business strategy**. The portfolio is more than a business enabler and should unlock new business strategy as well. • The portfolio should **mitigate via the mix of product and services the volatile influences** and focus on the overall technology strategy. • The project and product portfolio should have **business case and execution plans to**

Question	Question detail	Dominant keywords and concepts (families) of data
		generate ROI early in the project lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational process efficiencies induced, cost savings, communications, and so forth. • The complete portfolio should aim even in volatile periods to **have a value proposition and competitive edge** that customers favour and wish to have. Clients do **demand more value** and **requirements** from their funding provided during volatile periods.

Table 45: Prominent keywords in question feedback related to Hypothesis E

5.2.5.5.2 Relation to univariate quantitative data findings

- Survey question 15 quantitative finding (dependent variable): It was concluded according to the structured question and based on the sample data scope only that the selection of sellable products to be developed by IT business is of **higher importance** during volatile periods.

  The qualitative data received supports the quantitative view that the selection of sellable products to be developed by IT business is of **higher importance** during volatile periods. The dominant aspect listed by the respondents is that the IT business should have a diversified product portfolio with a lower unit cost, mature and sellable **products** and also available to be sold off the shelf to customers. Not all products should be in the development status of being “in progress, but not yet available”.

- Survey question 16 quantitative finding (independent variable): It was concluded according to the structured question and based on the sample data scope only, that the selection of projects for the IT business as offered by clients to execute is of **high importance** during volatile periods, more so than during non-volatile periods.

  The qualitative data received supports the quantitative view that the selection of projects for the IT business as offered by clients to execute is of **high importance** during volatile periods, more so than during non-volatile periods. The dominant concept is that projects should have value that makes them unique, competitive and have a high ROI with low risk.

- Survey question 17 quantitative finding (moderating variable): Thus it can be concluded according to the structured question and based on the sample data scope only, that IT businesses **have mature processes** in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects.

  The qualitative data received supports the quantitative view that IT businesses **have mature processes** in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects. Larger businesses with more formal processes tend to have more formal capacity planning since they execute more project and product development with large but limited teams of people and resources. Smaller IT businesses tend to scope capacity on a per project only with little excess capacity or overhead plan.

- Survey question 18 quantitative finding (nominal variable): Thus it can be concluded according to the structured question and based on the sample data scope only, that the formulation of the right product portfolio in support of potential projects to clients is **more critical** during periods of volatility than in periods of less volatility.

  The qualitative data received supports the quantitative view that the formulation of the right product portfolio in support of potential projects to clients is **more critical** during periods of volatility than in periods of less volatility (Hypothesis E). The portfolio must mitigate via the mix of product and services the volatile influences and focus on the overall technology strategy.

5.2.5.5.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Atlas.ti to indicate

- How data is grouped to support question 15 to 18
- Understand the interaction between the 3 questions.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 52 it is seen that there are many aspects involved in deciding to update the project and product portfolio in support of the technology plan. (Hypothesis E). Achieving a level of maturity in the portfolio and close alignment to the business strategy is critical to ensure that short-term volatility does not defocus the agreed technology plan.

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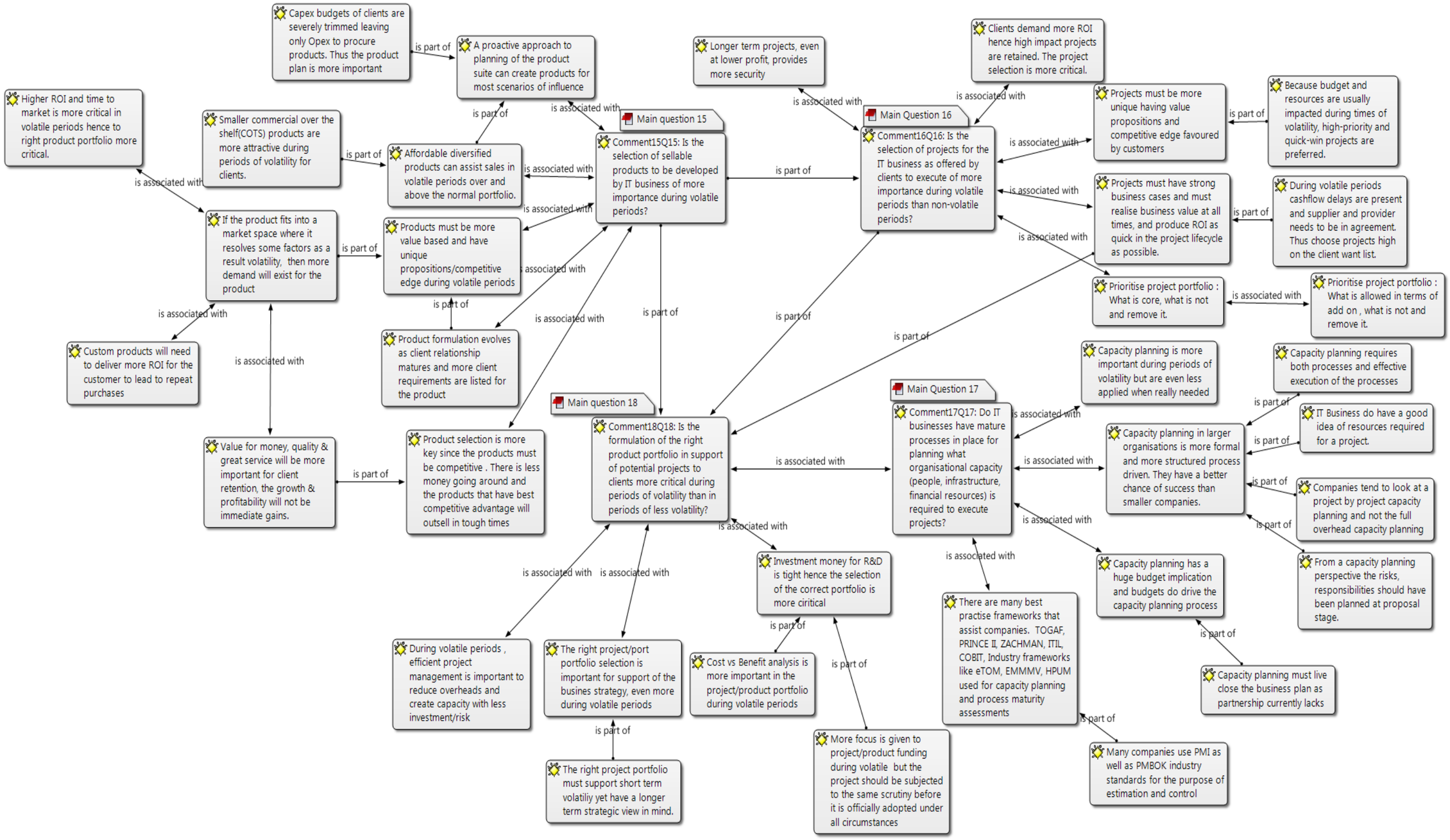

Figure 52: High level network diagram for qualitative nodes in questions 15, 16, 17, 18

5.2.6 Questions for Hypothesis F: Univariate Data Analysis and Qualitative analysis

5.2.6.1 Question 19, Variable ProdProjChanges: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
18 Q19	ProdProjChanges	Impact of project changes on product development	Independent variable Variable Type = Ordinal Structured scale: 1 = No risk 2 = Low risk 3 = Medium risk 4 = High risk 5 = Very High risk	Research Hypothesis F Research Question 6	Is there increased risk in product development as a result of changes in project execution for clients when volatility is present?

Table 46: Review questionnaire question 19 detail

The ordinal answer data feedback for the question in Table 46 is analysed by means of a graphical analysis as in Figure 53. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable ProdProjChanges functions as independent variable for the Hypothesis F.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 50, a category majority of 52 of the 115 respondents (45.22 per cent) indicated there is high increased risk in product development as a result of changes in project execution for clients when volatility is present. A total of 40 out of 115 respondents (34.78 per cent) indicated there is medium increased risk in product development as a result of changes in project execution for clients when volatility is present. The majority category is the high risk category but jointly with the medium risk 80 per cent of respondents indicated there is medium to high increased risk in product development as a result of changes in project execution for clients when volatility is present. This then becomes a significant result.

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- The nature of the distribution is at medium level risk category since the centre is at a mean of 3.53 and median of 3 as well as a spread which with a very small skew factor of 0.47.
- The median value of 4 is as a measure of location also indicating the medium skewed distribution towards the high risk level.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium increased risk in product development as a result of changes in project execution for clients when volatility is present.
- The 50th percentile value of 3 is indicative of the 50 per cent of respondent answers being smaller than or equal to high increased risk in product development as a result of changes in project execution for clients when volatility is present.
- The 75th percentile value of 3 is indicative of the 75 per cent of respondent answers being smaller than or equal to high increased risk in product development as a result of changes in project execution for clients when volatility is present.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, that there is **medium to high increased risk** in product development as a result of changes in project execution for clients when volatility is present.

The sample data is associated to the first part of the Hypothesis F and may provide support for the underlined part only.

> **H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment.

The addition of the unstructured qualitative data feedback in section 5.2.6.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

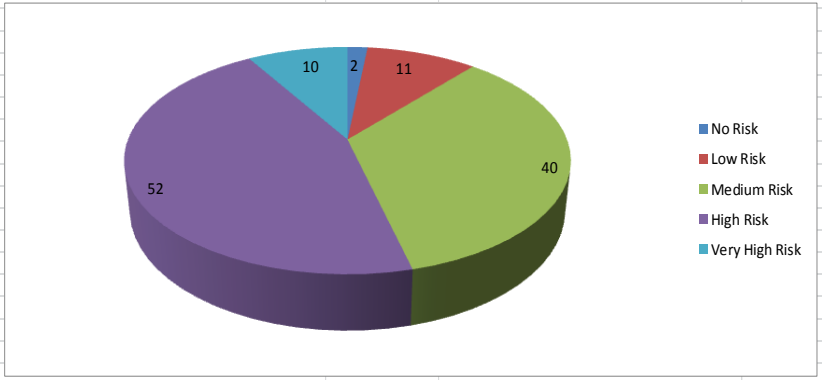
The measure of association between variables, including impact of the moderating variable and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.6.

Univariate Data Analysis:

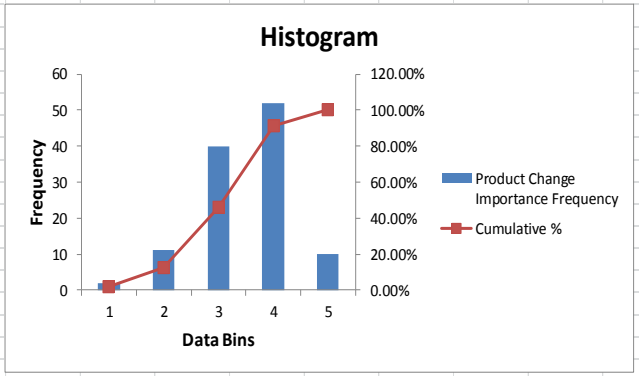
Variable 18:	ProdProjChanges
Variable Context:	Independant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Product Change Importance Frequency*	*Cumulative %*
No Risk	1	2	1.74%
Low Risk	2	11	12.38%
Medium Risk	3	40	46.09%
High Risk	4	52	91.30%
Very High Risk	5	10	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1	High Importance	
Mean =	3.534090909	Rounded(2 decimal)	3.53
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	0.465909091	Rounded(2 decimal)	0.47

Figure 53: Univariate data analysis of variable ProdProjChanges

5.2.6.2 Question 20, Variable CapacityPlanDelivery: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
19 Q20	CapacityPlan Delivery	Importance of capacity planning for project execution during volatile periods.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis F Research Question 6	Do IT businesses increase focus in capacity planning for project execution during volatile periods?

Table 47: Review questionnaire question 20 detail

The ordinal answer data feedback for the question in Table 47 is analysed by means of a graphical analysis as in Figure 54. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable CapacityPlanDelivery functions as dependent variable for the Hypothesis F.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 50, the largest category majority of 39 of the 115 respondents (33.91per cent) indicated IT business increases with high importance focus in capacity planning for project execution during volatile periods. A total of 35 out of 115 respondents (30.43 per cent) indicated IT business increases with medium importance focus in capacity planning for project execution during volatile periods. The majority category is the high risk category but jointly with the medium importance a total 64.34 per cent of respondents indicated IT business increases with medium to high importance focus in capacity planning for project execution during volatile periods. This then only becomes a significant result.

- The nature of the distribution is at medium level risk category since the centre is at a mean of 3.28 and median of 3 as well as a spread which with a small skew factor of -0.28.
- The median value of 3 is as a measure of location also indicating the medium skewed distribution towards the medium importance category level.
- The 25th percentile value of 3 is indicative of the 25per cent of respondent answers being smaller than or equal to medium importance level. IT business increases then with medium importance focus the capacity planning for project execution during volatile periods.
- The 50th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium importance level. IT business increases then with medium importance focus the capacity planning for project execution during volatile periods.
- The 75th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high importance level. IT business increases then with high importance focus the capacity planning for project execution during volatile periods.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, IT business increases with **medium to high importance** focus in capacity planning for project execution during volatile periods.

The sample data is associated to the second part of the Hypothesis F and may provide support for the underlined part only.

> **H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment.

The addition of the unstructured qualitative data feedback in section 5.2.6.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

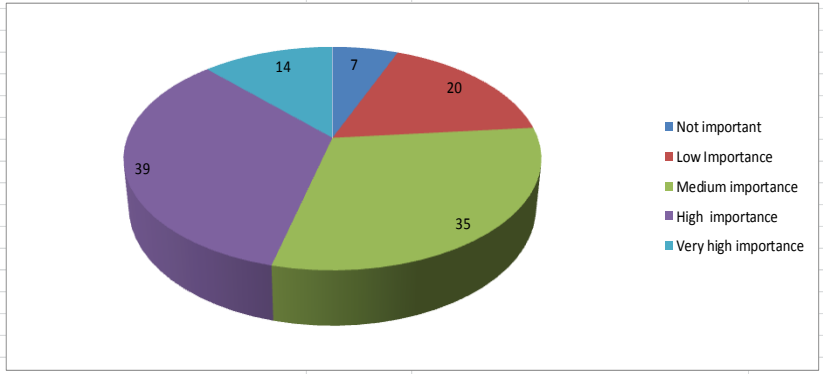
The measure of association between variables, including impact of the moderating variable and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.6.

Univariate Data Analysis:

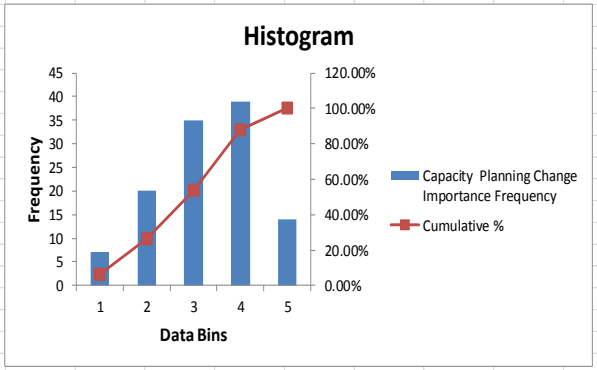
Variable 19:	CapacityPlanDelivery
Variable Context:	Dependent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Capacity Planning Change Importance Frequency*	*Cumulative %*
Not important	1	7	6.09%
Low Importance	2	20	26.73%
Medium importance	3	35	53.91%
High importance	4	39	87.83%
Very high importance	5	14	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	2	High Importance with a close following of medium importance	
Mean =	3.284090909	Rounded(2 decimal)	3.28
Median = middle value of range of number	3		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	3		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	-0.284090909	Rounded(2 decimal)	-0.28

Figure 54: Univariate data analysis of variable CapacityPlanDelivery

5.2.6.3 Question 21, Variable ProdProjChanges_vs_CapacityPlanDelivery: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
20 Q21	ProdProjChanges_vs_ CapacityPlan Delivery	Is there increased focus in capacity planning and product portfolio changes to support project execution during periods of volatility?	Association perception views from respondents Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis f Research Question 6	Is there an increased focus in capacity planning and product portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility?

Table 48: Review questionnaire question 21 detail

The nominal answer data feedback for the question in Table 48 is analysed by means of a graphical analysis as in Figure 55. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable ProdProjChanges_vs_ CapacityPlanDelivery functions as variable for the hypothesis F it describes the relationship between the dependent and independent variables as perceived by the respondents.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 55, a the largest category majority of 71 of the 115 respondents (61.74 per cent) indicated the increased focus in capacity planning and product portfolio changes in support of potential projects to clients is more critical during periods of volatility than in periods of less volatility. A total of 44 out of 115 respondents (38.26 per cent) indicated the increased focus in capacity planning and product portfolio changes in support of potential projects to clients is not more critical during periods of volatility than in periods of less volatility.
  The majority category is the agreement “Yes” category with a total of 61.74 per cent and this then only becomes a significant result.

- The nature of the distribution is at the “Yes” agreement category since the centre is at a mean of 1.59 rounded to the “Yes” category and mode being 2 for the largest amount of respondents with “Yes” answered.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, the increased focus in capacity planning and product portfolio changes in support of potential projects to clients is **more critical** during periods of volatility than in periods of less volatility.

The sample data is associated to the full Hypothesis F and provides support for the full hypothesis.

> **H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment.

The addition of the unstructured qualitative data feedback in section 5.2.6.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.6

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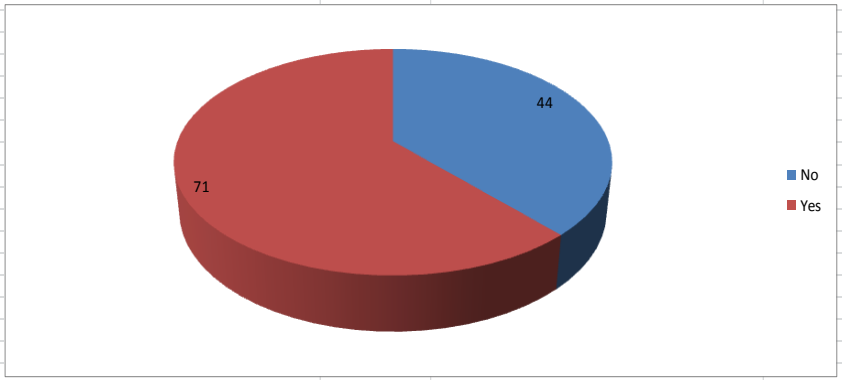
Univariate Data Analysis:

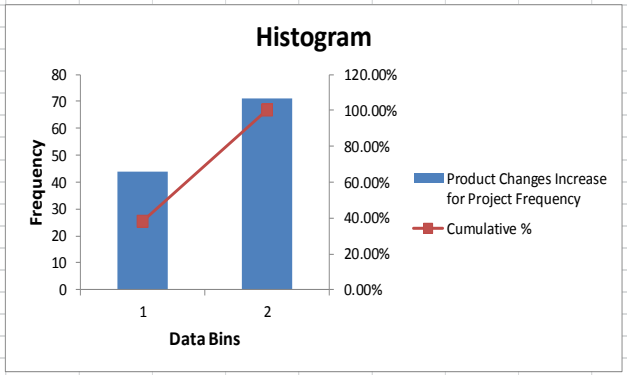
Variable 20:	ProdProjChanges_vs_ CapacityPlanDelivery
Variable Context:	Correlative
Variable Type:	Nominal

Data Bin Description	*Data Bins*	*Product Changes Increase for Project Frequency*	*Cumulative %*
No	1	44	38.26%
Yes	2	71	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1	Yes but No category fo not far out	
Mean =	1.590909091	Rounded(2 decimal)	1.59
Mode = Number most repeated	2		

Figure 55: Univariate data analysis of variable ProdProjChanges_vs_CapacityPlanDelivery

5.2.6.4 Inductive qualitative data analysis for Hypothesis F

The commentary data for research questions 19, 20, 21 were grouped together using Atas.ti to:

- Determine key words that describe concepts in the 3 questions;
- Be able to group key data words into families of similar meaning (see Table 49); and
- Derive relationships between the key words to understand the causal relationships possible between independent and dependent variable questions;
- The findings must be related to existing and or new theory in relation to the hypothesis and research question;
- Bold text indicates predominant concepts and keyword in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.6.4.1 Keywords and family concepts of data

Using the Co-occurrence tables, and codes to primary documents with query capabilities of Atlas.ti® majority keyword/concepts were extracted and depicted in Table 49:

Question	Question detail	Dominant keywords and concepts (families) of data
19	Is there increased risk in product development as a result of changes in project execution for clients when volatility is present? *(24 responses received)*	• Yes, there is **medium to high** risk in the product development as a result of project execution. • The **risk must be detected, tracked, mitigated** on a continuous basis to ensure product roadmap implementation remains on track for the overall project/product portfolio. • The **scope changes, risk/mitigation plans, unforeseen delays and budgets** should be managed under proper project management principles with stakeholders (both internal and external). • The **product portfolio should be optimised for client requirements** both in the short-term (contract specific but re-usable) and longer term strategic product features. • **Product functional specialising developers should be retained** with human resource management intervention to ensure personal

Question	Question detail	Dominant keywords and concepts (families) of data
		growth and career initiatives since training new developers will place lengthy delays on development.
20	Do IT businesses increase focus in capacity planning for project execution during volatile periods? (31 responses received)	• **Yes**, IT business does increase capacity planning for project execution during volatile periods. • **Capacity planning functions around people, infrastructure, resources, budget and client expectations.** For maximum value the focus should ensure near full utilisation of the listed functions and client communication updates to ensure maximum value add and risk mitigation. **Capacity should be retained for short term risk mitigation as well.** • The i**ncreased focus in capacity planning** should **mitigate risks induced by volatility** to the point where maximum quality and output is achievable with the available resources. • Expect that **clients will terminate** some non-core projects, services and business. See early ROI benefits in question 16 in section 5.2.5.5.1 being also applicable to this question. • In several IT businesses **capacity planning is reactive** and focused at immediate risk reduction only. This is potentially due to business size, management focus, organisational culture, and unforeseen risks.
21	Is there an increased focus in capacity planning and product portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility? *(23 responses received)*	• **Yes**, there is increased focus in capacity planning and product changes to support project deliveries during periods of volatility. • All internal stakeholders should **regularly (weekly) prioritise project/product development** focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management. • Clients do **demand more project/product**

Question	Question detail	Dominant keywords and concepts (families) of data
		requirements during periods of volatility. The **client requirements should be planned into a roadmap** (if time allows) and a commitment for delivery made to the customer. This ensures key resources remain **focused** toward roadmap-based development of products. • **Capacity planning should speed up delivery of projects/products and its value must exceed the time/cost to maintain the function**. Slow reaction speed to client requirements can place projects on risk to the point where clients delay or cancel them. • Simple **cost vs. benefit rules still apply**. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting the project successfully signed off, then do expect focus pressure from IT business management to implement the changes. Roadmap focused development is in those cases not a priority.

Table 49: Prominent keywords in questions feedback related to Hypothesis F

5.2.6.4.2 Relation to univariate quantitative data findings

- Survey question 19 quantitative finding (independent variable): It was concluded according to the structured question and based on the sample data scope only, that there is **medium to high increased risk** in product development as a result of changes in project execution for clients when volatility is present.

  The qualitative data received supports the quantitative view that there is **medium to high increased risk** in product development as a result of changes in project execution for clients when volatility is present. The scope changes, risk/mitigation plans, unforeseen delays and budgets should be managed under proper project management principles with stakeholders (both internal and external). The product portfolio should be optimised for client requirements both in the short-term (contract specific but re-usable) and longer term strategic product features.

- Survey question 20 quantitative finding (dependent variable): It was concluded according to the structured question and based on the sample data scope only, that IT business increases with **medium to high importance** focus in capacity planning for project execution during volatile periods.

  The qualitative data received supports the quantitative view that that IT business increases with **medium to high importance** focus in capacity planning for project execution during volatile periods. The increased focus in capacity planning should mitigate risks induced by volatility to the point where maximum quality and output is achievable with the available resources.

- Survey question 21 quantitative finding (nominal variable): It was concluded according to the structured question and based on the sample data scope only, that **there is an increased** focus in capacity planning and product portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility.

  The qualitative data received supports the quantitative view that **there is an increased** focus in capacity planning and product portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility. All internal stakeholders should regularly (weekly) prioritise project/product development focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management.

5.2.6.4.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Atlas.ti to indicate

- How data is grouped to support question 19 to 21
- Understand the interaction between the 3 questions.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 56 it is seen that there are many aspects involved in deciding to update the product portfolio with changes and organisational capacity planning to

ensure delivery projects to clients during times of volatility in the business environment (Hypothesis F). According to the respondent feedback, industry specific factors as well as short- vs. long-term action in product development play important roles in the product development updates. The underlying aspect of having re-usable products in projects do drive costs down and assist in speeding up the time of delivery that is pivotal for growth. During volatile periods clients are more demanding leading to projects/products that must be delivered faster from the portfolio. Re-usable products support this requirement and can assist in mitigating volatility risk.

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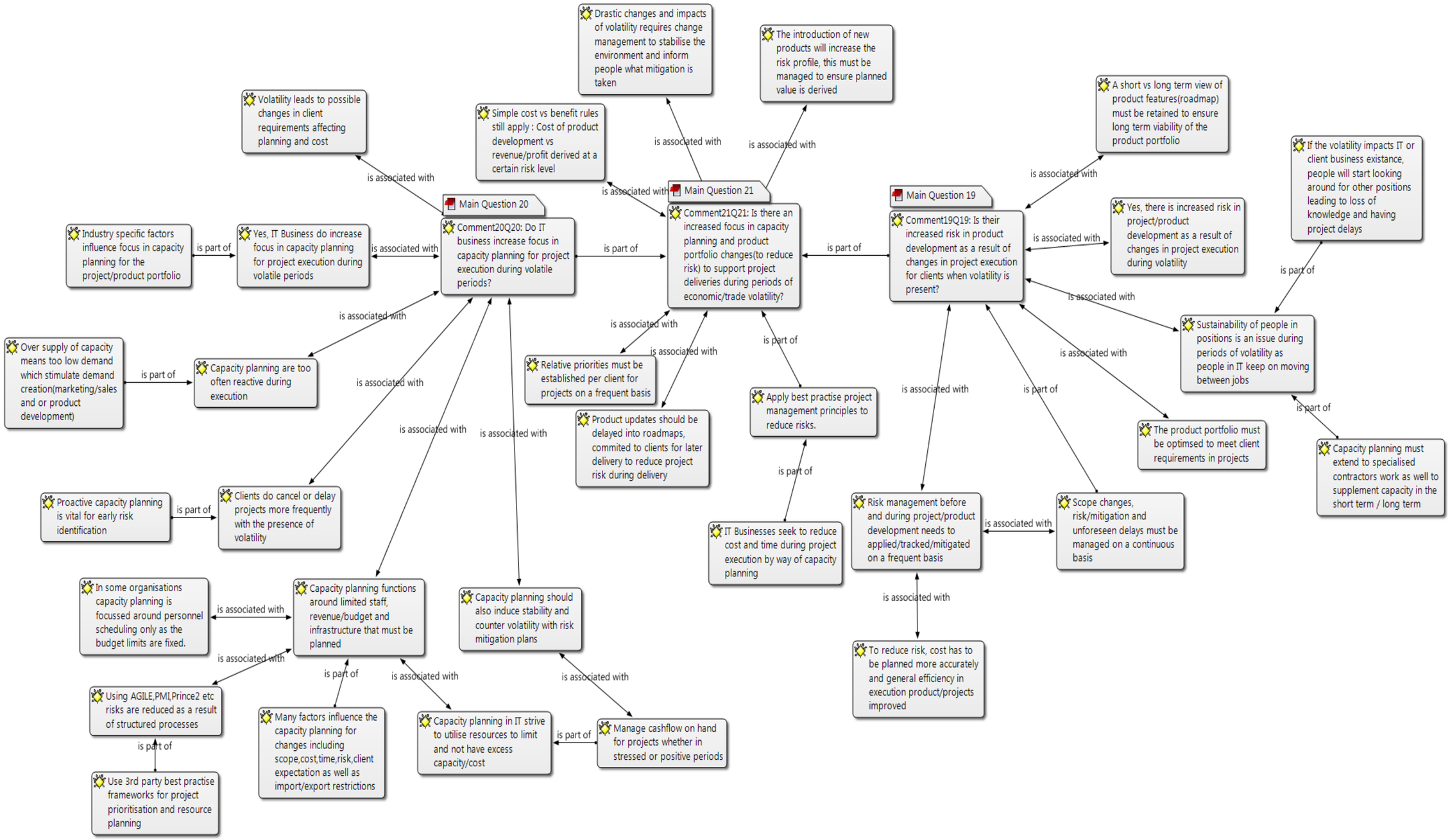


Figure 56: High level network diagram for qualitative nodes in questions 19, 20, 21

5.2.7 Questions for Hypothesis G: Univariate Data Analysis and Qualitative analysis

5.2.7.1 Question 22, Variable OrderIntake: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
21 Q22	OrderIntake	Level of importance of focus on the order book for IT businesses.	Independent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis G Research Question 7	How important is it for IT businesses to increase focus on their order book as a result of volatility?

Table 50: Review questionnaire question 22 detail

The ordinal answer data feedback for the question in Table 50 is analysed by means of a graphical analysis as in Figure 57. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable OrderIntake functions as independent variable for the Hypothesis G.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 57, a category majority of 54 of the 115 respondents (46.95 per cent) indicated there is high importance for IT business to increase focus on their order book as a result of volatility. A total of 30 out of 115 respondents (26.09 per cent) indicated there is very high importance for IT business to increase focus on their order book as a result of volatility. The majority category is the high importance category but jointly with the very high importance category from 73.04 per cent

of respondents that indicated high to very high importance for IT business to increase focus on their order book as a result of volatility. This then becomes a significant result.

- The nature of the distribution is at high importance category since the centre is at a mean of 3.92 and median of 4 as well as a spread which with a very small skew factor of 0.08.
- The median value of 4 is as a measure of location also indicating the medium skewed distribution towards the high importance level.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium importance for IT businesses to increase focus on their order book as a result of volatility.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondents' answers being smaller than or equal to high importance for IT businesses to increase focus on their order book as a result of volatility.
- The 75th percentile value of 5 is indicative of the 75 per cent of respondent answers being smaller than or equal to very high importance for IT businesses to increase focus on their order book as a result of volatility.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, there is **high to very high importance** for IT businesses to increase focus on their order book as a result of volatility.

The sample data is associated to the first part of the Hypothesis F and may provide support for the underlined part only.

> **H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

The addition of the unstructured qualitative data feedback in section 5.2.7.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

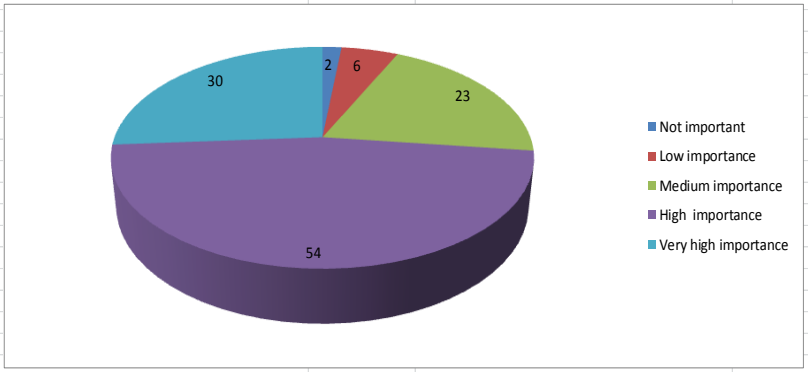
The measure of association between variables, including impact of the moderating variable and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.7.

Univariate Data Analysis:

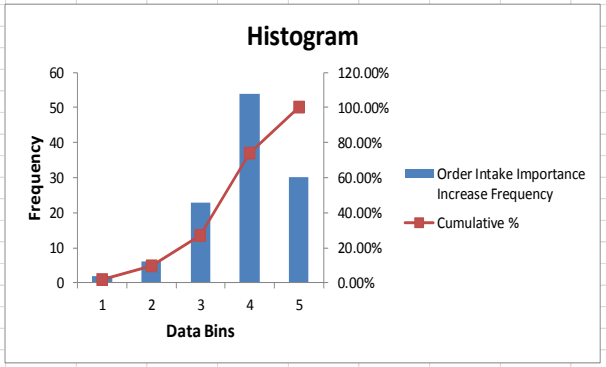
Variable 21:	OrderIntake
Variable Context:	Independant
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Order Intake Importance Increase Frequency*	*Cumulative %*
Not important	1	2	1.74%
Low importance	2	6	9.41%
Medium importance	3	23	26.96%
High importance	4	54	73.91%
Very high importance	5	30	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1	High Importance	
Mean =	3.920454545	Rounded(2 decimal)	3.92
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	5		
Interquantile range(75th - 25th percentile):	2		
Skew(difference between median and mean):	0.079545455	Rounded(2 decimal)	0.08

Figure 57: Univariate data analysis of variable OrderIntake

5.2.7.2 Question 23, Variable BalanceAbilityDelivery: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
22 Q23	BalanceAbilityDelivery	Level of importance of focus delivery of projects for IT businesses.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis G Research Question 7	Do IT businesses increase focus on delivery of projects successfully as a result of volatility?

Table 51: Review questionnaire question 23 detail

The ordinal answer data feedback for the question in Table 51 is analysed by means of a graphical analysis as in Figure 58. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable BalanceAbilityDelivery functions as dependent variable for the Hypothesis G.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 58, a category majority of 46 of the 115 respondents (40per cent) indicated there is high importance for IT business to increase focus on delivery of projects successfully as a result of volatility. A total of 34 out of 115 respondents (29.57 per cent) indicated there is medium importance for IT business to increase focus on delivery of projects successfully as a result of volatility. The majority category is the high importance category but jointly with the medium importance category form 69.57 per cent of respondents indicated medium to high importance for IT business to increase focus on delivery of projects successfully as a result of volatility. This then becomes a significant result.

- The nature of the distribution is at medium to high importance category since the centre is at a mean of 3.4 and median of 4 as well as a spread which with a small skew factor of 0.56.
- The median value of 4 as a measure of location also is indicating the medium skewed distribution towards the high importance level.
- The 25th percentile value of 3 is indicative of the 25 per cent of respondent answers being smaller than or equal to medium importance for IT business to increase focus on delivery of projects successfully as a result of volatility.
- The 50th percentile value of 4 is indicative of the 50 per cent of respondent answers being smaller than or equal to high importance for IT business to increase focus on delivery of projects successfully as a result of volatility.
- The 25th percentile value of 4 is indicative of the 75 per cent of respondent answers being smaller than or equal to high importance for IT business to increase focus on delivery of projects successfully as a result of volatility.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, there is **medium to high importance** for IT business to increase focus on delivery of projects successfully as a result of volatility.

The sample data is associated to the second part of the Hypothesis F and may provide support for the underlined part only.

> **H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

The addition the unstructured qualitative data feedback in section 5.2.7.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

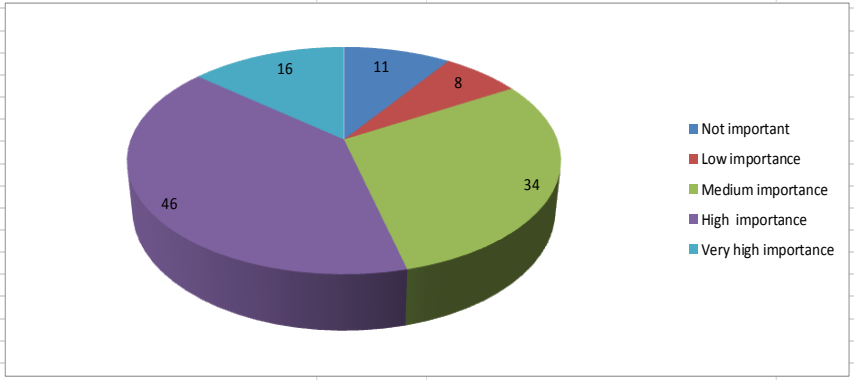
The measure of association between variables, including impact of the moderating variable and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.7.

Univariate Data Analysis:

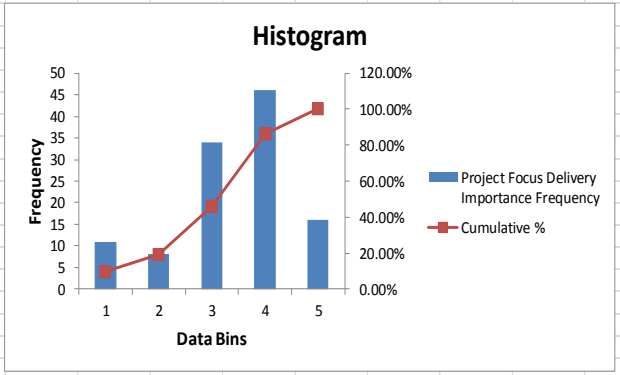
Variable 22:	BalanceAblilityDelivery
Variable Context:	Dependent
Variable Type:	Ordinal

Data Bin Description	*Data Bins*	*Project Focus Delivery Importance Frequency*	*Cumulative %*
Not important	1	11	9.57%
Low importance	2	8	19.19%
Medium importance	3	34	46.09%
High importance	4	46	86.09%
Very high importance	5	16	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1	High Importance with a close following of medium importance	
Mean =	3.443181818	Rounded(2 decimal)	3.44
Median = middle value of range of number	4		
Mode = Number most repeated	4		
Range = Largest minus smallest	4		
25th Percentile	3		
50th Percentile	4		
75th Percentile	4		
Interquantile range(75th - 25th percentile):	1		
Skew(difference between median and mean):	0.556818182	Rounded(2 decimal)	0.56

Figure 58: Univariate data analysis of variable BalanceAbilityDelivery

5.2.7.3 Question 24, Variable OrderIntake_vs_BalanceAbilityDelivery: Univariate data analysis

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire impact
23 Q24	OrderIntake_ vs_ BalanceAbilit yDelivery	Do IT businesses balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade?	Association perception views from respondents Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis G Research Question 7	Do IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade?

Table 52: Review questionnaire question 24 detail

The nominal answer data feedback for the question in Table 52 is analysed by means of a graphical analysis as in Figure 59. The data analysis result is derived from the combined sample data of 115 structured answers and shown in relation to the research hypothesis.

The variable OrderIntake_vs_ BalanceAbilityDelivery functions as a nominal variable for the Hypothesis G where it describes the relationship between the dependent and independent variables as perceived by the respondents.

Interpretation of structured data result:

- As can be seen in the pie chart and bar graph of Figure 59, the largest category majority of 59 of the 115 respondents (51.30 per cent) indicated IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. A total of 56 out of 115 respondents (48.70per cent) indicated IT businesses do not balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. The majority category is the agreement “Yes” category with a total of 51.3 per cent but it is almost an even split with the “No” category at 48.7 per cent which indicates volatility has little impact in this case.

- The nature of the distribution is slightly at the “Yes” agreement category since the centre is at a mean of 1.51 rounded to the “Yes” category and mode being 2 for the largest amount of respondents with “Yes” answered.

Thus it can be concluded according to the structured question, based on the sample data scope only and highest category, IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. This is, however, only 3 respondents more than the “No” category for the sample of data.

The sample data is associated to the full Hypothesis G and provides support for the full hypothesis.

> **H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

The addition of the unstructured qualitative data feedback in section 5.2.7.4 provides the most important descriptive concepts as perceived by the respondents in support of their structured answers.

The measure of association between variables and tests for significance of the sample result for validity in the hypothesis as well as the application in the larger population is tested in section 5.3.7

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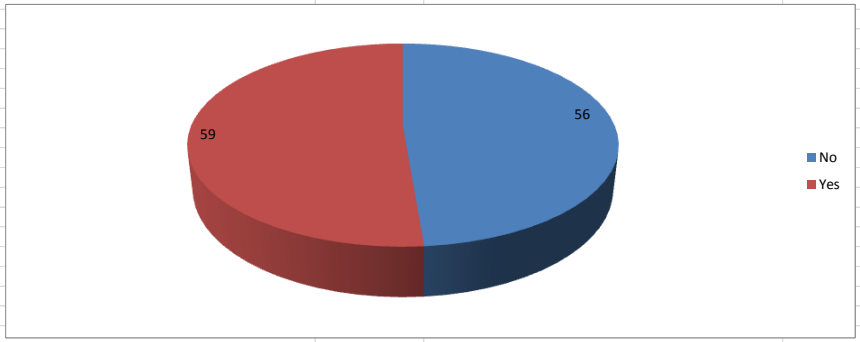
Univariate Data Analysis:

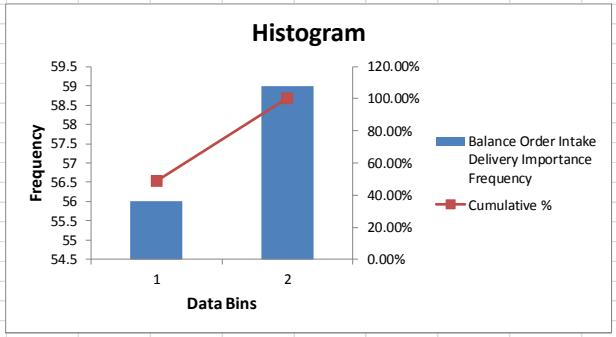
Variable 23:	OrderIntake_vs_ BalanceAblilityDelivery
Variable Context:	Correlative
Variable Type:	Nominal

Data Bin Description	*Data Bins*	*Balance Order Intake Delivery Importance Frequency*	*Cumulative %*
No	1	56	48.70%
Yes	2	59	100.00%

Sample Data Distribution Pie Chart



Nature of the distribution :Spread Histogram



Amount of populations:	1	Yes but No category fo not far out
Mean =	1.511363636	Rounded(2 decimal) 1.51
Mode = Number most repeated	2	

Figure 59: Univariate data analysis of variable OrderIntake_vs_BalanceAbilityDelivery

5.2.7.4 Inductive qualitative data analysis for Hypothesis G

The commentary data for research questions 22, 23, 24 were grouped together using Atlas.ti to:

- Determine key words that describe concepts in the 3 questions;
- Be able to group key data words into families of similar meaning (see Table 53); and
- Derive relationships between the key words to understand the causal relationships possible between independent and dependent variable questions;
- The findings should be related to existing and or new theory in relation to the hypothesis and research question;
- Bold text indicates predominant concepts and keyword in respondent feedback.

The commentary fields per survey question were not compulsory and respondents provided only answers which they deemed relevant.

5.2.7.4.1 Keywords and family concepts of data

Using the Co-occurrence tables and codes to primary documents with query capabilities of Atlas.ti® majority keyword/concepts were extracted and depicted in Table 53:

Question	Question detail	Dominant keywords and concepts (families) of data
22	How important is it for IT businesses to increase focus on their order book as a result of volatility? *(27 responses received)*	• **Yes**, it is important to increase focus on marketing as a **result but also before** volatility. • Successful IT businesses do **define marketing priorities, targets and clients up front and track progress against the plan continuously**. Volatile impact of less/more orders is reflected in an updated plan of budgets versus adjusted targets. • **Client requirements** should be reflected in product features, roadmaps or marketing efforts to fill the order book will be without success. During volatile periods this is even more important as clients wish to procure standard solutions. • **Operating faster than the competition** is absolute key since relationships with customers do impact the **order book positively** and **successful, quicker delivery**

Question	Question detail	Dominant keywords and concepts (families) of data
		of projects leads to more sales. • **Proactive marketing** to work closely with customers, potential customers and industry ensures that product launches are done at the right price, right feature level, timing and meeting client expectations. During volatile periods clients may buy even less hence the product should be on a par with expectations from the market.
23	Do IT business increase focus on delivery of projects successfully as a result of volatility? *(30 responses received)*	• **Yes,** there is an increased focus in the delivery of projects to **ensure timing, scope, quality and budget expectations are met**. • During volatility IT business still need to do what they do best and ensure **the solutions are delivered faster**, are **working and meet client expectations.** Successful projects means the **customer** is satisfied, the **IT business (i**ncluding shareholders) is satisfied and **project/product participants** are satisfied. • **Successful projects very often lead to more work** for the same IT business hence during volatile periods with fewer projects this is even more important. • **Quicker turnover** and **hand over** of projects during volatile periods to customers as a **result of successful capacity planning** leads to **reduced risk** for the IT business as well as **increased profit margins**. • Capacity planning prior to and during volatile periods should ensure that a pre-defined business strategy of **standardised products is implemented**. **Clients tend to procure more standardised products** and less of high-cost custom solutions due to budget constraints.
24	Do IT businesses balance their	• **Yes**, IT businesses do attempt to balance

Question	Question detail	Dominant keywords and concepts (families) of data
	order intake with ability to deliver focussed work during periods of volatility more than in stable periods of trade? *(28 responses received)*	order intake with the ability to deliver focused work more during periods of volatility because of uncertainty. This ability is less prevalent in smaller businesses where all work is taken up! • **Orders are not invoices**: Many businesses' non sales management realise that an **order for a project does require the ability to deliver on the order quicker during volatile periods**. In this area there is risk as the visibility of order intake vs. fulfilment lacks in project personnel teams. • Capacity planning during volatile periods has to be clear on the impact of volatility on order book as well as the delivery book (project/product deliveries) to ensure the **full value chain can be stabilised**. This is done more successfully in large business. Mitigation plans for volatility should be in place. • Since there are often **budget constraints** during volatile periods, more standardised less expensive projects are realised which use standardised products. **More products are developed during stable periods and sold in volume during volatile periods**. The order book and project delivery schedule will reflect this more during volatile periods. • According to respondents, **South African companies have a business drive of taking up all possible orders, and then quickly adapting capacity (resources, personnel, infrastructure) to fulfil execution to balance** the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable!

Table 53: Prominent keywords in questions feedback related to Hypothesis G

5.2.7.4.2 Relation to univariate quantitative data findings

- Survey question 22 quantitative finding (independent variable): It was concluded according to the structured question and based on the sample data scope only, that there is **high to very high importance** for IT businesses to increase focus on their order book as a result of volatility.

  The qualitative data received supports the quantitative view that there is **high to very high importance** for IT businesses to increase focus on their order book as a result of volatility.

- Survey question 23 quantitative finding (dependent variable): It was concluded according to the structured questions and based on the sample data scope only, that there is **medium to high importance** for IT business to increase focus on delivery of projects successfully as a result of volatility.

  The qualitative data received supports the quantitative view that there is **medium to high importance** for IT business to increase focus on delivery of projects successfully as a result of volatility.

- Survey question 24 quantitative finding (nominal variable): It was concluded according to the structured question and based on the sample data scope only; IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. This is, however, only 3 respondents more than the "No" category for the sample of data.

  The qualitative data received does **largely** support the quantitative view that, IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. **Some respondents did indicate that formal processes are bypassed under volatile conditions or no capacity planning is done hence the order book and organisational ability to execute the work are reactively managed and not balanced.**

5.2.7.4.3 Network relationships between keyword/families of data and eventual relations to theory

The coding keywords and family of keywords were linked in Atlas.ti to indicate

- How data is grouped to support question 19 to 21
- Understand the interaction between the 3 questions.

A network diagram was constructed to graphically indicate predominant concepts and terminologies obtained from the qualitative data and how they relate to the questions in the questionnaire. The conceptual structures supporting the research questions are represented in the networks using nodes and links (relationships). The nodes are obtained directly from the research qualitative data and in visualising the main concepts (nodes) which support the main questions.

Through the resulting network diagram in Figure 60 it is concluded that there are many aspects involved in deciding how IT businesses can balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade (Hypothesis G). According to the respondent feedback, the risks induced by volatility and specifically reduced amount of projects during negative periods make the execution of projects so much more important as clients will be conservative on budget, high in expectation, and demand requirements which have not been budgeted for. The counter side of positive volatility can create demand where capacity expansion for increased projects delivery and product development requires more focus and action from management to implement the required capacity.

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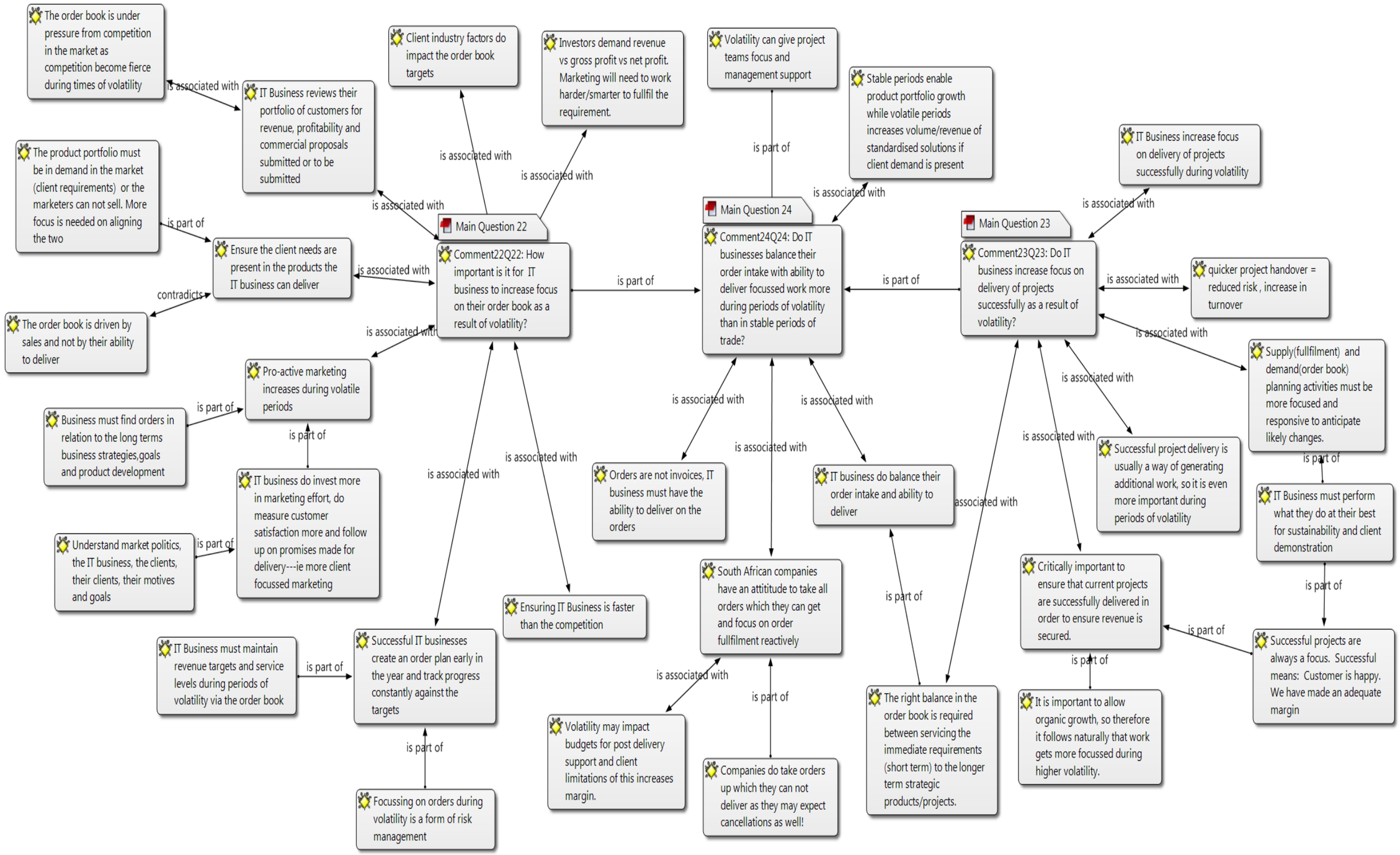

Figure 60: High level network diagram for qualitative nodes in questions 22, 23, 24

5.3 TESTING OF THE HYPOTHESIS WITH BIVARIATE ANALYSIS

A bivariate analysis was performed to visually determine the association as well as nature and strength of the association between the contributing variables for the Hypothesis. The approach extends the univariate approach in that variables are not only evaluated in singular context but also in relation to variables relevant to the same hypothesis. This assists in evaluating the validity of the relation proposed in the research hypothesis. The probability of the sample data in the research population was established and significant hypothesis results established.

In general calculations are rounded to 2 decimal places especially percentages.
Expected frequencies of the association between dependant and independent variables are not rounded to 2 decimals to retain integrity in the summarised balanced associations.
The final Chi-sum and Chi squared values are rounded off to two decimals.

The bivariate analysis results for the individual hypothesis testing in section 5.3 are combined and related back to the theory in section 5.4

5.3.1 Testing Hypothesis A: Bivariate Data Analysis

5.3.1.1 Variables related to Hypothesis A:

3 Variables are related to Hypothesis A as can be seen in Table 54:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
1 Q1	ExogVolatility	**Exogenous volatility** derives from sources of volatility that are outside of control of both households and policy makers in the short term for example	Independent variable Variable Type = Ordinal 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis A Research Question 1	Do IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
		Commodity prices, interest rates and skills shortages.			the longer term?
2a Q2	NewTechAdoptProca	Impact on clients adopting and procuring new IT technology.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Clients adopt/ procure much less IT projects/products 2 = Clients adopt/ procure somewhat less IT projects/products 3 = Clients adopt/ procure the same level IT projects/products 4 = Clients adopt/ procure somewhat more IT projects/products 5 = Clients adopt/ procure significantly more IT projects/products	Research Hypothesis A Research Question 1	a) What is the level of impact on the adoption/procurement of new IT technology in **negative** conducive volatile periods?
2b Q3	NewTechAdoptProcb	Impact on clients adopting and	Dependent variable Variable Type =	Research Hypothesis A Research	b) What is the level of impact on the

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
		procuring new IT technology.	Ordinal Structured scale: 1 = Clients adopt/ procure much less IT projects/products 2 = Clients adopt/ procure somewhat less IT projects/products 3 = Clients adopt/ procure the same level IT projects/products 4 = Clients adopt/ procure somewhat more IT projects/products 5 = Clients adopt/ procure significantly more IT projects/products	Question 1	adoption/procurement of new IT technology in **positively** conducive volatile periods?

Table 54: Review questionnaire questions 1, 2 and 3

5.3.1.2 What relationships do the same data indicate

The three variables in Table 54 are graphically depicted in Figure 61:

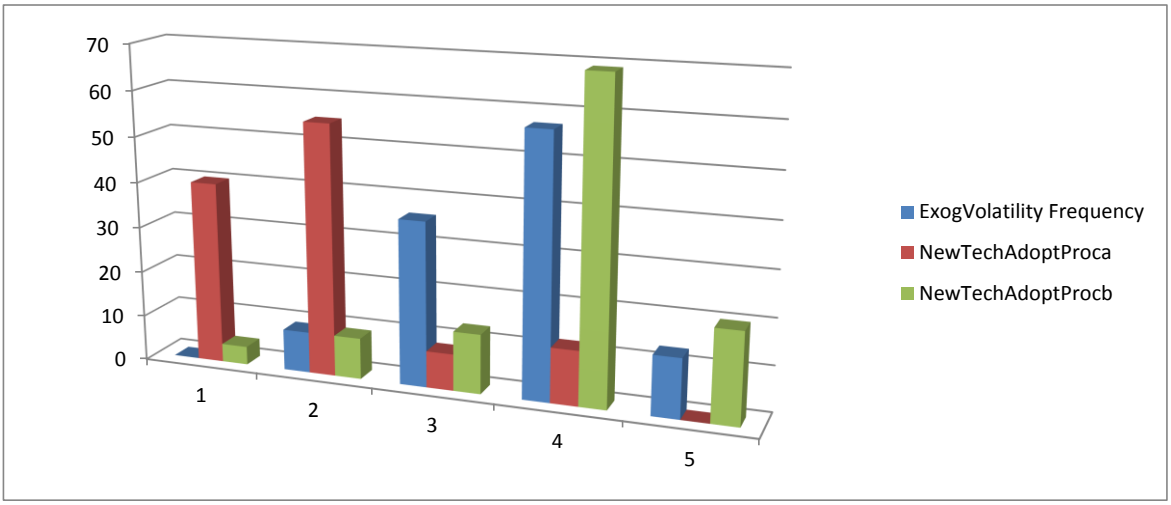

Figure 61: Graphical bivariate analysis for questions 1,2 and 3

Key visual findings from Figure 61:

- There is a positive visual association between the dependant variable (NewtechadoptProcb) and independent variable (ExogVolatility).
- There is a negative association between the dependent variable (NewtechadoptProca) and independent variable (ExogVolatility).
- Respondents indicated that clients say that they experience exogenous volatility as having a high impact on their business.
- Respondents indicated that IT clients procure somewhat less during conditions of negative volatility.
- Respondents indicated that IT clients procure somewhat more during conditions of positive volatility.

5.3.1.3 The strength of the relationship

5.3.1.3.1 Testing the association strength between Exogvolatility and NewTechAdoptProca

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association (without causation) for the variables Exogvolatility and NewTechAdoptProca association as depicted in Table 55:

		Low	Medium	High	Very high		
		ExogVolatility					
NewTechAdoptProca	Data	2	3	4	5	Grand Total	
1	Count of ExogVolatility	1	10	18	11	40	much less
	Sum of ExogVolatility	11.11%	27.78%	31.58%	84.62%	37.95%	
2	Count of ExogVolatility	7	17	30	1	55	somewhat less
	Sum of ExogVolatility	77.78%	47.22%	52.63%	7.69%	45.35%	
3	Count of ExogVolatility		2	6		8	same
	Sum of ExogVolatility	0.00%	5.56%	10.53%	0.00%	7.16%	
4	Count of ExogVolatility	1	7	3	1	12	somewhat more
	Sum of ExogVolatility	11.11%	19.44%	5.26%	7.69%	9.55%	
Total Count of ExogVolatility		9	36	57	13	115	
Total Sum of ExogVolatility		100.00%	100.00%	100.00%	100.00%	100.00%	

Table 55: Cross-tabulation for variables Exogvolatility vs. NewTechAdoptProca

Key findings in terms of the relationship strength as can be seen from Table 55:

- When exogenous volatility impact is perceived as high in negative periods, clients will procure somewhat less IT.
- When volatility is very high IT clients procure significantly less IT.

5.3.1.3.2 Testing the association strength between variables Exogvolatility and NewTechAdoptProcb

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association (without causation) for the variables Exogvolatility and NewTechAdoptProca association as depicted in Table 56:

		Low	Medium	High	Very high		
		ExogVolatility					
NewTechAdoptProcb	Data	2	3	4	5	Grand Total	
1	Count of ExogVolatility		2	1	1	4	much less
	Sum of ExogVolatility	0.00%	5.56%	1.75%	7.69%	3.58%	
2	Count of ExogVolatility	1	5	3		9	somewhat less
	Sum of ExogVolatility	11.11%	13.89%	5.26%	0.00%	6.92%	
3	Count of ExogVolatility	3	3	6	1	13	same
	Sum of ExogVolatility	33.33%	8.33%	10.53%	7.69%	10.50%	
4	Count of ExogVolatility	4	22	35	8	69	somewhat more
	Sum of ExogVolatility	44.44%	61.11%	61.40%	61.54%	60.62%	
5	Count of ExogVolatility	1	4	12	3	20	Significantly more
	Sum of ExogVolatility	11.11%	11.11%	21.05%	23.08%	18.38%	
Total Count of ExogVolatility		9	36	57	13	115	
Total Sum of ExogVolatility		100.00%	100.00%	100.00%	100.00%	100.00%	

Table 56: Cross-tabulation for variables Exogvolatility vs. NewTechAdoptProcb

Key findings in terms of the relationship strength as can be seen from Table 56:

- The Exogvolatility independent variable has a total of 57 respondents in the high category.
- When exogenous volatility is high during positive periods clients will procure somewhat more IT.
- The association on the medium and very high category Exogvolatility value seems spurious and not valid.

5.3.1.4 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis A is:

Research Hypothesis:

H1: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.

Null Hypothesis

H0: There is not a negative association between the new technology adoption/procurement and periods of exogenous volatility in the business environment

Hypothesis A also relates to the research question: **Research question 1: "**How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology?**"** The hypothesis focuses on the impact of changes required in response to volatile business conditions internally in the business?"

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.
Since the variables are of type ordinal, a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is potentially none, must be proved.
A p-value of 5% is used to test if a relationship exists when in fact there is no relationship.
If p < 5% then reject H0 and this is a significant test result.
If p > 5% then do not reject H0 and this is not a significant test result.

5.3.1.4.1 Testing for significance with the variables ExogVolatility and TechAdoptProca

The observed frequencies for the variables ExogVolatility and TechAdoptProca association are depicted in Table 57

Observed values	Low	Medium	High	Very high		
Count of ExogVolatility	ExogVolatility					
NewTechAdoptProca	2	3	4	5	Grand Total	
1	1	10	18	11	40	much less
2	7	17	30	1	55	somewhat less
3		2	6		8	same
4	1	7	3	1	12	somewhat more
Grand Total	9	36	57	13	115	

Table 57: Observed frequencies of variables ExogVolatility vs. TechAdoptProca

The expected frequencies for the variables are calculated as follows:

(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables ExogVolatility and TechAdoptProca association are depicted in Table 58:

		Independent var Exogvolatility				
Dependant var New TechAdoptProca	1	2	3	4	5	Total Sum
1	0	3.130434783	12.52173913	19.82608696	4.52173913	40
2	0	4.304347826	17.2173913	27.26086957	6.217391304	55
3	0	0.626086957	2.504347826	3.965217391	0.904347826	8
4	0	0.939130435	3.756521739	5.947826087	1.356521739	12
5						
Total Sum	0	9	36	57	13	

Table 58: Expected frequencies of variables ExogVolatility vs. TechAdoptProca

The chi squared value for each cell is calculated and added up in Table 59:

Dependant variable	Independent variable		Chi Square
TechAdoptProca	Exogvolatility = 2		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	1	3.130434783	1.449879227
2	7	4.304347826	1.68818621
3	0	0.626086957	0.626086957
4	1	0.939130435	0.00394525
	Exogvolatility = 3		
	Observed	Expected	
1	10	12.52173913	0.507850242
2	17	17.2173913	0.00274484
3	2	2.504347826	0.101570048
4	7	3.756521739	2.800503221
	Exogvolatility = 4		
	Observed	Expected	
1	18	19.82608696	0.16819222
2	30	27.26086957	0.275223632
3	6	3.965217391	1.04416476
4	3	5.947826087	1.460983982
	Exogvolatility = 5		
	Observed	Expected	
1	11	4.52173913	9.281354515
2	1	6.217391304	4.378230465
3	0	0.904347826	0.904347826
4	1	1.356521739	0.093701226
		Chi-Sum	24.79

Table 59: Calculate Chi-Sum for the cells of variables values ExogVolatility vs. TechAdoptProca

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (4-1)* (4-1) = 9

The Chi-squared (p=0.05, df=9) = 16.30 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.0032161 which is smaller than 0.05 hence H0 is rejected in the negative volatility case.

Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from. H0 can be rejected.

5.3.1.4.2 Testing for significance with the positive volatility

The observed frequencies for the variables ExogVolatility and TechAdoptProcb association are depicted in Table 60:

Observed values	Low	Medium	High	Very high		
Count of ExogVolatility	ExogVolatility					
NewTechAdoptProcb	2	3	4	5	Grand Total	
1		2	1	1	4	much less
2	1	5	3		9	somewhat less
3	3	3	6	1	13	same
4	4	22	35	8	69	somewhat more
5	1	4	12	3	20	significantly more
Grand Total	9	36	57	13	115	

Table 60: Observed frequencies of variables ExogVolatility vs. TechAdoptProcb

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the positive volatility association are depicted in Table 61:

		Independent var Exogvolatility				
Dependant var New TechAdoptProcb	1	2	3	4	5	Total Sum
1	0	0.313043478	1.252173913	1.982608696	0.452173913	4
2	0	0.704347826	2.817391304	4.460869565	1.017391304	9
3	0	1.017391304	4.069565217	6.443478261	1.469565217	13
4	0	5.4	21.6	34.2	7.8	69
5	0	1.565217391	6.260869565	9.913043478	2.260869565	20
Total Sum	0	9	36	57	13	

Table 61: Expected frequencies of variables ExogVolatility vs. TechAdoptProcb

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The chi-squared value for each expected frequency value is calculated and added up in Table 62:

Dependant variable	Independent variable		Chi Square
TechAdoptProcb	Exogvolatility = 2		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	0	0.313043478	0.313043478
2	1	0.704347826	0.124100913
3	3	1.017391304	3.863545151
4	4	5.4	0.362962963
5	1	1.565217391	0.20410628
	Exogvolatility = 3		
	Observed	Expected	
1	2	1.252173913	0.446618357
2	5	2.817391304	1.690848094
3	3	4.069565217	0.281103679
4	22	21.6	0.007407407
5	4	6.260869565	0.816425121
	Exogvolatility = 4		
	Observed	Expected	
1	1	1.982608696	0.486994661
2	3	4.460869565	0.478413425
3	6	6.443478261	0.030522795
4	35	34.2	0.01871345
5	12	9.913043478	0.439359268
	Exogvolatility = 5		
	Observed	Expected	
1	1	0.452173913	0.663712375
2	0	1.017391304	1.017391304
3	1	1.469565217	0.15003859
4	8	7.8	0.005128205
5	3	2.260869565	0.241638796
		Chi-Sum	11.64

Table 62: Calculate Chi-Sum for the cells of variables values ExogVolatility vs. TechAdoptProcb

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (5-1)* (4-1) = 12

The Chi-squared (p=0.05, df=12) = 21.03

Since Chi-Sum < Chi-Sqr (p=0.05), H0 cannot be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.48 which is larger than 0.05 hence H0 is not rejected in the positive volatility case.
Hence the research hypothesis H1 is not accepted and significant in the positive volatility case.
The patterns visible in the sample result are likely not present in the population the sample was taken from.

5.3.2 Testing Hypothesis B: Bivariate Data Analysis

5.3.2.1 Variables related to Hypothesis B:

Four variables are related to Hypothesis B as can be seen in Table 63:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
3 Q4	CustomerReq	Level of impact of understanding customer requirements during periods of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does a clearer understanding of customer requirements during periods of volatility assist in growing project portfolio and supporting product development?
4 Q5	CustomerOpImpact	Level of the impact of volatility on customer operations.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact	Research Hypothesis B Research Question 2	Does an understanding of the impact of volatility on customer operations assist in growing IT business project portfolio and supporting

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
			5 = Very High Impact		product development?
5 Q6	CustomerInt Act	Level of the impact of one-on-one customer interaction assist growth of IT project and supporting product development.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Does one-on-one interaction with clients during periods of volatility assist in growing project portfolio and supporting product development?
6 Q7	ITProjProdGrowth	Business IT project and product development levels.	Dependent variable Variable Type = Ordinal Structured scale: 1 = No Impact 2 = Low impact 3 = Medium Impact 4 = High Impact 5 = Very High Impact	Research Hypothesis B Research Question 2	Have client responses to volatility impacted IT business project development and supporting product development?

Table 63: Review questionnaire questions 4, 5, 6 and 7

5.3.2.2 Associations that are graphically present in the data

The three variables from Table 63 are graphically depicted in Figure 62:

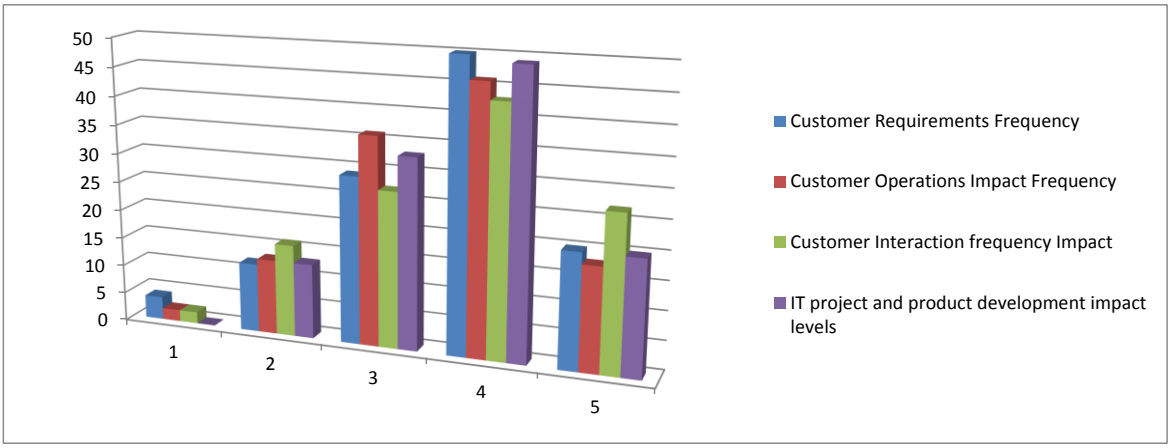

Figure 62: Graphical bivariate analysis for questions 4, 5, 6 and 7

Key visual findings from Figure 62:

- Respondents indicated that understanding customer requirements has a high impact on growing project and product development portfolio growth during times of volatility. There is a positive visual association between the dependent variable (ITProjProdGrowth) and independent variable (CustomerReq).
- Respondents indicated that understanding the impact of volatility on customer operations as a high impact on growing project and product development portfolio growth. There is a positive visual association between the dependent variable (ITProjProdGrowth) and independent variable (CustomerOpImpact).
- Respondents indicated that one-on-one interaction with clients has a high impact on growing project and product development portfolio growth during periods of volatility. There is a positive visual association between the dependent variable (ITProjProdGrowth) and independent variable (CustomerIntAct).

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5.3.2.3 The strength of the relationship

5.3.2.3.1 Testing the association strength between CustomerReq and ITProjProdGrowth

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association (without causation) association as depicted in Table 64:

		No Impact	Low Impact	Medium Impact	High Impact	Very high Impact		
		CustomerReq						
ITProjProdGrowth	Data	1	2	3	4	5	Grand Total	
2	Count of CustomerReq		6	3	4		13	Low Impact
	Sum of CustomerReq	0.00%	50.00%	10.34%	8.00%	0.00%	8.92%	
3	Count of CustomerReq	2	4	10	15	2	33	Medium Impact
	Sum of CustomerReq	50.00%	33.33%	34.48%	30.00%	10.00%	26.51%	
4	Count of CustomerReq	1	2	12	25	9	49	High Impact
	Sum of CustomerReq	25.00%	16.67%	41.38%	50.00%	45.00%	44.82%	
5	Count of CustomerReq	1		4	6	9	20	Very high Impact
	Sum of CustomerReq	25.00%	0.00%	13.79%	12.00%	45.00%	19.76%	
Total Count of CustomerReq		4	12	29	50	20	115	
Total Sum of CustomerReq		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 64: Cross-tabulation for variables CustomreReq and ITProjProdGrowth

Key findings in terms of the relationship strength as can be seen from Table 64 :

- When the perceived impact of understanding client requirements is high the impact has influenced project and product development at high level.

5.3.2.3.2 Testing the association strength between CustomerOpImpact and ITProjProdGrowth

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association (without causation) association as depicted in Table 65:

		No Impact	Low Impact	Medium Impact	High Impact	Very high Impact		
		CustomerOpImp						
ITProjProdGrowth	Data	1	2	3	4	5	Grand Total	
2	Count of CustomeropImpact		4	3	5	1	13	Low Impact
	Sum of CustomeropImpact	0.00%	30.77%	8.33%	10.87%	5.56%	10.24%	
3	Count of CustomeropImpact	1	5	17	9	1	33	Medium Impact
	Sum of CustomeropImpact	50.00%	38.46%	47.22%	19.57%	5.56%	25.12%	
4	Count of CustomeropImpact		2	13	28	6	49	High Impact
	Sum of CustomeropImpact	0.00%	15.38%	36.11%	60.87%	33.33%	45.12%	
5	Count of CustomeropImpact	1	2	3	4	10	20	Very high Impact
	Sum of CustomeropImpact	50.00%	15.38%	8.33%	8.70%	55.56%	19.51%	
Total Count of CustomeropImpact		2	13	36	46	18	115	
Total Sum of CustomeropImpact		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 65: Cross-tabulation for variables CustomerOpImpact and ITProjProdGrowth

Key findings in terms of the relationship strength as can be seen in Table 65:

- When the perceived impact on client operations is medium the impact has influenced project and product development at a medium level.
- When the perceived impact of on client operations is high the impact has influenced project and product development at a high level.

5.3.2.3.3 Testing the association strength between CustomerIntact and ITProjProdGrowth

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association (without causation) for the positive volatility association as depicted in Table 66:

		No Impact	Low Impact	Medium Impact	High Impact	Very high Impact		
		CustomerIntAct						
ITProjProdGrowth	Data	1	2	3	4	5	Grand Total	
2	Count of CustomerIntAct		3	3	6	1	13	Low Impact
	Sum of CustomerIntAct2	0.00%	18.75%	11.11%	13.95%	3.70%	10.43%	
3	Count of CustomerIntAct	1	5	10	13	4	33	Medium Impact
	Sum of CustomerIntAct2	50.00%	31.25%	37.04%	30.23%	14.81%	26.78%	
4	Count of CustomerIntAct		6	10	22	11	49	High Impact
	Sum of CustomerIntAct2	0.00%	37.50%	37.04%	51.16%	40.74%	43.84%	
5	Count of CustomerIntAct	1	2	4	2	11	20	Very high Impact
	Sum of CustomerIntAct2	50.00%	12.50%	14.81%	4.65%	40.74%	18.96%	
Total Count of CustomerIntAct		2	16	27	43	27	115	
Total Sum of CustomerIntAct2		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 66: Cross-tabulation for variables CustomerOpImpact and ITProjGrowth

Key finding in terms of the relationship strength as can be seen from Table 66:

- When the perceived impact of one on one customer interaction is high then the impact has influenced project and product development at a high level.

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5.3.2.4 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis B is:

Research Hypothesis:

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result of volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business, IT projects and supporting product development growth.

Null Hypothesis

H0: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result of volatility as well as
- one-on-one customer interaction activities

do not have **a positive association** on IT business IT projects and supporting product development growth.

Hypothesis B relates to the **Research question 2: "**What impact does the resulting client response have on IT business project portfolio and new product development?**"**
The basic question of being more customer-centric during volatile periods may assist business realisation. The cost of failure of IT products and services acquisition may be especially higher during exogenous volatile conditions since success is critically required with every new project execution. Hypothesis B relates to research question 2 since it focuses on the IT client's response to business environment volatility.

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.
Since the variables are of ordinal type, a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is potentially none, must be proved.
A p-value of 5% is used to test if a relationship exists when in fact there is no relationship.
If $p < 5\%$ then reject H0 and this is a significant test result.
If $p > 5\%$ then do not reject H0 and this is not a significant test result.

5.3.2.4.1 Testing for significance with variables CustomerReq and ITProjProdGrowth

The observed frequencies for the for the variables CustomerReq and ITProjProdGrowth association are depicted in Table 67

Observed values	No Impact	Low Impact	Medium Impact	High Impact	Very high Impact		
Count of CustomerReq	CustomerReq						
ITProjProdGrowth	1	2	3	4	5	Grand Total	
2		6	3	4		13	Low Impact
3	2	4	10	15	2	33	Medium Impact
4	1	2	12	25	9	49	High Impact
5	1		4	6	9	20	Very high Impact
Grand Total	4	12	29	50	20	115	

Table 67: Observed frequencies of variables CustomerReq vs. ITProjProdGrowth

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables CustomerReq and ITProjProdGrowth association are depicted in Table 68:

		CustomerReq				
Dependant var ITProjProdGrowth	1	2	3	4	5	Total Sum
2	0.452173913	1.356521739	3.27826087	5.652173913	2.260869565	13
3	1.147826087	3.443478261	8.32173913	14.34782609	5.739130435	33
4	1.704347826	5.113043478	12.35652174	21.30434783	8.52173913	49
5	0.695652174	2.086956522	5.043478261	8.695652174	3.47826087	20
Total Sum	4	12	29	50	20	

Table 68: Expected frequencies of variables CustomerReq vs. ITProjProdGrowth

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The chi squared value for each expected frequency value is calculated and added up in Table 69:

Dependant variable	Independent variable		Chi Square
ITProjProdGrowth	CustomerReq = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1			
2	0	0.452173913	0.452173913
3	2	1.147826087	0.632674572
4	1	1.704347826	0.29108252
5	1	0.695652174	0.133152174
	CustomerReq = 2		
	Observed	Expected	
1			
2	6	1.356521739	15.89498328
3	4	3.443478261	0.089942907
4	2	5.113043478	1.895356403
5	0	2.086956522	2.086956522
	CustomerReq = 3		
	Observed	Expected	
1			
2	3	3.27826087	0.02361896
3	10	8.32173913	0.338458044
4	12	12.35652174	0.010286693
5	4	5.043478261	0.215892054
	CustomerReq = 4		
	Observed	Expected	
1			
2	4	5.652173913	0.482943144
3	15	14.34782609	0.029644269
4	25	21.30434783	0.64108252
5	6	8.695652174	0.835652174
	CustomerReq = 5		
	Observed	Expected	
1			
2	0	2.260869565	2.260869565
3	2	5.739130435	2.436100132
4	9	8.52173913	0.026841171
5	9	3.47826087	8.76576087
		Chi-sum	37.54

Table 69: Calculate Chi-Sum for the cells of variables values CustomerReq and ITProjProdGrowth

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (4-1)* (5-1) = 12

The Chi-squared (p=0.05, df=12) = 21.03 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.0001822296 which is smaller than 0.05 hence H0 is rejected.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from.

5.3.2.4.2 Testing for significance with variables CustomerOpImpact and ITProjProdGrowth

The observed frequencies for the variables CustomerOpImpact and ITProjProdGrowth association are depicted in Table 70:

Observed values	No Impact	Low Impact	Medium Impact	High Impact	Very high Impact		
Count of CustomeropImpact	CustomerOpImpact						
ITProjProdGrowth	1	2	3	4	5	Grand Total	
2		4	3	5	1	13	Low Impact
3	1	5	17	9	1	33	Medium Impact
4		2	13	28	6	49	High Impact
5	1	2	3	4	10	20	Very high Impact
Grand Total	2	13	36	46	18	115	

Table 70: Observed frequencies of variables CustomerOpImpact vs. ITProjProdGrowth

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables CustomerOpImpact and ITProjProdGrowth association are depicted in Table 71:

			CustomerOpImpact			
Dependant var ITProjProdGrowth	1	2	3	4	5	Total Sum
1						
2	0.226086957	1.469565217	4.069565217	5.2	2.034782609	13
3	0.573913043	3.730434783	10.33043478	13.2	5.165217391	33
4	0.852173913	5.539130435	15.33913043	19.6	7.669565217	49
5	0.347826087	2.260869565	6.260869565	8	3.130434783	20
Total Sum	2	13	36	46	18	

Table 71: Expected frequencies of variables CustomerOpImpact vs. ITProjProdGrowth

The chi squared value for each expected frequency value is calculated and added up in Table 72:

Dependant variable	Independent variable		Chi Square
ITProjProdGrowth	CustomerOpImpact = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1			
2	0	0.226086957	0.226086957
3	1	0.573913043	0.316337286
4	0	0.852173913	0.852173913
5	1	0.347826087	1.222826087
	CustomerOpImpact = 2		
	Observed	Expected	
1			
2	4	1.469565217	4.357139182
3	5	3.730434783	0.432066484
4	2	5.539130435	2.261265443
5	2	2.260869565	0.030100334
	CustomerOpImpact = 3		
	Observed	Expected	
1			
2	3	4.069565217	0.281103679
3	17	10.33043478	4.306024008
4	13	15.33913043	0.356704131
5	3	6.260869565	1.698369565
	CustomerOpImpact = 4		
	Observed	Expected	
1			
2	5	5.2	0.007692308
3	9	13.2	1.336363636
4	28	19.6	3.6
5	4	8	2
	CustomerOpImpact = 5		
	Observed	Expected	
1			
2	1	2.034782609	0.5262356
3	1	5.165217391	3.358820085
4	6	7.669565217	0.363442768
5	10	3.130434783	15.07487923
		Chi-Sum	42.61

Table 72: Calculate Chi-Sum for the cells of variables values CustomerOpImpact and ITProjProdGrowth

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (4-1)* (5-1) = 12

The Chi-squared (p=0.05, df=12) = 21.03 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.000026307293 which is smaller than 0.05 hence H0 is rejected in the negative volatility case.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from.

5.3.2.4.3 Testing for significance with variables CustomerIntAct and ITProjProdGrowth

The observed frequencies for the variables CustomerIntAct and ITProjProdGrowth association are depicted in Table 73:

Observed values	No Impact	Low Impact	Medium Impact	High Impact	Very high Impact		
Count of CustomerIntAct	CustomerIntAct						
ITProjProdGrowth	1	2	3	4	5	Grand Total	
2		3	3	6	1	13	Low Impact
3	1	5	10	13	4	33	Medium Impact
4		6	10	22	11	49	High Impact
5	1	2	4	2	11	20	Very high Impact
Grand Total	2	16	27	43	27	115	

Table 73: Observed frequencies of variables CustomerIntAct vs. ITProjProdGrowth

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables CustomerIntAct and ITProjProdGrowth association are depicted in Table 74:

		CustomerIntAct				
Dependant var ITProjProdGrowth	1	2	3	4	5	Total Sum
1						
2	0.226086957	1.808695652	3.052173913	4.860869565	3.052173913	13
3	0.573913043	4.591304348	7.747826087	12.33913043	7.747826087	33
4	0.852173913	6.817391304	11.50434783	18.32173913	11.50434783	49
5	0.347826087	2.782608696	4.695652174	7.47826087	4.695652174	20
Total Sum	2	16	27	43	27	

Table 74: Expected frequencies of variables CustomerIntAct vs. ITProjProdGrowth

The chi-squared value for each expected frequency value is calculated and added up in Table 75:

Dependant variable	Independent variable		Chi Square
ITProjProdGrowth	CustomerIntAct= 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1			
2		0.226086957	0.226086957
3	1	0.573913043	0.316337286
4		0.852173913	0.852173913
5	1	0.347826087	1.222826087
	CustomerIntAct = 2		
	Observed	Expected	
1			
2	3	1.808695652	0.784657191
3	5	4.591304348	0.036380105
4	6	6.817391304	0.098003549
5	2	2.782608696	0.220108696
	CustomerIntAct = 3		
	Observed	Expected	
1			
2	3	3.052173913	0.000891862
3	10	7.747826087	0.654672327
4	10	11.50434783	0.196713661
5	4	4.695652174	0.103059581
	CustomerIntAct = 4		
	Observed	Expected	
1			
2	6	4.860869565	0.266951855
3	13	12.33913043	0.03539541
4	22	18.32173913	0.738445348
5	2	7.47826087	4.01314459
	CustomerIntAct= 5		
	Observed	Expected	
1			
2	1	3.052173913	1.379809241
3	4	7.747826087	1.812921485
4	11	11.50434783	0.022110487
5	11	4.695652174	8.464170692
		Chi-Sum	21.44

Table 75: Calculate Chi-Sum for the cells of variables values CustomerIntAct and ITProjProdGrowth

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (4-1)* (4-1) = 9

The Chi-squared (p=0.05, df=9) = 16.92 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.044233548 which is smaller than 0.05 hence H0 is rejected.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from.

5.3.3 Testing Hypothesis C: Bivariate Data Analysis

5.3.3.1 Variables related to Hypothesis C:

2 Variables are related to Hypothesis C as can be seen in Table 54:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
8 Q9	BusStratChange	Change level in IT business for period of volatility. Retain focus on business objectives vs. short term/longer term survival.	Dependent variable Variable type = Nominal 1 = Shorter Term IT changes 2 = Longer term IT planning 3 = Both short and longer term changes 4 = Remain with original IT planning in	Research Hypothesis C Research Questions 3	Do IT businesses gather market intelligence for shorter or longer term strategy changes during periods of volatility?

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
			support of business changes irrespective of short and longer term.		
9 Q10	MarketIntel	Determine level of increase of market intelligence during periods of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Increase 2 = Low increase 3 = Medium increase 4 = High Increase 5 = Very High Increase	Research Hypothesis C Research Question 3	Do businesses increase their collection of market intelligence during periods of volatility?

Table 76: Review questionnaire questions 1, 2 and 3

5.3.3.2 Associations that are graphically present in the data

The two variables from Table 76 are graphically depicted in Figure 63:

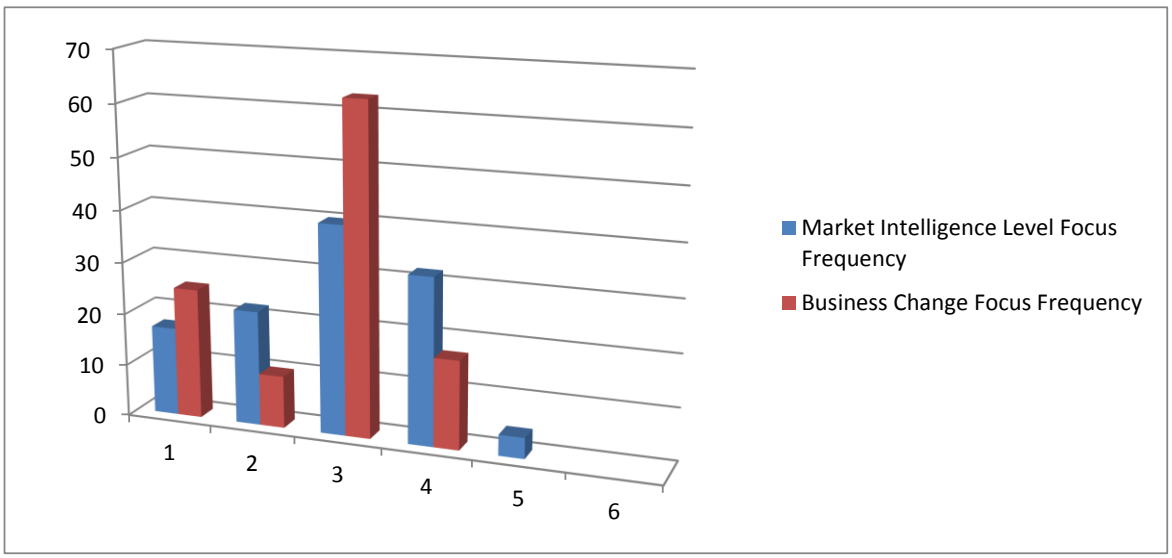

Figure 63: Graphical bivariate analysis for questions 9 and 10

Key visual findings from Figure 63:

- There is a nonlinear association which tends to show a more positive relationship between the dependent variable (BusStratChange) and independent variable (MarketIntel).
- Respondents indicated that collection of market intelligence during times of volatility has a medium to high impact on business orientation towards strategy changes.

5.3.3.3 The strength of the relationship

5.3.3.3.1 Testing the association strength between variable MarketIntel and BusStratChange

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association (without causation) for the variables MarketIntel and BusStratChange association as depicted in Table 77:

		No Increase	Low Increase	Medium Increas	High Increase	ery high Increase		
		MarketIntel						
BusStratChange	Data	1	2	3	4	5	Grand Total	
1	Count of MarketIntel2	4	9	5	7		25	Shorter Term IT changes
	Count of MarketIntel	23.53%	40.91%	12.50%	21.88%	0.00%	21.74%	
2	Count of MarketIntel2	2	2	3	3		10	Longer term IT changes
	Count of MarketIntel	11.76%	9.09%	7.50%	9.38%	0.00%	8.70%	
3	Count of MarketIntel2	5	9	28	19	2	63	Both short and longer term changes
	Count of MarketIntel	29.41%	40.91%	70.00%	59.38%	50.00%	54.78%	
4	Count of MarketIntel2	6	2	4	3	2	17	Remain with original IT planning
	Count of MarketIntel	35.29%	9.09%	10.00%	9.38%	50.00%	14.78%	
Total Count of MarketIntel2		17	22	40	32	4	115	
Total Count of MarketIntel		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 77: Cross-tabulation for variables MarketIntel vs. BusStratChange

Key finding in terms of the relationship strength as can be seen from Table 77:

- Respondents indicated that when the perceived market intelligence increases on medium level, the impact has influenced business focus towards change for both short and long term.

5.3.3.4 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis C is:

Research Hypothesis:

H1: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility.

.

Null Hypothesis

H0: A business's strategic focus towards change is **not positively associated** with its market intelligence (client requirements) at the time of significant volatility.

(i.e. business strategic and technical innovation decisions are more reliant on market intelligence including client requirements when volatility is present in the business environment.)

Hypothesis C relates to the research questions since it focuses on the IT client's response to business volatility: **Research questions 3:** "Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients?"

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.

Since the variables are of type ordinal, a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is in fact potentially none, must be proved.

A p-value of 5% is used to test if a relationship exists when in fact there is no relationship.

If p < 5% then reject H0 and this is a significant test result.

If p > 5% then do not reject H0 and this is not a significant test result.

5.3.3.4.1 Testing for significance with variables MarketIntel and BusStratChange

The observed frequencies for the variables MarketIntel vs. BusStratChange association are depicted in Table 78:

Observed values	No Increase	Low Increase	Medium Increase	High Increase	Very high Increase		
Count of MarketIntel	MarketIntel						
BusStratChange	1	2	3	4	5	Grand Total	
1	4	9	5	7		25	Shorter Term IT changes
2	2	2	3	3		10	Longer term IT changes
3	5	9	28	19	2	63	Both short and longer term changes
4	6	2	4	3	2	17	Remain with original IT planning
Grand Total	17	22	40	32	4	115	

Table 78: Observed frequencies of variables MarketIntel vs. BusStratChange

The expected frequencies for the variables//*calculated as follows:

(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables MarketIntel vs. BusStratChange association are depicted in Table 79:

Dependant var BusStratChange	1	2	3	4	5	
1	3.695652174	4.782608696	8.695652174	6.956521739	0.869565217	25
2	1.47826087	1.913043478	3.47826087	2.782608696	0.347826087	10
3	9.313043478	12.05217391	21.91304348	17.53043478	2.191304348	63
4	2.513043478	3.252173913	5.913043478	4.730434783	0.591304348	17
	17	22	40	32	4	

Table 79: Expected frequencies of variables MarketIntel vs. BusStratChange

The chi-squared value for each expected frequency value is calculated and added up in Table 80:

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Dependant variable	Independent variable		Chi Square
BusStratChange	MarketIntel = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	4	3.695652174	0.025063939
2	2	1.47826087	0.184143223
3	5	9.313043478	1.997450574
4	6	2.513043478	4.838302994
	MarketIntel = 2		
	Observed	Expected	
1	9	4.782608696	3.718972332
2	2	1.913043478	0.003952569
3	9	12.05217391	0.772953134
4	2	3.252173913	0.482120437
	MarketIntel = 3		
	Observed	Expected	
1	5	8.695652174	1.570652174
2	3	3.47826087	0.06576087
3	28	21.91304348	1.690821256
4	4	5.913043478	0.618925831
	MarketIntel = 4		
	Observed	Expected	
1	7	6.956521739	0.000271739
2	3	2.782608696	0.016983696
3	19	17.53043478	0.123192719
4	3	4.730434783	0.633008312
	MarketIntel = 5		
	Observed	Expected	
1	0	0.869565217	0.869565217
2	0	0.347826087	0.347826087
3	2	2.191304348	0.016701173
4	2	0.591304348	3.35601023
		Chi-Sum	21.33

Table 80: Calculate Chi-Sum for the cells of variables values MarketIntel vs. BusStratChange

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (4-1)* (5-1) = 12

The Chi-squared (p=0.05, df=12) = 21.03 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.

The Chi-Sum value correlates with the value as calculated in the Stattools® software product. The calculated p value according to Stattools® is: 0.045716037 which is smaller than 0.05 hence H0 is rejected.

There is a contradiction: The visual association indicated a non-linear association which tends to be more positive correlated between variables MarketIntel (Question 10) and BusStratChange (Question 9) only, which does not support H1's relation of being "positively associated".

The research hypothesis C is thus partially accepted only.

Since $p < 0.05$ (border case) the research hypothesis H1 is accepted and significant. The patterns visible in the sample result also may be present in the population the sample was taken from.

5.3.4 Testing Hypothesis D: Bivariate Data Analysis

5.3.4.1 Variables related to Hypothesis D:

2 Variables are related to Hypothesis D as can be seen in Table 81:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
11 Q12	ShortLongStratDef	Level of change in IT businesses in short-term technology strategy to induce business value growth as a result of using market intelligence of volatility.	Independent variable Variable Type = Ordinal Structured scale: 1 = No Changes 2 = Minimal Changes 3 = Medium Changes 4 = High amount of changes 5 = Very High levels of changes	Research Hypothesis D Research Question 4	To what extent do IT businesses adapt their short term technology strategy to induce business value growth as a result of using market intelligence of volatility?
12	ProjectProduct	Level of	Dependent	Research	When the IT

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
Q13	ExecChange	increase in project and product portfolio adaptations as a result of IT changes in business strategy/ technology strategy for volatility.	variable Variable Type = Ordinal Structured scale: 1 = No Changes 2 = Minimal Changes 3 = Medium Changes 4 = High amount of changes 5 = Very High levels of changes	Hypothesis D Research Question 4	business / technology strategy is adapted for volatile reasons, are major adaptations required in the project portfolio and supporting product development?

Table 81: Review questionnaire questions 12 and 13

5.3.4.2 Associations that are graphically present in the data

The two variables from Table 81 are graphically depicted in Figure 64:

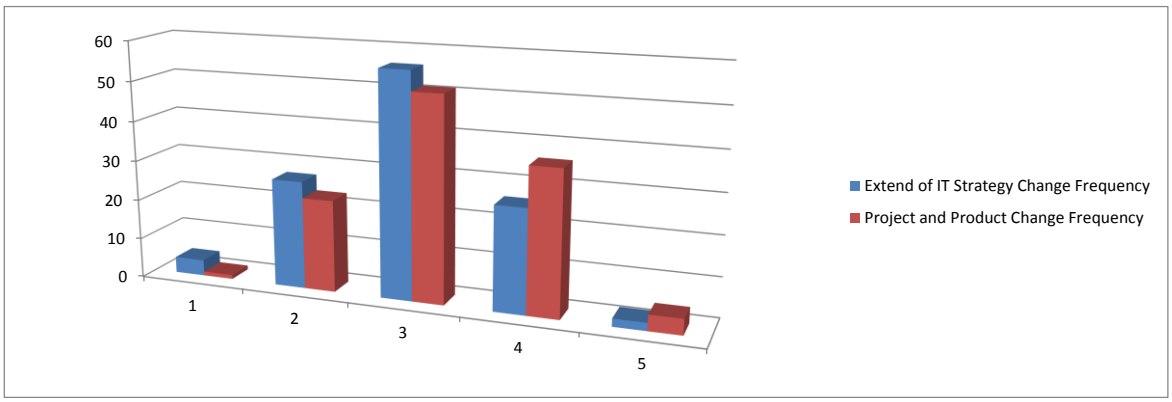

Figure 64: Graphical bivariate analysis for questions 12 and 13

Key visual findings from Figure 64:

- There is a visually positive association between the dependent variable (ProjectProductExecChange) and independent variable (ShortLongStratDef) at medium to high level.

- Respondents indicate that medium changes in short term technology strategy to create business value during times of volatility have a medium impact on project and product portfolio changes.
- Fewer respondents indicate that high changes in short term technology strategy to create business value during times of volatility have a high impact on project and product portfolio changes.

5.3.4.3 The strength of the relationship

5.3.4.3.1 Testing the association strength between variable ShortLongStratDef and ProjectProductExecChange

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association| (without causation) for the variables ShortLongStratDef and ProjectProductExecChange association as depicted in Table 82:

	No Changes	Minimal Changes	Medium Changes	High amount of changes	Very high level of changes		
	ShortLongStratDef						
Data	1	2	3	4	5	Grand Total	
Count of ShortLongStratDef2				1		1	No Changes
Count of ShortLongStratDef	0.00%	0.00%	0.00%	3.85%	0.00%	0.87%	
Count of ShortLongStratDef2		12	11			23	Minimal Changes
Count of ShortLongStratDef	0.00%	44.44%	19.64%	0.00%	0.00%	20.00%	
Count of ShortLongStratDef2	1	11	28	11		51	Medium Changes
Count of ShortLongStratDef	25.00%	40.74%	50.00%	42.31%	0.00%	44.35%	
Count of ShortLongStratDef2	3	3	16	12	2	36	High amount of changes
Count of ShortLongStratDef	75.00%	11.11%	28.57%	46.15%	100.00%	31.30%	
Count of ShortLongStratDef2		1	1	2		4	Very high level of changes
Count of ShortLongStratDef	0.00%	3.70%	1.79%	7.69%	0.00%	3.48%	
ef2	4	27	56	26	2	115	
ef	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 82: Cross-tabulation for variables ShortLongStratDef vs. ProjectProductExecChange

Key finding in terms of the relationship strength Table 82:

- Respondents indicated that when the changes in short term technology strategy is of a medium level (supporting business value growth) then the impact has medium changes on project and product development changes.
- Respondents indicated to a lesser extent that when the changes in short term technology strategy are high (supporting business value growth) then the impact has the effect of high changes on project and product development.

5.3.4.4 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis D is:

Research Hypothesis:

H1: There is a **positive association** between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

Null Hypothesis

H0: There is **not a positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

Hypothesis D relates to the research question 4 since it firstly assesses the volatile business conditions and secondly responds via decision making with the information known. **Research question 4:**"What is the resulting impact this market intelligence mechanism has on IT business strategy in terms of project and product development in the short vs. longer term when volatility is present?"

Hypothesis D also relates to the research question: "**Research question 2:** What impact does the resulting client response have on IT business project portfolio and new product development? "

The hypothesis does not just focus on the assessment of the volatile business conditions but also uses the information for decision making.

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.

Since the variables are of ordinal type , a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is in fact potentially none, should be proved.

A p-value of 5% is used to test if a relationship exists when in fact there is no relationship.

If $p < 5\%$ then reject H0 and this is a significant test result.

If $p > 5\%$ then do not reject H0 and this is not a significant test result.

5.3.4.4.1 Testing for significance with variables ShortLongStratDef and ProjectProductExecChange

The observed frequencies for the variables ShortLongStratDef vs. ProjectProductExecChange association are depicted in Table 78:

Observed values	No Changes	Minimal changes	Medium changes	High amount of changes	Very high level of changes		
Count of ShortLongStratDef	ShortLongStratDef						
ProjectProductExecChange	1	2	3	4	5	Grand Total	
1				1		1	No Changes
2		12	11			23	Minimal Changes
3	1	11	28	11		51	Medium Changes
4	3	3	16	12	2	36	High amount of changes
5		1	1	2		4	Very high level of changes
Grand Total	4	27	56	26	2	115	

Table 83: Observed frequencies of variables ShortLongStratDef vs. ProjectProductExecChange

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables ShortLongStratDef vs. ProjectProductExecChange association are depicted in Table 84:

		ShortLongStratDef				
Dependant var ProjectProductExecChange	1	2	3	4	5	
1	0.034782609	0.234782609	0.486956522	0.226086957	0.017391304	1
2	0.8	5.4	11.2	5.2	0.4	23
3	1.773913043	11.97391304	24.83478261	11.53043478	0.886956522	51
4	1.252173913	8.452173913	17.53043478	8.139130435	0.626086957	36
5	0.139130435	0.939130435	1.947826087	0.904347826	0.069565217	4
	4	27	56	26	2	

Table 84: Expected frequencies of variables ShortLongStratDef vs. ProjectProductExecChange

The chi-squared value for each expected frequency value is calculated and added up in Table 85:

Dependant variable	Independent variable		Chi Square
ProjectProductExecChange	ShortLongStratDef = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	0	0.034782609	0.034782609
2	0	0.8	0.8
3	1	1.773913043	0.337638534
4	3	1.252173913	2.439673913
5	0	0.139130435	0.139130435
Dependant variable	Independentt variable		
ProjectProductExecChange	ShortLongStratDef = 2		
	Observed	Expected	
1	0	0.234782609	0.234782609
2	12	5.4	8.066666667
3	11	11.97391304	0.079214423
4	3	8.452173913	3.516988728
5	1	0.939130435	0.00394525
	ShortLongStratDef = 3		
	Observed	Expected	
1	0	0.486956522	0.486956522
2	11	11.2	0.003571429
3	28	24.83478261	0.40341006
4	16	17.53043478	0.133609386
5	1	1.947826087	0.461218944
	ShortLongStratDef = 4		
	Observed	Expected	
1	1	0.226086957	2.64916388
2	0	5.2	5.2
3	11	11.53043478	0.0244016
4	12	8.139130435	1.831438127
5	2	0.904347826	1.327424749
	ShortLongStratDef = 5		
	Observed	Expected	
1	0	0.017391304	0.017391304
2	0	0.4	0.4
3	0	0.886956522	0.886956522
4	2	0.626086957	3.014975845
5	0	0.069565217	0.069565217
		Chi Sum	32.56

Table 85: Calculate Chi-Sum for the cells of variables values ShortLongStratDef vs. ProjectProductExecChange

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). The 0 value rows and columns are excluded since no association exists between the variables for these conditions. (5-1)* (5-1) = 16

The Chi-squared (p=0.05, df=16) = 26.23 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.008440121 which is smaller than 0.05 hence H0 is rejected.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population from which the sample was taken.

5.3.5 Testing Hypothesis E: Bivariate Data Analysis

5.3.5.1 Variables related to Hypothesis E:

3 Variables are related to Hypothesis D as can be seen in Table 86:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
14 Q15	HighTechProd Select	New high technology product selection impact for development during volatile periods.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis E Research Question 5	Is the selection of sellable products to be developed by IT business of more importance during volatile periods?
15 Q16	ProjectPortfSlect	New high technology	Independent variable	Research Hypothesis E	Is the selection of projects for

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
		project selection impact from clients for execution during volatile periods	Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Question 5	the IT business as offered by clients to execute of more importance during volatile periods than non-volatile periods?
16 Q17	AbiliDeliverProdClient	Importance of IT business having the organisational capacity (people, infrastructure, financial resources) and technology to deliver contracted products/services taken on for delivery.	Moderating Variable Variable Type = Nominal Structured scale: 1 = No 2 = Yes	Research Hypothesis E Research Question 5	Do IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects?

Table 86: Review questionnaire questions 15 and 16

5.3.5.2 Associations that are graphically present in the data

The two variables from Table 86 are graphically depicted in Figure 65:

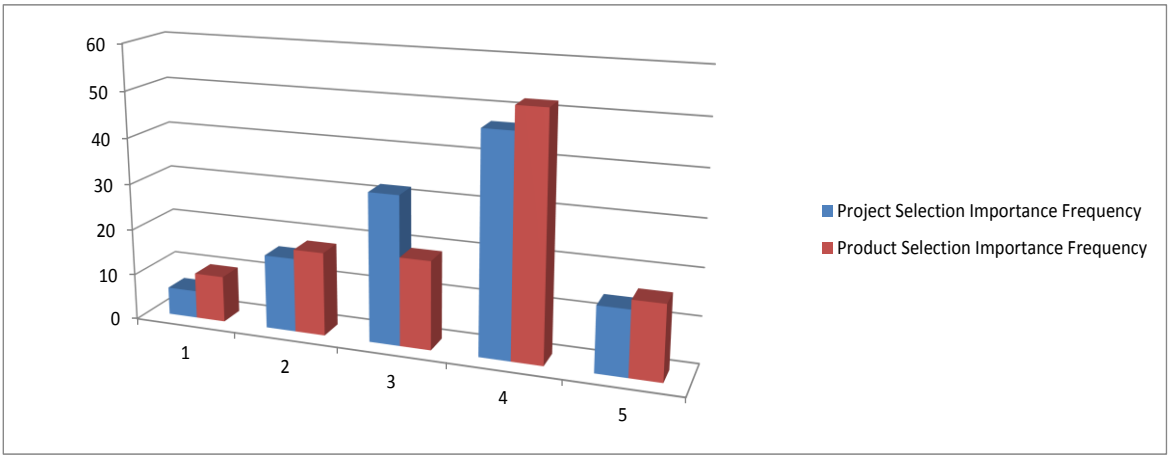

Figure 65: Graphical bivariate analysis for questions 15 and 16

Key visual findings from Figure 65:

- There is a visually positive association between the dependent variable (HighTechProdSelect) and independent variable (ProjectPortfSlect) at all levels but lower at medium level.
- Respondents indicate that a high importance of project portfolio selection during periods of volatility has a high importance of product selection.
- Fewer respondents indicate that a very high importance of project portfolio selection during periods of volatility has a very high importance for product selection.

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5.3.5.3 The strength of the relationship

5.3.5.3.1 Testing the association strength between variable ProjectPortfSlect and HighTechProdSelect

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association| (without causation) for the variables ProjectPortfSlect and HighTechProdSelect association as depicted in Table 87:

		Not important	Low importance	Medium importance	High importance	Very high importance		
		ProjectPortfSlect						
HighTechProdSelect	Data	1	2	3	4	5	Grand Total	
1	Count of ProjectPortfSlect2	1	2	6		1	10	Not important
	Count of ProjectPortfSlect	16.67%	12.50%	18.75%	0.00%	7.14%	8.70%	
2	Count of ProjectPortfSlect2	1	6	4	7		18	Low importance
	Count of ProjectPortfSlect	16.67%	37.50%	12.50%	14.89%	0.00%	15.65%	
3	Count of ProjectPortfSlect2	2		8	7	2	19	Medium importance
	Count of ProjectPortfSlect	33.33%	0.00%	25.00%	14.89%	14.29%	16.52%	
4	Count of ProjectPortfSlect2	1	7	14	25	5	52	High importance
	Count of ProjectPortfSlect	16.67%	43.75%	43.75%	53.19%	35.71%	45.22%	
5	Count of ProjectPortfSlect2	1	1		8	6	16	Very high importance
	Count of ProjectPortfSlect	16.67%	6.25%	0.00%	17.02%	42.86%	13.91%	
Total Count of ProjectPortfSlect2		6	16	32	47	14	115	
Total Count of ProjectPortfSlect		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 87: Cross-tabulation for variables ProjectPortfSlect vs. HighTechProdSelect

Key finding in terms of the relationship strength as can be seen from Table 87:

- Respondents indicate a high importance of project portfolio selection during periods of volatility has a high importance for product selection.

Since the moderating variable AbiliDeliverProdClient influences the dependent variable and independent variables the impact of the moderating variable should also be investigated.
An additional filter criterion was set on the pivot table in Microsoft Excel® for the cross-tabulation representation.
The AbiliDeliverProdClient = 2 = Yes had an overwhelming counted value of 74 of the 115 respondents.
The AbiliDeliverProdClient = 1 = No had a lesser counted value of 41 of the 115 respondents.

With the AbiliDeliverProdClient = 2 the cross tabulation approach followed then measured the association (without causation) for the variables ProjectPortfSlect and HighTechProdSelect association as depicted in Table 88:

AbiliDeliverProdClient	1							
		Not important	Low importance	Medium importance	High importance	Very high importance		
		ProjectPortfSlect						
HighTechProdSelect	Data	1	2	3	4	5	Grand Total	
1	Sum of ProjectPortfSlect		2	6			8	Not important
	Count of ProjectPortfSlect	0.00%	33.33%	16.67%	0.00%	0.00%	7.32%	
2	Sum of ProjectPortfSlect		2	3	20		25	Low importance
	Count of ProjectPortfSlect	0.00%	33.33%	8.33%	26.32%	0.00%	17.07%	
3	Sum of ProjectPortfSlect	1		6	12	10	29	Medium importance
	Count of ProjectPortfSlect	100.00%	0.00%	16.67%	15.79%	33.33%	19.51%	
4	Sum of ProjectPortfSlect		2	21	28	15	66	High importance
	Count of ProjectPortfSlect	0.00%	33.33%	58.33%	36.84%	50.00%	43.90%	
5	Sum of ProjectPortfSlect				16	5	21	Very high importance
	Count of ProjectPortfSlect	0.00%	0.00%	0.00%	21.05%	16.67%	12.20%	
Total Sum of ProjectPortfSlect		1	6	36	76	30	149	
Total Count of ProjectPortfSlect		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 88: Cross-tabulation for variables ProjectPortfSlect vs. HighTechProdSelect with AbiliDeliverProdClient = 2

Key findings in terms of the relationship strength as can be seen from Table 88:

- Respondents indicate a medium importance of project portfolio selection during periods of volatility has a high importance for product selection.
- The AbiliDeliverProdClient = 2 reduces the total amount of ProjectPortfSlect count from 188 to 76 and decreases the impact of the medium categories from 96 to 36.

5.3.5.4 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis E is:

Research Hypothesis:

H1: New high technology product development selection is **more dependent** on project portfolio selection during periods of volatility.

Null Hypothesis

H0: New high technology product development selection is **not more dependent** on project portfolio selection during periods of volatility.

Hypothesis E relates to the research question: **Research question 5:**" How do businesses balance their internal capabilities for IT project portfolio execution and new product development within conditions of economic / trade volatility?" (i.e. is the choice of product to be developed more critical during periods of volatility as the right projects must be selected?) Hypothesis E also relates to a lesser extent to the research question: Research question 6 and 7: "What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development in the short vs. longer term when volatility is present? How do they balance their order and delivery books?" The hypothesis also impacts on capacity planning in the organisation. It has relevance for research question 4, which also relates to capacity planning in the organisation.

The hypothesis focuses on the relationship between project portfolio selection and new product development and secondly on the impact changes required in response to the volatile business conditions internally in the business.

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.

Since the variables are of ordinal type , a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is in fact potentially none, should be proved.
A p-value of 5% is used to test if a relationship exists when in fact there is no relationship.
If $p < 5\%$ then reject H0 and this is a significant test result.
If $p > 5\%$ then do not reject H0 and this is not a significant test result.

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5.3.5.4.1 Testing for significance with variables ProjectPortfSlect and HighTechProdSelect

The observed frequencies for the variables ProjectPortfSlect vs. HighTechProdSelect association are depicted in Table 89:

Observed values	Not important	Low importance	Medium importance	High importance	Very high importance		
Count of ProjectPortfSlect	ProjectPortfSlect						
HighTechProdSelect	1	2	3	4	5	Grand Total	
1	1	2	6		1	10	Not important
2	1	6	4	7		18	Low importance
3	2		8	7	2	19	Medium importance
4	1	7	14	25	5	52	High importance
5	1	1		8	6	16	Very high importance
Grand Total	6	16	32	47	14	115	

Table 89: Observed frequencies of variables ProjectPortfSlect vs. HighTechProdSelect

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables ProjectPortfSlect vs. HighTechProdSelect association are depicted in Table 90:

		ProjectPortfSlect				
Dependant var HighTechProdSelect						
1	0.52173913	1.391304348	2.782608696	4.086956522	1.217391304	10
2	0.939130435	2.504347826	5.008695652	7.356521739	2.191304348	18
3	0.991304348	2.643478261	5.286956522	7.765217391	2.313043478	19
4	2.713043478	7.234782609	14.46956522	21.25217391	6.330434783	52
5	0.834782609	2.226086957	4.452173913	6.539130435	1.947826087	16
Total Sum	6	16	32	47	14	115

Table 90: Expected frequencies of variables ProjectPortfSlect vs. HighTechProdSelect

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The chi squared value for each expected frequency value is calculated and added up in Table 91:

Dependant variable	Independent variable		Chi Square
HighTechProdSelect	ProjectPortfSlect = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	1	0.52173913	0.438405797
2	1	0.939130435	0.00394525
3	2	0.991304348	1.026392067
4	1	2.713043478	1.081633222
5	1	0.834782609	0.032699275
	ProjectPortfSlect = 2		
	Observed	Expected	
1	2	1.391304348	0.266304348
2	6	2.504347826	4.879347826
3	0	2.643478261	2.643478261
4	7	7.234782609	0.007619147
5	1	2.226086957	0.675305707
	ProjectPortfSlect = 3		
	Observed	Expected	
1	6	2.782608696	3.720108696
2	4	5.008695652	0.203140097
3	8	5.286956522	1.39221968
4	14	14.46956522	0.015238294
5	0	4.452173913	4.452173913
	ProjectPortfSlect = 4		
	Observed	Expected	
1	0	4.086956522	4.086956522
2	7	7.356521739	0.01727824
3	7	7.765217391	0.075407761
4	25	21.25217391	0.660930051
5	8	6.539130435	0.326364477
	ProjectPortfSlect = 5		
	Observed	Expected	
1	1	1.217391304	0.038819876
2	0	2.191304348	2.191304348
3	2	2.313043478	0.042366787
4	5	6.330434783	0.279610607
5	6	1.947826087	8.429968944
		Chi-Sum	36.99

Table 91: Calculate Chi-Sum for the cells of variables values ProjectPortfSlect vs. HighTechProdSelect

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1).

(5-1)* (5-1) = 16

The Chi-squared (p=0.05, df=16) = 26.23 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.002105912 which is smaller than 0.05 hence H0 is rejected.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from.

5.3.6 Testing Hypothesis F: Bivariate Data Analysis

5.3.6.1 Variables related to Hypothesis F:

2 Variables are related to Hypothesis F as can be seen in Table 92:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
18 Q19	ProdProjChanges	Impact of project changes on product development	Independent variable Variable Type = Ordinal Structured scale: 1 = Not risk 2 = Low risk 3 = Medium risk 4 = High risk 5 = Very High risk	Research Hypothesis f Research Question 6	Is there increased risk in product development as a result of changes in project execution for clients when volatility is present?
19 Q20	CapacityPlanDelivery	Importance of capacity planning for project execution during volatile	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low	Research Hypothesis f Research Question 6	Do IT business increase focus on capacity planning for project execution during volatile periods?

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
		periods.	importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance		

Table 92: Review questionnaire questions 19 and 20

5.3.6.2 Associations that are graphically present in the data

The two variables from Table 92 are graphically depicted in Figure 66: Graphical bivariate analysis for questions 19 and 20:

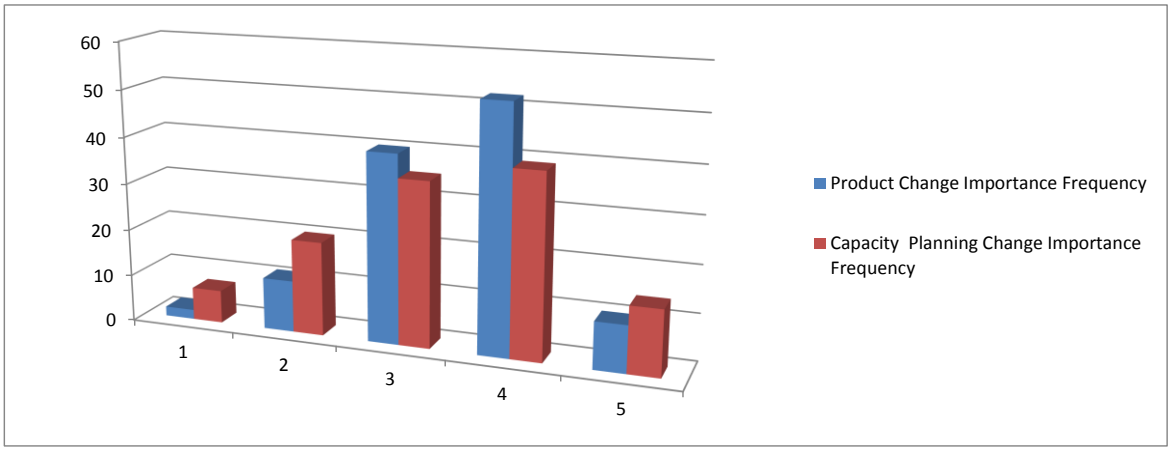

Figure 66: Graphical bivariate analysis for questions 19 and 20

Key visual findings from Figure 66:

- There is a visually positive association between the dependant variable (CapacityPlanDelivery) and independent variable (ProdProjChanges) at low to high levels.
- Respondents indicate that a medium to high importance of product changes in support of project portfolio during periods of volatility has a medium to high importance for capacity planning for execution.

5.3.6.3 The strength of the relationship

5.3.6.3.1 Testing the association strength between variable ProdProjChanges and CapacityPlanDelivery

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association| (without causation) for the variables ProdProjChanges and CapacityPlanDelivery association as depicted in Table 93:

		Not Important	Low importance	Medium importance	High importance	Very high importance		
		ProdProjChanges						
CapacityPlanDelivery	Data	1	2	3	4	5	Grand Total	
1	Count of ProdProjChanges2	1	3	2	1		7	Not important
	Count of ProdProjChanges	50.00%	27.27%	5.00%	1.92%	0.00%	6.09%	
2	Count of ProdProjChanges2	1	3	8	8		20	Low Importance
	Count of ProdProjChanges	50.00%	27.27%	20.00%	15.38%	0.00%	17.39%	
3	Count of ProdProjChanges2		2	18	13	2	35	Medium importance
	Count of ProdProjChanges	0.00%	18.18%	45.00%	25.00%	20.00%	30.43%	
4	Count of ProdProjChanges2		3	8	25	3	39	High importance
	Count of ProdProjChanges	0.00%	27.27%	20.00%	48.08%	30.00%	33.91%	
5	Count of ProdProjChanges2			4	5	5	14	Very high importance
	Count of ProdProjChanges	0.00%	0.00%	10.00%	9.62%	50.00%	12.17%	
Total Count of ProdProjChanges2		2	11	40	52	10	115	
Total Count of ProdProjChanges		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 93: Cross-tabulation for variables ProdProjChanges vs. CapacityPlanDelivery

Key finding in terms of the relationship strength as can be seen from Table 93:

- Based on the respondent feedback there seems to be positive association between the dependent variable (ProdProjChanges) and independent variable (CapacityPlanDelivery).
- Respondents indicated that a medium importance of product changes in support of project portfolio execution during periods of volatility has a medium importance of capacity planning to ensure delivery of projects.
- Respondents indicated that a high importance of product changes in support of project portfolio execution during periods of volatility has a high importance for capacity planning to ensure delivery of projects. Based on a total respondent feedback of 52 items in the high category this is the most significant.
- Respondents indicated that a very high importance of product changes in support of project portfolio execution during periods of volatility has a very high importance of capacity planning to ensure delivery of projects.

5.3.6.4 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis F is:

Research Hypothesis:

H1: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment. (i.e. whether positive or negative in level, project portfolio changes are more strongly related to capacity planning during periods of volatility?)

Null Hypothesis

H0: There is **not an increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment.

Hypothesis F also relates to the research question: **Research question 6:**" How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions?**"**

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.

Since the variables are of ordinal type, a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is in fact potentially none, should be proved.
A p-value of 5% is used to test if a relationship exists when in fact there is not.
If $p < 5\%$ then reject H0 and this is a significant test result.
If $p > 5\%$ then do not reject H0 and this is not a significant test result.

5.3.6.4.1 Testing for significance with variables ProdProjChanges and CapacityPlanDelivery

The observed frequencies for the variables ProdProjChanges and CapacityPlanDelivery association are depicted in Table 94:

Observed values	Not Important	Low importance	Medium importance	High importance	Very high importance		
Count of ProdProjChanges	ProdProjChanges						
CapacityPlanDelivery	1	2	3	4	5	Grand Total	
1	1	3	2	1		7	Not important
2	1	3	8	8		20	Low Importance
3		2	18	13	2	35	Medium importance
4		3	8	25	3	39	High importance
5			4	5	5	14	Very high importance
Grand Total	2	11	40	52	10	115	

Table 94: Observed frequencies of variables ProdProjChanges vs. CapacityPlanDelivery

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables ProdProjChanges vs. CapacityPlanDelivery association are depicted in Table 95:

	ProdProjChangest					
Dependant var CapacityPlanDelivery	1	2	3	4	5	
1	0.12173913	0.669565217	2.434782609	3.165217391	0.608695652	7
2	0.347826087	1.913043478	6.956521739	9.043478261	1.739130435	20
3	0.608695652	3.347826087	12.17391304	15.82608696	3.043478261	35
4	0.67826087	3.730434783	13.56521739	17.63478261	3.391304348	39
5	0.243478261	1.339130435	4.869565217	6.330434783	1.217391304	14
Total Sum	2	11	40	52	10	

Table 95: Expected frequencies of variables ProdProjChanges vs. CapacityPlanDelivery

The chi squared value for each cell is calculated and added up in Table 96:

Dependant variable	Independent variable		Chi Square
CapacityPlanDelivery	ProdProjChangest = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	1	0.12173913	6.336024845
2	1	0.347826087	1.222826087
3	0	0.608695652	0.608695652
4	0	0.67826087	0.67826087
5	0	0.243478261	0.243478261
	ProdProjChanges = 2		
	Observed	Expected	
1	3	0.669565217	8.111123659
2	3	1.913043478	0.617588933
3	2	3.347826087	0.542631282
4	3	3.730434783	0.143022195
5	0	1.339130435	1.339130435
	ProdProjChanges = 3		
	Observed	Expected	
1	2	2.434782609	0.077639752
2	8	6.956521739	0.156521739
3	18	12.17391304	2.788198758
4	8	13.56521739	2.283166109
5	4	4.869565217	0.155279503
	ProdProjChanges = 4		
	Observed	Expected	
1	1	3.165217391	1.481151457
2	8	9.043478261	0.120401338
3	13	15.82608696	0.504658385
4	25	17.63478261	3.076104108
5	5	6.330434783	0.279610607
	ProdProjChanges = 5		
	Observed	Expected	
1	0	0.608695652	0.608695652
2	0	1.739130435	1.739130435
3	2	3.043478261	0.357763975
4	3	3.391304348	0.045150502
5	5	1.217391304	11.75310559
		Chi-Sum	45.27

Table 96: Calculate Chi-Sum for the cells of values of ProdProjChanges vs. CapacityPlanDelivery

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1).

(5-1)* (5-1) = 16

The Chi-squared (p=0.05, df=16) = 26.30 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.000126188 that is smaller than 0.05 hence H0 is rejected.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from.

5.3.7 Testing Hypothesis G: Bivariate Data Analysis

2 Variables are related to Hypothesis G as can be seen in Table 97:

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
21 Q22	OrderIntake	Level of importance of focus on the order book for IT businesses.	Independent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low Importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance	Research Hypothesis G Research Question 7	How important is it for IT businesses to increase focus on their order book as a result of volatility?
22 Q23	BalanceAbility Delivery	Level of importance of focus delivery of projects for IT businesses.	Dependent variable Variable Type = Ordinal Structured scale: 1 = Not Important 2 = Low	Research Hypothesis G Research Question 7	Do IT business increase focus on delivery of projects successfully as a result of volatility?

Variable Number	Variable	Conceptual Definition	Variable Context Type of Variable & Variable Range	Hypothesis relevancy/ Research Question relevancy	Questionnaire Impact
			Importance 3 = Medium Importance 4 = High Importance 5 = Very High Importance		

Table 97: Review questionnaire questions 22 and 23

5.3.7.1 Associations that are graphically present in the data

The two variables from Table 97 are graphically depicted in Figure 67:

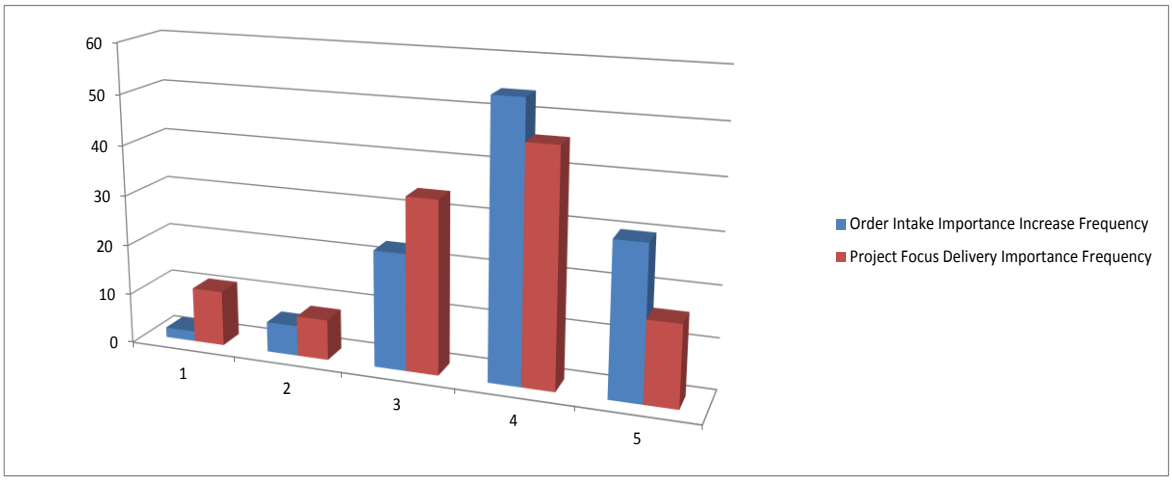

Figure 67: Graphical bivariate analysis for questions 22 and 23

Key visual findings from Figure 67:

- There is a visually positive association between the dependant variable (BalanceAbilityDelivery) and independent variable (OrderIntake) at low to high levels.
- Respondents indicate that a high importance of order intake during periods of volatility has a medium to high importance of ability to execute projects successfully.

5.3.7.2 The strength of the relationship

5.3.7.2.1 Testing the association strength between variable OrderIntake and BalanceAbilityDelivery

Since the data is of a discrete ordinal type a cross tabulation approach is followed to measure the association| (without causation) for the variables OrderIntake and BalanceAbilityDelivery association as depicted in Table 98:

		Not important	Low importance	Medium importance	High importance	Very high importance		
		OrderIntake						
BalanceAblilityDelivery	Data	1	2	3	4	5	Grand Total	
1	Count of OrderIntake2	2	1	2	2	4	11	Not important
	Count of OrderIntake	100.00%	16.67%	8.70%	3.70%	13.33%	9.57%	
2	Count of OrderIntake2		2	3	3		8	Low importance
	Count of OrderIntake	0.00%	33.33%	13.04%	5.56%	0.00%	6.96%	
3	Count of OrderIntake2			12	17	5	34	Medium importance
	Count of OrderIntake	0.00%	0.00%	52.17%	31.48%	16.67%	29.57%	
4	Count of OrderIntake2		2	4	28	12	46	High importance
	Count of OrderIntake	0.00%	33.33%	17.39%	51.85%	40.00%	40.00%	
5	Count of OrderIntake2		1	2	4	9	16	Very high importance
	Count of OrderIntake	0.00%	16.67%	8.70%	7.41%	30.00%	13.91%	
Total Count of OrderIntake2		2	6	23	54	30	115	
Total Count of OrderIntake		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Table 98: Cross-tabulation for variables OrderIntake vs. BalanceAblilityDelivery

Key findings in terms of the relationship strength as can be seen from Table 98:

- Based on the respondent feedback there seems to be positive association between the dependent variable (BalanceAblilityDelivery) and independent variable (OrderIntake).
- Respondents indicate that a medium importance of order intake during periods of volatility has a medium importance of ability to execute projects successfully.
- Respondents indicate that a high importance of order intake during periods of volatility has a high importance of ability to execute projects successfully.

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5.3.7.3 Determine the probability of the sample in the population from which the sample was drawn

The proposed research hypothesis G is:

Research Hypothesis:

H1: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

Null Hypothesis

H0: IT businesses **do not** balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

Hypothesis G also relates to the research question: **Research question 7:** "How do IT businesses balance their order and delivery books during periods of volatility?"
The hypothesis impacts the balancing of internal organisational capacity with external client requirements. The impact of volatile business conditions on the level of capacity planning process in the business is of specific concern.

The hypothesis testing is required to determine if the pattern visible in a sample also exists in the population from which the sample was obtained.

Since the variables are of ordinal type, a Chi-squared test of association as test statistic is followed.

The probability to commit a type 1 error (p) has to be tested to ensure the assumption that there is a relationship when there is in fact potentially none, should be proved.
A p-value of 5% is used to test if a relationship exists when in fact there is no relationship.
If $p < 5\%$ then reject H0 and this is a significant test result.
If $p > 5\%$ then do not reject H0 and this is not a significant test result.

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5.3.7.3.1 Testing for significance with variables ProdProjChanges and CapacityPlanDelivery

The observed frequencies for the variables ProdProjChanges vs. CapacityPlanDelivery association are depicted in Table 99:

Observed values	Not important	Low importance	Medium importance	High importance	Very high importance		
Count of BalanceAblilityDelivery	BalanceAblilityDelivery						
OrderIntake	1	2	3	4	5	Grand Total	
1	2					2	Not important
2	1	2		2	1	6	Low importance
3	2	3	12	4	2	23	Medium importance
4	2	3	17	28	4	54	High importance
5	4		5	12	9	30	Very high importance
Grand Total	11	8	34	46	16	115	

Table 99: Observed frequencies of variables ProdProjChanges vs. CapacityPlanDelivery

The expected frequencies for the variables are calculated as follows:
(column total * row total) divided by the total amount of values (115)

The expected frequencies for the variables ProdProjChanges vs. CapacityPlanDelivery association are depicted in Table 100:

		BalanceAblilityDeliveryt				
Dependant varBalanceAblilityDelivery	1	2	3	4	5	
1	0.191304348	0.139130435	0.591304348	0.8	0.27826087	2
2	0.573913043	0.417391304	1.773913043	2.4	0.834782609	6
3	2.2	1.6	6.8	9.2	3.2	23
4	5.165217391	3.756521739	15.96521739	21.6	7.513043478	54
5	2.869565217	2.086956522	8.869565217	12	4.173913043	30
Total Sum	11	8	34	46	16	115

Table 100: Expected frequencies of variables ProdProjChanges vs. CapacityPlanDelivery

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The chi squared value for each expected frequency value is calculated and added up in Table 101:

Dependant variable	Independentt variable		Chi Square
BalanceAblilityDelivery	BalanceAblilityDeliveryt = 1		((Exp-Obs)Power 2)/Expected
	Observed	Expected	
1	2	0.191304348	17.10039526
2	1	0.573913043	0.316337286
3	2	2.2	0.018181818
4	2	5.165217391	1.939628166
5	4	2.869565217	0.445322793
	BalanceAblilityDelivery = 2		
	Observed		
1	0	0.139130435	0.139130435
2	2	0.417391304	6.000724638
3	3	1.6	1.225
4	3	3.756521739	0.152355072
5	0	2.086956522	2.086956522
	BalanceAblilityDelivery = 3		
	Observed	Expected	
1	0	0.591304348	0.591304348
2	0	1.773913043	1.773913043
3	12	6.8	3.976470588
4	17	15.96521739	0.067069243
5	5	8.869565217	1.688192668
	BalanceAblilityDelivery = 4		
	Observed	Expected	
1	0	0.8	0.8
2	2	2.4	0.066666667
3	4	9.2	2.939130435
4	28	21.6	1.896296296
5	12	12	0
	BalanceAblilityDelivery = 5		
	Observed	Expected	
1	0	0.27826087	0.27826087
2	1	0.834782609	0.032699275
3	2	3.2	0.45
4	4	7.513043478	1.642673108
5	9	4.173913043	5.580163043
		Chi Sum	51.21

Table 101: Calculate Chi-Sum for the cells of values of ProdProjChanges vs. CapacityPlanDelivery

The degrees of freedom are calculated as (amount of rows -1)* (amount of columns -1). (5-1)* (5-1) = 16

The Chi-squared (p=0.05, df=16) = 26.30 (Soper, 2004).

Since Chi-Sum > Chi-Sqr (p=0.05), H0 can be rejected.
The Chi-Sum value correlates with the value as calculated in the Stattools® software product.
The calculated p value according to Stattools® is: 0.0000146981398876858 which is smaller than 0.05 hence H0 is rejected.
Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from.

5.4 INFERENCE OF NEW HYPOTHESIS BASED ON OBSERVED FACTS (DEDUCTIVE AND RETRODUCTIVE REASONING)

5.4.1 What results are interesting or significant and what is achieved from the data

The 24 question questionnaire provided substantial and significant data with the 115 qualified respondents' feedback. In the majority of cases the univariate single variable data analysis had clear categories of respondent preference. Viewing the univariate data analysis does, however, not take into consideration the relationships between the variables which is very important to measure the proposed relationship in the hypotheses. The bivariate analysis assisted in establishing the nature and strength relationship. When considering volatility as an event influencing IT clients and IT business the study wished to postulate and identify mechanisms in a retroductive way which is capable of producing them.

Hypothesis testing is used to

- uncover the real relations which produce empirical phenomena as well as
- Substantiate the findings with the aid of the qualitative data.

The Inductive qualitative data analysis provides valuable input into the hypothesis parts for understanding the sources and references of information from the respondents (retroductive).

The approach followed for combining related results for a hypothesis is depicted in Figure 27.

The quantitative data relevant for the research hypothesis are combined with the qualitative data. The summarised results from the bivariate analysis are finally evaluated with the hypothesis tests for significance and being accepted or rejected.

5.4.1.1 Hypothesis A: Findings

Research Hypothesis:

H1: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.

Null Hypothesis

H0: There is not a negative association between the new technology adoption/procurement and periods of exogenous volatility in the business environment.

The univariate data analysis indicated:

- **Question 1 / variable 1**: Do IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term?

  Univariate data analysis finding: Yes, IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term on a high impact level.

  Qualitative keyword/concepts of importance:
  - **Skills shortage** was listed as a significant factor. External recruitment of personnel remains under pressure with lower than expected availability of resources in the market.
  - **Training and up-skilling** are seen as a risk due to turnover of personnel.
  - **Cost of doing business** increasing significantly with commodities like energy, communications and regulatory aspects of compliance.
  - **Exchange rates volatility** makes planning, execution and delivery difficult
  - **Time to market** products is reduced in general.
  - Business strategy followed by different **sizes of businesses** makes the business more or less susceptible to influences of skills, interest rates and exchange rates.

- **Question 2 / variable 2a:** What is the level of impact on the adoption/procurement of new IT technology in negative conducive volatile periods?

  Univariate data analysis finding: Yes, IT clients adopt/procure somewhat less IT projects/products during negative conducive volatile periods.

Qualitative keyword/concepts of importance:

- **Industry specific factors** have an influence in terms of impact of adoption/procurement of new IT.
- **New market required technologies in** the market require IT clients to upgrade product/projects even when negative volatility is present since they must remain efficient in delivery of their products and services.
- IT is seen as an enabler and is used to reduce cost and improve productivity; hence during negative volatility focused expenditure for **value-based returns is more required due to limited funding**.
- IT clients reduce project and product development investment in line with business strategy of lower OPEX funding for IT. They then **catch up** when more funding is available.
- IT clients put a significant focus on their product growth and **use IT to identify the growth areas**. IT investment is then carefully directed to these areas.

- **Question 3 / variable 2b**: What is the level of impact on the adoption/procurement of new IT technology in positively conducive volatile periods?

  Univariate data analysis finding: Yes, IT clients adopt/procure somewhat more IT projects/products during positively conducive volatile periods.

  Qualitative keyword/concepts of importance:

  - The business and technology strategy dictates the focus and priorities for investment. During positive volatile periods more funding is generally available to **improve IT investments** and directed to further investment in growth areas. Clients do remain conservative on IT spending.
  - Provided the **business case is viable** and accepted there is increased expenditure in the IT project portfolio and product development.
  - IT project/product portfolio is typically more upgraded during these positive periods to **be current and competitive**.
  - **Value derived from IT** investment remains the deciding factor for expenditure.
  - IT industry refocuses as a result of **major technology shifts** like mobile IT products for users. These shifts may likely motivate more funding from clients as well during periods of positive volatility.

- Question 1 relates to the second part of the research hypothesis and Questions 2a/b relate to the first part of the research hypothesis:

H1: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.

The bivariate data analysis between variables ExogVolatility (Question 1), NewTechAdoptProca (Question 2) and NewTechAdoptProcb (Question3) revealed the following associations between the sample data:

- There is a positive visual association between the dependent variable (NewtechadoptProcb) and independent variable (ExogVolatility).
- There is a negative association between the dependent variable (NewtechadoptProca) and independent variable (ExogVolatility).
- Respondents indicated that clients say that they experience exogenous volatility as having a high impact on their business.
- Respondents indicated that IT clients procure somewhat less during conditions of negative volatility.
- Respondents indicated that IT clients procure somewhat more during conditions of positive volatility.

The **measures of the associations** between variables ExogVolatility (Question 1), NewTechAdoptProca (Question 2) and NewTechAdoptProcb (Question3) revealed the following associations between the sample data:

- Cross-tabulation for variables Exogvolatility (Question 1) vs. NewTechAdoptProca (Question 2) revealed that when exogenous volatility impact is perceived as high in negative periods, clients will procure somewhat less IT. Also when volatility is very high IT clients procure significantly less IT.
- Cross-tabulation for variables Exogvolatility (Question 1) vs. NewTechAdoptProcb (Question3) revealed that the Exogvolatility independent variable has a total of 57 respondents in the high category. When exogenous volatility is on a high level during positive periods clients will procure somewhat more IT. When the association is on the medium and very high level, Exogenous volatility seems spurious and not valid.

The measure of association indicated:

- A negative association between variables Exogvolatility (Question 1) and NewTechAdoptProca (Question 2).
- A positive association between variables Exogvolatility (Question 1) and NewTechAdoptProcb (Question 3).

In the case of negative volatility, there is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment (Chi-square sum = 24.78696462, df=9, p<0.05). The visual association indicated a negative association between variables Exogvolatility (Question 1) and NewTechAdoptProca (Question 2) which supports the research hypothesis relation of being “negative” association. Thus H1 has significance, as H0 is rejected.

In the case of positive volatility, there is **a negative association (according to H1)** between new technology adoption/procurement and periods of exogenous volatility in the business environment (Chi-square sum = 11.64207431, df=12, p>0.05). Thus H0 cannot be rejected. The measure of association indicated a positive association between variables Exogvolatility (Question 1) and NewTechAdoptProcb (Question 3) which does not support the research hypothesis relation of being “negative” associated.

The research hypothesis A is thus accepted in the case of negative volatility and rejected for positive volatility.

In relation to the full model of Figure 22 the following result set has been completed:

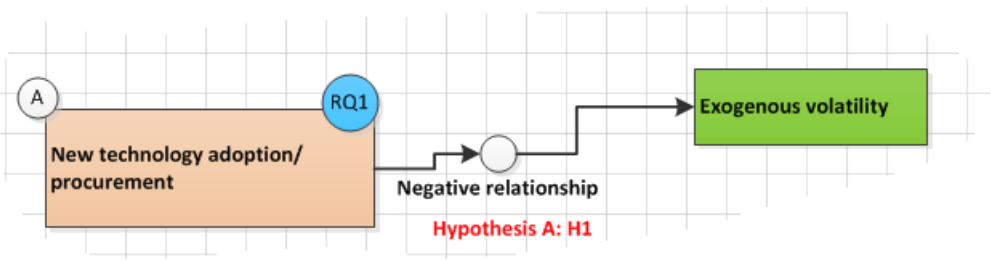

Figure 68: Impact model relation for Hypothesis A completed

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5.4.1.2 Hypothesis B: Findings

Research Hypothesis:

H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

have a **positive association** on IT business, IT projects and supporting product development growth.

Null Hypothesis

H0: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

do not have **not a positive association** with IT business, IT projects and supporting product development growth.

The univariate data analysis indicated:

- **Question 4 / variable 3**: Does a clearer understanding of customer requirements during periods of volatility assist in growing project portfolio and supporting product development?

Univariate data analysis finding: Yes, having a clearer understanding of IT client requirements has a **high impact** on assisting in growing the project portfolio and supporting product development.

Qualitative keyword/concepts of importance:

- **Client business goals** need to translate to requirements to be serviced by the IT businesses with project and product portfolios even more **flexible** during volatile periods.
- **Understanding client operations and impact of volatility** can be used to promote project and supporting product features during proposal stage.
- Client requirements translate the **application of IT products** via projects to **improve operational processes (and cost)** during volatile periods and not the reason to create products.
- IT business must be focused at client-**centric innovation and delivering growth focused products/projects** and not purely at integration of systems which increase running costs for the client.

- Knowing the customer and their requirements during volatile periods imply the IT business portfolio of projects and products must lead to a **customer-centric culture and systems base.**

- **Question 5 / variable 4:** Does an understanding of the impact of volatility on customer operations assist in growing IT business project portfolios and supporting product development?

  Univariate data analysis finding: Yes, having a clearer understanding of the impact that volatility has on client operations has a high impact on assisting in growing the project portfolio and supporting product development.

  Qualitative keyword/concepts of importance:
  - IT business should understand the **pain areas** of IT clients to assist them in identifying **sweet spot areas** where IT projects and products can make a difference in their business.
  - Customers are **seeking return on investment (ROI) improvement** during volatile periods with a refocus of IT budgets in support of the ROI optimisation. The already defined product suite can be **optimised and stage validated to be aligned** to client requirements via project based applications.
  - Products should be **operationally matured** for client requirements and the **strategic intent of the product suite optimised with product road mapping for future focus.**
  - During negative volatile periods clients **will slow down or halt higher risk IT projects**. The IT business should realise this can happen and proactively seek concurrent business with more customers to ensure project/product portfolio is not stagnated when projects are halted.
  - **Well-defined business cases** for IT projects are subject to volatile conditions but may still grow the project/product portfolio if the focus is retained to realise promised value from executing the business case (p**rice vs. quality vs. competitive advantage**).
  - Clients focus on **internal process optimisation** more frequently during volatile periods and IT should support process optimisation **without inducing and increasing running costs overheads.**

- **Question 6 / variable 5**: Does one-on-one interaction with clients during periods of volatility assist in growing project portfolio and supporting product development?

Univariate data analysis finding: Yes, having one-on-one interaction with clients has a **high impact** on growing the IT project and supporting product development during periods of volatility.

Qualitative keyword/concepts of importance:

- **Communications and mutual understanding** between IT client and IT business is a prerequisite for expectation management leading to successful project and product development.
- **Know your customer, know your product, know your market and know competitive pricing for a suitable IT projects/products portfolio.**
- Turning the IT proposal to the client into a successful sale very often **requires close co-operation with the customer to refine** scope, pricing/budgeting, quality requirements, commercial conditions and operational requirements. This creates a demand for the project and the product portfolio to grow.
- **Joint decisions and fulfilment on the decisions with the customer** lead to operational risk reduction and acceptance of new products which improve performance.
- **Slow response speed kills IT.** The communication with the client identifies IT project/product opportunities or existing risks which should be solved timeously by focused IT projects and product development.

- **Question 7 / variable 6**: Has client response to volatility impacted IT business project development and supporting product development?

Univariate data analysis finding: Yes, IT client response during volatility has a high impact on IT project and supporting product development.

Qualitative keyword/concepts of importance:

- **Yes,** IT client response during volatility has a high impact on IT projects and supporting product development;
- **Projects are halted** leading to reductions in IT project/product development.
- Focus is shifted to **high ROI IT projects/products;**
- **Customers focus on pain points in processes** and not gearing for growth opportunities of new IT projects/products if they are a small business;
- IT businesses see a reduction during negative volatility on orders; they then **relate this to client budgets/operational priorities** and reassess their project and product portfolio focus.

- **Question 8 / variable 7**: Does the combined impact of an understanding of customer requirements, impact of volatility on customer operations and one-on-one interaction have a more positive impact on growing IT projects and supporting product development during the presence of volatility?

  Univariate data analysis finding: Yes, the category of strongly in agreement categorises the positive impact that the independent variables (customer requirements, customer operational impact as a result of volatility as well as one-on-one customer interaction activities) have on the dependent variable (IT business, IT projects and supporting product development growth).

  Qualitative keyword/concepts of importance:
  - **Yes,** the combined impact has an effect on IT projects and supporting product development growth.
  - Focus in project and product development is **optimised to client requirement applications**, feedback and general business environment volatility conditions.
  - Customers know what they **receive** and IT businesses know what IT projects/products should be **supplied**.
  - **New requirements from the market** for innovative IT products (like mobile portable IT devices) are discussed with clients, **refined for their processes** and this may likely realise in new innovative IT applications. Together IT business and clients **unlock competitive opportunities**.
  - IT clients also need to provide service and satisfy their client's needs. The interaction capabilities of new technologies like social media, e-mail, Voiceover Internet Protocol (VOIP) products unlocks opportunities **to link back end systems with client interaction**. This can grow the IT project/product portfolio irrespective of volatility.

- Questions 4,5,6 relate to the first part of the research hypothesis and question 7 relates to the second part of the research hypothesis:

  H1: The 3 elements of a clear understanding of
  - customer requirements
  - customer operational impact as a result volatility as well as
  - One-on-one customer interaction activities have a **positive association** with IT business IT projects and supporting product development growth.

- Question 8 relates to a direct question measuring the respondents view on the hypothesis hence the Likert scale data. This is a loose standing question with no measured association to questions 4,5,6 and 7.

The bivariate data analysis between variables CustomerReq (Question 4), CustomerOpImpact (Question 5), CustomerIntAct (Question 6), and ITProjProdGrowth (Question 7) revealed the following associations between the sample data:

- Respondents indicated that understanding customer requirements has a high impact on growing project and product development portfolio growth during times of volatility. There is a positive visual association between the dependent variable (ITProjProdGrowth) and independent variable (CustomerReq).
- Respondents indicated that understanding the impact of volatility on customer operations has a high impact on project and product development portfolio growth. There is a positive visual association between the dependent variable (ITProjProdGrowth) and independent variable (CustomerOpImpact).
- Respondents indicated that one-on-one interaction with clients has a high impact on growing project and product development portfolio growth during periods of volatility. There is a positive visual association between the dependent variable (ITProjProdGrowth) and independent variable (CustomerIntAct).

The **measures of the associations** between variables CustomerReq (Question 4), CustomerOpImpact (Question 5), CustomerIntAct (Question 6) and ITProjProdGrowth (Question 7) revealed the following associations in the sample data:

- Cross-tabulation for variables CustomerReq (Question 4) vs. ITProjProdGrowth (Question 7) revealed that when the perceived impact of understanding client requirements is high the impact has influenced project and product development at high level.
- Cross-tabulation for variables CustomerOpImpact (Question 5) vs. ITProjProdGrowth (Question 7) revealed that when the perceived impact on client operations is medium the impact has influenced project and product development at a medium level.
- Cross-tabulation for variables CustomerOpImpact (Question 5) vs. ITProjProdGrowth (Question 7) revealed that when the perceived impact on client operations is high the impact has influenced project and product development at a high level.
- Cross-tabulation for variables CustomerIntAct (Question 6) vs. ITProjProdGrowth (Question 7) revealed that when the perceived impact of one-on-one customer interaction is high then the impact has influenced project and product development at a high level.

The measure of association indicated:

- A positive association between variables CustomerReq (Question 4) and ITProjProdGrowth (Question 7).
- A positive association between variables CustomerOpImpact (Question 5) and ITProjProdGrowth (Question 7).
- A positive association between variables CustomerIntAct (Question 6) and ITProjProdGrowth (Question 7).

In the case of CustomerReq (Question 4) vs. ITProjProdGrowth (Question 7), understanding customer requirements has a positive association on IT business, IT projects and supporting product development growth (Chi-square-sum = 37.54347188, df=12, p<0.05). Thus H0 should be rejected.

In the case of CustomerOpImpact (Question 5) vs. ITProjProdGrowth (Question 7), understanding customer operational impact has a positive association on IT business IT projects and supporting product development growth (Chi-square-sum = 42.60763069, df=12, p<0.05). Thus H0 should be rejected.

In the case of CustomerIntAct (Question 6) and ITProjProdGrowth (Question 7), understanding one-on-one customer interaction activities has a positive association on IT business, IT projects and supporting product development growth (Chi- square- sum = 21.44486032, df=9, p<0.05). - Thus H0 should be rejected.

The research hypothesis B is thus acceptable as the survey data results for the questionnaire do not contradict the hypothesis. The finding correlates with the respondent views of question 8 where strong agreement was provided by the respondents in relation to the complete hypothesis.

In relation to the full model of Figure 22 the following result set has been completed:

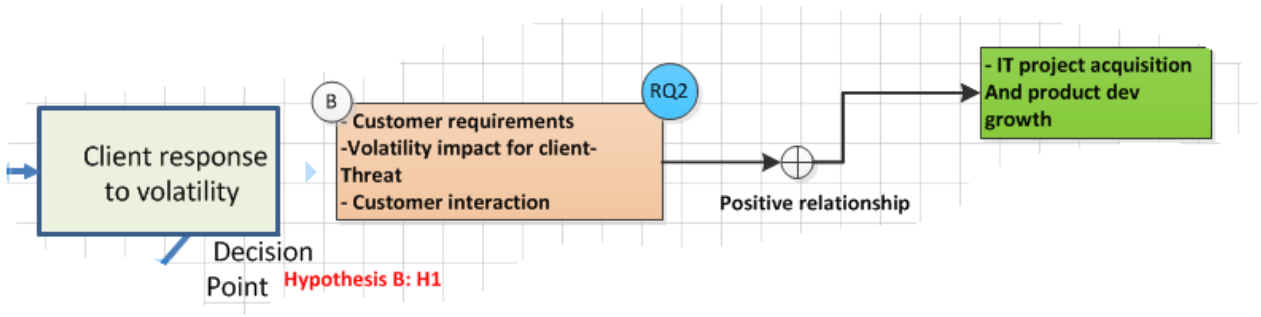

Figure 69: Impact model relation for Hypothesis B completed

5.4.1.3 Hypothesis C: Findings

Research Hypothesis:

H1: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility.

Null Hypothesis

H0: A business's strategic focus towards change is **not positively associated** with its market intelligence (client requirements) at the time of significant volatility.

The univariate data analysis indicated:

- **Question 9 / variable 8**: Does business gather market intelligence for shorter or longer term strategy changes during periods of volatility?

  Univariate data analysis finding: Yes, business response during volatility is still focused at obtaining market intelligence that can lead to **short and longer term strategy changes.**

  Qualitative keyword/concepts of importance:
  - Short-term **collection for crisis/threat management** and longer term collection for **strategic intent** and growth are indicated by several respondents.
  - **Understanding customer responses** to volatility requires constant collection and analysis of market intelligence.
  - **Proactive opportunities** identified during volatile periods should be capitalised on over the short and longer terms—Look beyond volatility.
  - **Business size, financial position, order book level and status in project/product development** will also determine frequency of collection of market intelligence. Businesses utilise market intelligence as part of formal **risk plans for time periods** immediate, one year, three years or five years.
  - Business can be **innovative/evolving** or **stable/reliable** and this requires different types and frequencies of market intelligence.

- **Question 10 / variable 9:** Do IT businesses increase their collection of market intelligence during periods of volatility?

  Univariate data analysis finding: Yes, business response during volatility is to increase their collection of market intelligence at predominantly a **medium level (category wise).** The high increase categories should, however, not be ignored as respondents did offer wider spreading opinions.

  Qualitative keyword/concepts of importance:
  - Yes business increases focus on **short term survival** (due to insecurity/threats) and management of the business variables are influenced by volatility.
  - Business uses increased market intelligence to **plan strategy and increase action for post volatility cycles of down turn or upturn**.

- Business increases market **intelligence to obtain information on how to stabilise itself operationally** in the short and mid-term.
- Business increases market intelligence at medium level to also understand **volatility impact for clients**.
- Being **flexible in approach** to do business implies use of accurate market intelligence collected constantly to be able to adapt to changing customer behaviour as a result of volatility.

- **Question 11 / variable 10**: Do businesses adapt their IT business /IT strategy during periods of volatility based on market intelligence for short term benefit?

  Univariate data analysis finding: Yes, the category of somewhat agreement is the largest category of impact of the independent variables (market intelligence) on the dependent variable (a business's strategic focus towards change).

  Qualitative keyword/concepts of importance:
  - **Somewhat agreement,** as business makes **informed decisions on strategy** as a result of volatility it has **operational focus changes and budget constraints which both impact on IT strategy**.
  - Proactive opportunities identified as a result of **market intelligence** during volatility may demand **quicker innovative responses** from IT implementations.
  - IT strategies in larger businesses are annually set and **not frequently adapted** to ensure reaching planned IT scope is achieved and business cases promises realised (Typical key performance indicator approach to management).
  - Many businesses focus on **core business during volatility** which requires stable working IT functions without operational risk of changes in the short term.
  - Market intelligence indicating **customer operational IT/business changes**, requires potential short-term changes in own IT project/products. This is done to **improve delivery of services, communications and engagement**.

- Question 9 relates to the first part of the research hypothesis and Question10 relates to the last part of the research hypothesis:

  H1: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility.

- Question 11 relates to a direct question measuring the respondents' view on the hypothesis hence the Likert scale data. This is a loose-standing question with no measured association to questions 9 and 10.

The bivariate data analysis between variables MarketIntel (Question 10) and BusStratChange (Question 9) revealed the following associations between the sample data:

- There is a partial, only positive association between the dependent variable (BusStratChange) and independent variable (MarketIntel).
- Respondents indicated that collection of market intelligence during times of volatility has a medium to high impact on business orientation towards strategy changes.

The **measures of the associations** between variables MarketIntel (Question 10) and BusStratChange (Question 9) revealed the following associations between the sample data:

- Cross-tabulation for variables MarketIntel (Question 10) vs. BusStratChange (Question 9) revealed that Respondents indicated that when the perceived market intelligence increases on medium level, the impact that has influenced business focus towards change is geared for both short and long term. This is consistent with the partial, positive only association between the variables.

The measure of association indicated:

- A partial positive association between variables MarketIntel (Question 10) and BusStratChange (Question 9).

In the case of MarketIntel (Question 10) vs. BusStratChange (Question 9) a business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility (Chi-square-sum = 21.33267851, df=12, $p<0.05$). Thus H0 should be rejected. Thus H1 has significance, as H0 is rejected. The difference to Chi (df=12, $p<0.05$) = 21.02606982 is marginal only suggesting issues in the significance of the result.

There is a contradiction: The visual association indicated a non-linear association with some positive relationship between variables MarketIntel (Question 10) and BusStratChange (Question 9) only, which does not fully support H1's relation of being "positively associated".

The research hypothesis C is thus only partially accepted .
Since $p < 0.05$ (border case) the research hypothesis H1 is accepted and significant. The patterns visible in the sample result may also be present in the population the sample was taken from.

In relation to the full model of Figure 22 the following result set has been completed:

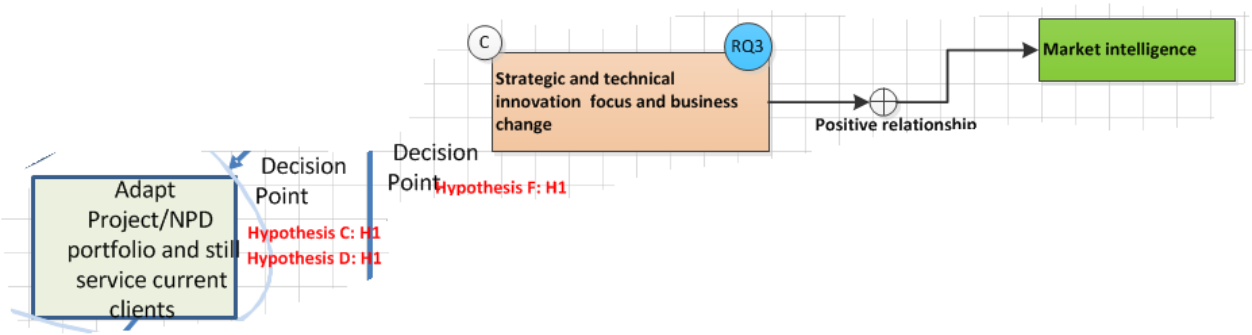

Figure 70: Impact model relation for Hypothesis C completed

5.4.1.4 Hypothesis D: Findings

Research Hypothesis:

H1: There is a **positive association** between business value growth as a result of short - term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

Null Hypothesis

H0: There is **not a positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

The univariate data analysis indicated:

- **Question 12 / variable 11**: To what extent do IT businesses adapt their short-term technology strategy to induce business value growth as a result of using market intelligence of volatility?

Univariate data analysis finding: Yes, IT businesses adapt their short term technology strategy at predominantly **medium levels** as a result of market intelligence indicating the presence of volatility in the business environment.

Qualitative keyword/concepts of importance:

- The technology strategy should **support the changes in IT business strategy** and also **unlock new business value** for the business.
- **Changes (medium or drastic) in the technology strategy must have business value** attached to it extending beyond short-term revenue focus to longer term strategic intent.

- A **flexible technology strategy (being able to make some changes)** which can create some value for customers with project/product adaptations does go a long way to realise short-term value and business.
- The technology strategy should be adaptable with medium level changes for being able to **successful fulfil many small orders (contracts) to make up large amounts**. If a repeatable project/product solution is delivered at low technical risk and low non-recurring engineering cost, profit may quickly be realised.
- The technology strategy with some changes should phase out technical projects with low margin, low long-term business potential and high cost. **Apply simple cost of technology vs. business benefit rules**.

- **Question 13 / variable 12:** When the IT business / technology strategy is adapted for volatile reasons, are major adaptations required in the project portfolio and supporting product development?

  Univariate data analysis finding: Yes, change in the business/technology strategy as a result of volatility leads to **medium level** changes in the project portfolio and product development.

  Qualitative keyword/concepts of importance:
  - The answer is **context specific** since the level of change required, the business's ability to consume volatility, budget, competition position and maturity of own project /product portfolio will determine the adaptation level required. In most cases there are medium changes required only.
  - The medium changes in the portfolio are usually split between **short-term benefit** realisation but still having **longer term focus** and strategic intent to grow the portfolio.
  - The technology strategy must also be robust to facilitate medium changes in technical scope, cost, time required to **mitigate variables induced by volatility** for example release versions based functional products with interim IT product deliveries.
  - The **project/product portfolio maturity should be market leading** maturing level to be changed a maximum of medium level, extended and scaled for **flexible deliveries.**
  - For example, clients procuring modular solutions over time via several project phases as budget permits.
  - **Accelerate changes planned** into technical strategy into the portfolio not to miss new opportunities. Slow reaction speed in IT means lost opportunities.

- **Question 14 / variable 13**: Do Businesses adapt their IT business /IT strategy during periods of volatility based on market intelligence for short term benefit?

Univariate data analysis finding: Yes, medium **impact** categorises the effect of the independent variable (of short-term technology strategy definition) on the dependent variable (project/product portfolio execution).

Qualitative keyword/concepts of importance:

- **New market required technology** will alter the business strategy leading with medium level changes in technology strategy and subsequent development in the project and supported products.
- If market intelligence indicates larger volumes for similar products in the market, **consider lowering pricing** on already developed projects/products to retain volume sales. The product portfolio should also include **low-risk, already developed products** with fixed costs for delivery.
- The technology strategy should make provision for **roadmap planning** in the project/product portfolio. This should facilitate **short-term extensions** in the project/product portfolio to keep the customer satisfied but also **longer term client requested, larger requirements** into the portfolio.
- Market intelligence should be **constantly reviewed** to ensure the business and technology strategy changes are based on best available accurate information about the business environment.
- **Competitors' projects/products portfolios** should be continuously assessed and compared to own projects/products portfolio. Required capabilities may be **generically developed** into the portfolio over time or based on **urgency "forced" into the short-term development tracks** for the portfolio.

- Question 12 relates to the first part of the research hypothesis and Question13 relates to the last part of the research hypothesis:

  H1: There is a **positive association** between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

- Question 14 relates to a direct question measuring the respondents view on the hypothesis hence the Likert scale data. This is a loose standing question with no measured association to questions 12 and 13.

The bivariate data analysis between variables ShortLongStratDef (Question 12) and ProjectProductExecChange (Question 13) revealed the following associations between the sample data:

- There is a positive association between the dependent variable (ProjectProductExecChange) and independent variable (ShortLongStratDef) at medium to high level.
- Respondents indicate that medium changes in short-term technology strategy to create business value during times of volatility have a medium impact on project and product portfolio changes.
- Fewer respondents indicate that high changes in short-term technology strategy to create business value during times of volatility have a high impact on project and product portfolio changes.

The **measures of the associations** between variables ShortLongStratDef (Question 12) and ProjectProductExecChange (Question 13) revealed the following associations between the sample data:

- Cross-tabulation for variables ShortLongStratDef (Question 12) vs. ProjectProductExecChange (Question 13) revealed respondents indicated that when the changes in short-term technology strategy is of a medium level (supporting business value growth) then the impact has medium changes on project and product development as a consequence.
- Cross-tabulation for variables ShortLongStratDef (Question 12) vs. ProjectProductExecChange (Question 13) revealed respondents indicated high level (supporting business value growth) then the impact of this has high changes on project and product development as a consequence.

The measure of association also indicated:

- A positive association between variables ShortLongStratDef (Question 12) vs. ProjectProductExecChange (Question 13).

In the case of ShortLongStratDef (Question 12) vs. ProjectProductExecChange (Question 13) There is a **positive association** between business value growth as a result of short-term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility (Chi-square-sum = 26.2962276, df=16, $p<0.05$). H0 can be rejected. Thus H1 has significance, as H0 is rejected. This is consistent with the findings of question 14.

The research hypothesis D is thus accepted and has significance.
In relation to the full model of Figure 22 the following result set has been completed:

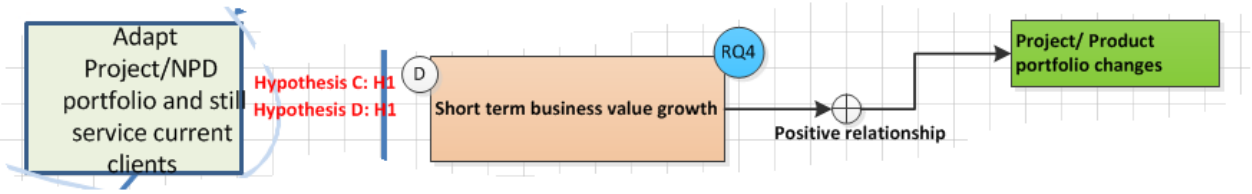

Figure 71: Impact model relation for Hypothesis D completed

5.4.1.5 Hypothesis E: Findings

Research Hypothesis:

H1: New high technology product development selection is **more dependent** on project portfolio selection during periods of volatility.

Null Hypothesis

H0: New high technology product development selection is **not more dependent** on project portfolio selection during periods of volatility.

The univariate data analysis indicated:

- **Question 15 / variable 14**: Is the selection of sellable products to be developed by IT business of more importance during volatile periods?

  Univariate data analysis finding: Yes, the selection of sellable products to be developed by IT business is of **higher importance** during volatile periods.

  Qualitative keyword/concepts of importance:
  - **Yes,** the selection of products is very important before and during volatile periods.
  - The dominant aspect listed by the respondents is that the IT business should have a **diversified product portfolio with lower unit costs, mature and sellable products** also available to be sold off the shelf to customers. Not all products should be "in progress, but not yet available" development status.
  - A **proactive product management/planning** (with commercial and sales skill) function should ensure the products have features, function and price to be able to be sold in volatile/non-volatile environments.
  - Be in **close contact with customers where relationship can expose key product attributes required** for the existing and new products. This should focus **limited budgets** at **re-usable, key client requirements and a competitive edge** to be implemented into product development during volatile periods.

- **Return on investment (ROI) in the short term** is important for cash flow yet product **roadmaps should also fit into short time** for delivery to customers.

- **Question 16 / variable 15:** Is the selection of projects for the IT business as offered by clients to execute of more importance during volatile periods than non-volatile periods?

  Univariate data analysis finding: Yes, the selection of projects for the IT business as offered by clients to execute is of **high importance** during volatile periods rather than during non-volatile periods.

  Qualitative keyword/concepts of importance:
  - **Yes, project selection is more important during periods of volatility.**
  - The dominant concept is that **projects should have value that makes them unique, competitive and have a high ROI with low risk**.
  - Projects should have **business case and execution plans to generate ROI early** in the project lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational process efficiencies induced, cost savings, communications and so forth.
  - Because client **project budgets are tight, IT business must stick to core product features, remove "nice to haves", include some customer required features and remove unnecessary cost drivers**.

- **Question 17 / variable 16**: Do IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects?

  Univariate data analysis finding: Yes, IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects.

  Qualitative keyword/concepts of importance:
  - **Yes**, in a case-by-case approach where **processes are in place** and being **executed as such**.
  - **Larger businesses** with more **formal processes** tend to have more formal capacity planning since they execute more project and product development with large but **limited teams** of people and resources.
  - **Smaller IT businesses** tend to scope capacity on a **per project only** with little excess capacity or overhead plans.

- **Budget constraints** have a significant impact on capacity planning since the ideal available resources may often not fit into the budget**.**
- Many IT businesses utilise **best practice industry frameworks** like TOGAF®, PRINCE II ®, ZACHMAN®, ITIL®, COBIT® and Industry frameworks like eTOM®, EMMMV®, HPUM® for capacity planning and process maturity assessments.

- **Question 18 / variable 17**: Is the formulation of the right product portfolio in support of potential projects to clients more critical during periods of volatility than in periods of less volatility?

  Univariate data analysis finding: Yes, the formulation of the right product portfolio in support of potential projects to clients is more critical during periods of volatility than in periods of less volatility.

  Qualitative keyword/concepts of importance:
  - **Yes**, the right project and product portfolio strategy is more required during volatile periods as there is **potentially less funding available from IT clients.**
  - The technology strategy that manages the **project and product portfolio should be benchmarked/aligned to the business strategy**. The portfolio is more than a business enabler and should unlock new business strategy as well.
  - The portfolio should **mitigate via the mix of product and services the volatile influences** and focus on the overall technology strategy.
  - The project and product portfolio should have a **business case and execution plan to generate ROI early** in the project's lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational process efficiencies induced, cost savings, communications, and so forth.
  - The complete portfolio should aim even in volatile periods to **have a value propositions and competitive edge** that customers favour and want to have. Clients do **demand more value** and **requirements** from their funding provided during volatile periods.

- Question 15 relates to the first part of the research hypothesis and Question 16 relates to the last part of the research hypothesis:

  H1: New high technology product development selection is **more dependent** on project portfolio selection during periods of volatility.

- Question 17 is a moderating variable of nominal scale which influences both the dependent and independent variables.

- Question 18 relates to a direct question measuring the respondents view on the hypothesis hence the Likert scale data. This is a loose-standing question with no measured association to questions 15 and 16.

The bivariate data analysis between variables ProjectPortfSlect (Question 16) and HighTechProdSelect (Question 15) revealed the following associations between the sample data:

- There is a visually positive association between the dependant variable (HighTechProdSelect) and independent variable (ProjectPortfSlect) at all levels but lower at medium level.
- Respondents indicate that a high importance of project portfolio selection during periods of volatility has a high importance of product selection.
- Fewer respondents indicate that a very high importance on project/ portfolio selection during periods of volatility has a very high importance on product selection.

The **measures of the associations** between variables ProjectPortfSlect (Question 16) and HighTechProdSelect (Question 15) revealed the following associations between the sample data:

- Cross-tabulation for variables ProjectPortfSlect (Question 16) vs. HighTechProdSelect (Question 15) revealed respondents indicate a high importance of project portfolio selection during periods of volatility has a high importance on product selection.
- A positive association between variables ProjectPortfSlect (Question 16) vs. HighTechProdSelect (Question 15).

Since the moderating variable AbiliDeliverProdClient (Question 17) influences the dependent a variable and independent variables the impact of the moderating variable should also be investigated.

An additional filter criterion was set on the pivot table in Microsoft Excel® for the cross-tabulation representation.

The AbiliDeliverProdClient = 2 = “Yes” had an overwhelming counted value of 74 of the 115 respondents.

The AbiliDeliverProdClient = 1 = “No” had a lesser counted value of 41 of the 115 respondents.

With the AbiliDeliverProdClient = 2 the cross-tabulation approach followed, **measures of the associations** between variables ProjectPortfSlect (Question 16) and HighTechProdSelect (Question 15) revealed the following associations between the sample data:

- Cross-tabulation for variables ProjectPortfSlect (Question 16) vs. HighTechProdSelect (Question 15) revealed respondents indicate a medium importance of project portfolio selection during periods of volatility has a medium importance for product selection.
    - The AbiliDeliverProdClient = 2 reduces the total amount of ProjectPortfSlect count from 188 to 76 and decreases the impact of the medium categories from 96 to 36.

In the case of ProjectPortfSlect (Question 16) vs. HighTechProdSelect (Question 15), new high technology product development selection is **more dependent** on project portfolio selection during periods of volatility (Chi-squaresum = 36.98701919, df=16, p<0.05). H0 can be rejected. Thus H1 has significance, as H0 is rejected. This is consistent with the finding of question 18.

The research hypothesis E is thus accepted and has significance.

In relation to the full model of Figure 22 the following result set has been completed:

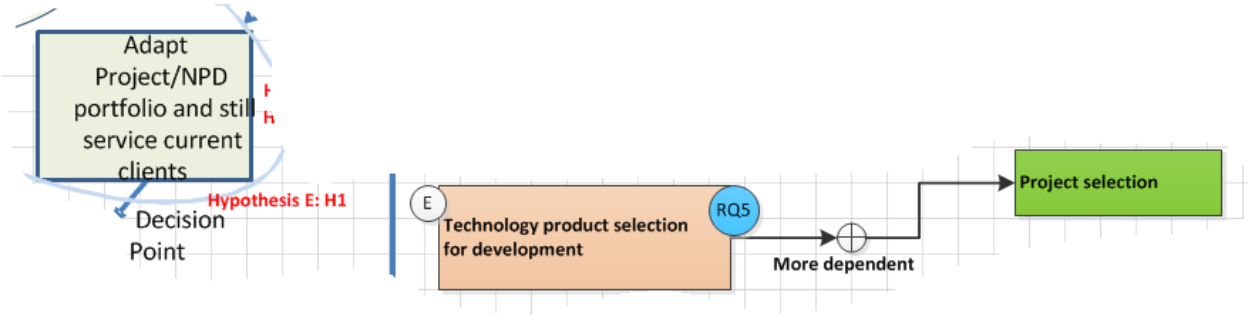

Figure 72: Impact model relation for Hypothesis E completed

5.4.1.6 Hypothesis F: Findings

Research Hypothesis:

H1: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment, (i.e. whether positive or negative in level, project portfolio changes are more strongly related to capacity planning during periods of volatility?)

Null Hypothesis

H0: There is **not an increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment.

The univariate data analysis indicated:

- **Question 19 / variable 18**: Is there increased risk in product development as a result of changes in project execution for clients when volatility is present?

Univariate data analysis finding: Yes, there is **medium to high increased risk** in product development as a result of changes in project execution for clients when volatility is present.

Qualitative keyword/concepts of importance:

- Yes, there is **medium to high** risk in the product development as a result of project execution.
- The **risk must be detected, tracked, mitigated** on a continuous basis to ensure product roadmap implementation remains on track for the overall project/product portfolio.
- The **scope changes, risk/mitigation plans, unforeseen delays and budgets** should be managed under proper project management principles with stakeholders (both internal and external).
- The **product portfolio should be optimised for client requirements** both in the short term (contract specific but reusable) and longer term strategic product features.
- **Product functional specialising developers should be retained** with human resource management intervention to ensure personal growth and career initiatives since training new developers will place lengthy delays on development.

- **Question 20 / variable 19:** Do IT businesses increase focus in capacity planning for project execution during volatile periods?

Univariate data analysis finding: Yes, IT business increases with **medium to high importance** focus in capacity planning for project execution during volatile periods.

Qualitative keyword/concepts of importance:

- **Yes**, IT business does increase capacity planning for project execution during volatile periods.
- **Capacity planning functions around people, infrastructure, resources, budget and client expectations.** For maximum value the focus should ensure near full utilisation of the listed functions and client communication updates to ensure maximum value add and risk mitigation. **Capacity should be retained for short term risk mitigation as well.**
- The i**ncreased focus in capacity planning** should **mitigate risks induced by volatility** to the point where maximum quality and output is achievable with the available resources.

- Expect that **clients will terminate** some non-core projects, services and business. See early ROI benefits in question 16 in section 5.2.5.5.1 being also applicable to this question.
- In several IT businesses **capacity planning is reactive** and focused on immediate risk reduction only. This is potentially due to business size, management focus, organisational culture, and unforeseen risks.

- **Question 21 / variable 20**: Is there an increased focus in capacity planning and product portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility?

  Univariate data analysis finding: Yes, the increased focus in capacity planning and product portfolio changes in support of potential projects to clients is **more critical** during periods of volatility than in periods of less volatility.

  Qualitative keyword/concepts of importance:
  - **Yes**, there is increased focus in capacity planning and product changes to support project deliveries during periods of volatility.
  - All internal stakeholders **must regularly (weekly) prioritise project/product development** focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management.
  - Clients do **demand more project/product requirements during periods of volatility**. The **client requirements should be planned into roadmaps** (if time allows) and a commitment for delivery made to the customer. This ensures key resources remain **focused** toward roadmap-based development of products.
  - **Capacity planning should speed up delivery of projects/products and its value should exceed the time/cost to maintain the function**. Slow reaction speed to client requirements can place projects at risk to the point where clients delay or cancel them.
  - Simple **cost vs. benefit rules still apply**. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting the project successfully signed off, then do expect focus pressure from IT business management to implement the changes. Roadmap-focused development is in those cases not a priority.

- Question 19 relates to the first part of the research hypothesis and Question 20 relates to the last part of the research hypothesis:

  H1: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment. (i.e. whether positive or

negative in level, project portfolio changes are more strongly related to capacity planning during periods of volatility)

- Question 21 relates to a direct question measuring the respondents' view on the hypothesis hence the nominal scale data. This is a loose standing question with no measured association to questions 19 and 20.

The bivariate data analysis between variables ProdProjChanges (Question 19) and CapacityPlanDelivery (Question 20) revealed the following associations between the sample data:

- There is a visually positive association between the dependent variable (CapacityPlanDelivery) vs. independent variable (ProdProjChanges) at low to high levels.
- Respondents indicate that a medium to high importance of product changes in support of project portfolio during periods of volatility has a medium to high importance of capacity planning for execution.

The **measures of the associations** between variables ProdProjChanges (Question 19) vs. CapacityPlanDelivery (Question 20) revealed the following associations between the sample data:

- Cross-tabulation for variables variable (ProdProjChanges) vs. independent variable (CapacityPlanDelivery) revealed a positive association between variables).
- Respondents indicated that a medium importance of product changes in support of project portfolio execution during periods of volatility has a medium importance for capacity planning to ensure delivery of projects.
- Respondents indicated that a high importance of product changes in support of project portfolio execution during periods of volatility has a high importance for capacity planning to ensure delivery of projects. Based on a total respondent feedback of 52 items in the high category this is the most significant.
- Respondents indicated that a very high importance of product changes in support of project portfolio execution during periods of volatility has a very high importance of capacity planning to ensure delivery of projects.

In the case of ProdProjChanges (Question 19) vs. CapacityPlanDelivery (Question 20), There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment (Chi-square-sum = 45.26936013, df=16, $p<0.05$). H0 can be rejected. Thus H1 has significance, as H0 is rejected. This is consistent with the findings of question 21.

The research hypothesis F is thus accepted and has significance.
In relation to the full model of Figure 22 the following result set has been completed:

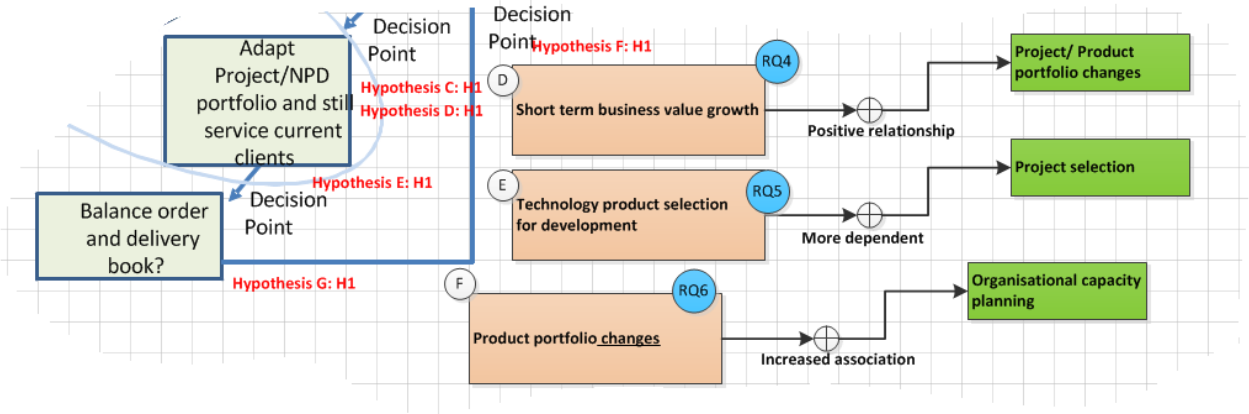

Figure 73: Impact model relation for Hypothesis F completed

5.4.1.7 Hypothesis G: Findings

The proposed research hypothesis G is:

Research Hypothesis:

H1: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

Null Hypothesis

H0: IT businesses **do not** balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

The univariate data analysis indicated:

- **Question 22 / variable 21**: How important is it for IT businesses to increase focus on their order book as a result of volatility?

Univariate data analysis finding: Yes, there is **high to very high importance** for IT businesses to increase focus on their order book as a result of volatility.

Qualitative keyword/concepts of importance:

- **Yes**, it is important to increase focus on marketing as a **result of but also before** volatility.
- Successful IT businesses do **define marketing priorities, targets and clients up front and track progress against the plan continuously**. Volatile impact of less/more orders is reflected in an updated plan of budgets versus adjusted targets.

- **Client requirements** should be reflected in product features and roadmaps or marketing efforts to fill the order book will be without success. During volatile periods this is even more important as clients wish to procure standard solutions.
- **Operating faster than the competition** is absolute key since relationships with customers do impact on the **order book positively** and **successful, quicker delivery of projects leads to more sales**.
- **Proactive marketing** to work closely with customers, potential customers and industry ensures that product launches are done at the right price, right feature level, timing and meeting client expectations. During volatile periods clients may buy even less hence the product should be on a par with expectations on the part of the market.

- **Question 23 / variable 22:** Do IT businesses increase focus on delivery of projects successfully as a result of volatility?

  Univariate data analysis finding: Yes, there is **medium to high importance** for IT business to increase focus on delivery of projects successfully as a result of volatility.

  Qualitative keyword/concepts of importance:
  - **Yes,** there is an increased focus in the delivery of projects to **ensure timing, scope, quality and budget expectations are met**.
  - During volatility periods IT business still need to do what they do best and ensure **the solutions are delivered faster**, are **working and meeting client expectations.** Successful projects mean that the **customer** is satisfied, **IT businesses (i**ncluding shareholders) are satisfied and **project/product participants** are satisfied.
  - **Successful projects very often lead to more work** for the same IT business hence during volatile periods with fewer projects this is even more important.
  - **Quicker turnover** and **hand over** of projects during volatile periods to customers as a **result of successful capacity planning** leads to **reduced risk** for the IT business as well as **increased profit margins**.
  - Capacity planning must be done prior to and during volatile periods ensure that a pre-defined business strategy of **standardised products is implemented. Clients tend to procure more standardised products** and less of high-cost custom solutions due to budget constraints.

- **Question 24 / variable 23**: Do IT businesses balance their order intake with the ability to deliver focused work during periods of volatility more than in stable periods of trade?

Univariate data analysis finding: Yes, IT businesses balance their order intake with the ability to deliver focused work during periods of volatility more than in stable periods of trade. This is, however, only three respondents more than the "No" category for the sample of data.

Qualitative keyword/concepts of importance:

- **Yes**, IT businesses do attempt to balance order intake with the ability to deliver focused work more during periods of volatility because of uncertainty. This ability is less prevalent in smaller businesses where all work is taken up!
- **Orders are not invoices**: Many businesses non-sales management, realise that an **order for a project does require the ability to deliver on the order quicker during volatile periods**. In this area there is some risk as the visibility of order intake vs. fulfilment lacks in personnel project teams.
- Capacity planning during volatile periods has to be clear on the impact of volatility on order book as well as the delivery book (project/product deliveries) to ensure the **full value chain can be stabilised**. This is done more successfully in large business. Mitigation plans for volatility should be in place.
- Since there are often **budget constraints** during volatile periods, more standardised less expensive projects are realised which use standardised products. **More products are developed during stable periods and sold in volume during volatile periods**. The order book and project delivery schedule will reflect this more during volatile periods.
- According to respondents **South African Companies have a business drive of taking up all possible orders, and then quickly adapt capacity (resources, personnel, and infrastructure) to fulfil execution to balance** the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable!

- Question 22 relates to the first part of the research hypothesis and question 23 relates to the last part of the research hypothesis:

  H1: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.

- Question 24 relates to a direct question measuring the respondents' view on the hypothesis hence the nominal scale data. This is a loose-standing question with no measured association to questions 22 and 23.

The bivariate data analysis between variables OrderIntake (Question 22) and BalanceAbilityDelivery (Question 23) revealed the following associations between the sample data:

- There is a visually positive association between the dependent variable (BalanceAblilityDelivery) and independent variable (OrderIntake) at low to high levels.
- Respondents indicate that a high importance of order intake during periods of volatility has a medium to high importance for ability to execute projects successfully.

The **measures of the associations** between variables OrderIntake (Question 22) vs. BalanceAbilityDelivery (Question 23) revealed the following associations between the sample data:

- Based on the respondent feedback there seems to be positive association between the dependent variable (BalanceAblilityDelivery) and independent variable (OrderIntake).
- Respondents indicate that a medium importance of order intake during periods of volatility has a medium importance of ability to execute projects successfully.
- Respondents indicate that a high importance of order intake during periods of volatility has a high importance of ability to execute projects successfully.

In the case of OrderIntake (Question 22) vs. BalanceAbilityDelivery (Question 23), IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade. (Chi-square-sum = 51.20687157, df=16, p<0.05). H0 can be rejected. Thus H1 has significance, as H0 is rejected. This is consistent with the finding of question 24.

The research hypothesis G is thus accepted and has significance.

In relation to the full model of Figure 22 the following result set has been completed:

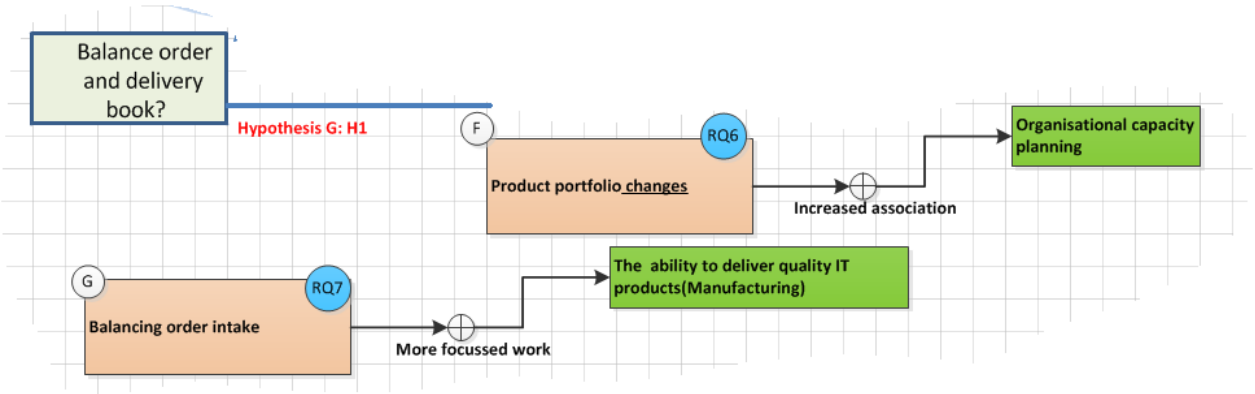

Figure 74: Impact model relation for Hypothesis G completed

5.4.2 Meaningful comparisons

A review of the interesting results from the research data in section 5.4.1 brings forward the requirement to also link the results back to original research question, problem and the model in Figure 22.

The resulting findings on the qualitative data must be:

- linked to the hypotheses,
- the research questions each hypothesis supports and
- the research problem every research question supports.

The consistency matrix listed in Table 19 is amended to include the findings and briefly relate them to the research problem as can be seen in Table 102.

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
The market demanding new technology and subsequent client responses to volatility require **clients to change their adoption/procurement of technology during negative periods.**	Cearly & Claunch (2012)	**Research Hypothesis A in relation to RQ1:** How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? **H1**: There is **a negative association** between new technology adoption/procurement	The null hypothesis is partially rejected: In the case of negative volatility impact the null hypothesis is rejected. In the case of positive volatility impact the null hypothesis is **not** rejected. Hence the research hypothesis H1 is only significant during negative volatility and the patterns visible in the sample result are then also present in the population from which the sample was taken. In the case of negative volatility clients do procure somewhat less IT as

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
		and periods of exogenous volatility in the business environment.	volatility increases (univariate analysis of variable NewTechAdoptProcA). According to the qualitative data new market required technologies do require IT clients to adopt /procure new technology to remain efficient in the delivery of their products and services. Budgets are reduced and clients do later play catch-up during improved economic conditions. Value for IT investment (money) becomes more critical. During positive volatility clients do tend to adopt slightly more IT technology (univariate analysis of variable NewTechAdoptProcB). The relationship is not of negative association, however, as more positive volatility does not restrict funding and IT investments improve leading to more procurement of IT. IT clients are more inclined to take risks during positive volatile periods leading to high amounts of procurement of IT projects/products. From a business management perspective investment in IT projects/products must still be value based and satisfy the requirements of the business case in question.
IT clients in the formal corporate sector are also in the same business environment as IT businesses and **they**	Cooper (2001) Navarro (2009)	**Research Hypothesis B in relation to RQ2:** What impact does the resulting client response have as a result of volatility shock on IT business project portfolio	The null hypothesis is rejected. Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from. According to the quantitative analysis of variable ITProjProdGrowth, IT

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
experience the same shocks as a result of volatility. They change their short and long term business strategies as well as requirements for IT systems, products and services. Projects may be halted as a result of budget constraints and ROI required with available IT funding.		and new product development? **H1**: The 3 elements of a clear understanding of • customer requirements • customer operational impact as a result volatility as well as • one-on-one customer interaction activities have a **positive association** on IT business, IT projects and supporting product development growth.	client response during volatility has a high impact on IT project and supporting product development. The qualitative data indicated that clients do focus on optimising their business processes and this leads to interfacing with potential IT suppliers of projects and products. As clients are impacted by the volatility shocks they are looking for avenues to reduce IT maintenance/overhead costs and create the IT product that can ensure growth. A customer-centric IT business will attempt to understand the impact of the volatility on the customer and create products to assist the customer via project deliveries.
The IT business adapts its business strategy to adopt for the changing economic and trade conditions. Although businesses attempt to	Grant (cited in Wu & Lin p.76) Nocco and Stulz (2006) Weeks (2009) Burton et al	**Research Hypothesis C in relation to RQ3:** Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with	The null hypothesis is rejected. This is, however, on borderline case due to $p < 0.05$ on marginal level. Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from. According to the quantitative analysis of variable marketintel business

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
understand their industry and technology products they can potentially not have sufficient **detection mechanisms** for volatile conditions and respond too late with too little!	(2009)	the market intelligence gathered from clients via volatility detection mechanisms? **H1**: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility.	response during volatility is still focused at obtaining market intelligence via volatility detection mechanisms that can lead to short and longer term strategy changes. The qualitative data indicated that understanding customer responses to volatility requires constant collection and analysis of market intelligence. Having mechanisms to detect the volatility should for part of the risk management plan and this should enable a flexible management approach to act fast if required. The detection mechanisms should enable an organisation to build itself to align for innovative, evolving or stable and reliable operations. Business will utilise the intelligence to make it resilient and **stabilise** itself operationally in the short and mid-term.
When business strategy changes it impacts on the project and product portfolio selection. Changes in the output of new product conceptualisation, design, development, production	Aizeman and Pinto (2005) Porter (1998) Ulrich and Eppinger (2008)	**Research Hypothesis D in relation to RQ4:** What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is	The null hypothesis is rejected. Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the sample was taken from. According to the quantitative analysis of variable ShortLongStratDef, IT businesses adapt their short term technology strategy at predominantly medium levels as a result of market intelligence indicating the presence of

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
and delivery processes will be required in response to changes in project/production portfolio selection. The changed project/product portfolio should be done whilst business operations are being executed. Thus businesses **need to change and still get current products to clients**. The transitional change state requires detailed planning for internal process changes and remains risky.		present? **H1**: There is a **positive association** between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.	volatility in the business environment. The change induced in the technology strategy as a result of the volatility t according to the qualitative data should realise some business value. Some businesses focus on fulfilling many small product orders by means of repeatable project/product solutions. They can be delivered at low technical risk and low non-recurring engineering cost hence profit can quickly be realised. The technology strategy should support the changes in IT business strategy and also unlock new business value for the business. Competitors' projects/products portfolios should be assessed continuously and compared to own projects/products portfolios. Required capabilities can be generically developed into the portfolios over time or based on urgency "forced" into the short -term development tracks for the portfolio.
Businesses do struggle to cope with **project**	Cooper and Edgett (2006)	**Research Hypothesis E in relation to RQ5:** How do	The null hypothesis is rejected. Hence the research hypothesis H1 is accepted and significant. The

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
changes as a result of volatility while executing current business operations.	Le (2004)	businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility? **H1**: New high technology product development selection is **more dependent** on correct project portfolio selection during periods of volatility. How do businesses adapt their IT projects and resulting product portfolio changes and still maintain product delivery to clients?	patterns visible in the sample result are also present in the population the sample was taken from. According quantitative data analysis of variable HighTechProdSelect, the selection of sellable products to be developed by IT business is of **higher importance** during volatile periods. The dominant aspect listed by the respondents in the qualitative data analysis is that IT business should have a **diversified product portfolio with lower unit cost, mature and sellable products** also available to be sold off the shelf to customers. Not all products should be "in progress, but not yet available" development status. Many changes to products as a result of project change due to volatile conditions inhibit the ability to create the diversified product portfolio.
The selection of **products** that must be built for **project** deliveries to	Cooper and Kleinschmidt (2007:6)	**Research Hypothesis F in relation to RQ6:** How do businesses adapt their IT project	The null hypothesis is rejected. Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population the

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
clients while the business environment is changing as a result of volatility leads to uncertainties in the business and technology strategy.	Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43) Navarro (2009)	with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? **H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery of projects to clients while changing the business during times of volatility in the business environment	sample was taken from. According to the quantitative data analysis for variable ProdProjChanges, there is **medium to high increased risk** in product development as a result of changes in project execution for clients when volatility is present. According to the quantitative analysis for variable CapacityPlanDelivery, IT business increases with **medium to high importance** focus in capacity planning for project execution during volatile periods. According to qualitative data the increased focus in capacity planning should mitigate risks induced by volatility to the point where maximum quality and output are achievable with the available resources for projects. All internal stakeholders regularly (weekly) should prioritise project/product development focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management. Simple cost vs. benefit rules still apply. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting the project successfully signed off, then expect focus pressure from IT business management to implement the changes. Roadmap focused development is in those cases

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
			not a priority.
In high technology product/project environments products may already be ordered before they exist. The IT business orders will be impacted by changing economic conditions and this means the businesses need to adapt their resource allocation and utilisation. **Balancing the product/project order book with the limited organisational resources is a constant risk for businesses.**	Cooper and Edgett (2001) Cooper and Kleinschmidt (2007:6)	**Research Hypothesis G in relation to RQ7:** How do IT businesses balance their order and delivery books during periods of volatility? **H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.	The null hypothesis is rejected. Hence the research hypothesis H1 is accepted and significant. The patterns visible in the sample result are also present in the population from which the sample was taken. According to quantitative variable OrderIntake_vs_ BalanceAbilityDelivery, IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. This is, however. Only in the case of three respondents more than the “No” category for the sample of data. According to the qualitative data South African Companies have an attitude of taking up all possible orders then quickly adapting capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable!

Research Consistency Matrix			
Sub-Problem	**Literature Review**	**Hypothesis/ propositions or Research Questions**	**Key findings and cause of finding:**
			Since there are often budget constraints during volatile periods, more standardised less expensive projects are realised using standardised products. Many businesses' non- sales management, realise that an order for a project does require the ability to deliver on the order quicker during volatile periods. In this area there is risk as the visibility of order intake vs. fulfilment lacks in project personnel teams. Capacity planning during volatile periods should be clear on the impact of volatility on order books as well as delivery books (project/product deliveries) to ensure the full value chain can be stabilised. This is done more successfully in large business.

Table 102: Modified research consistency matrix with research findings added

5.5 CONCLUSION

As can be seen from Figure 27 a consistent structured approach was followed to analyse the seven hypotheses. The structured approach provided for a similar approach to the analysis of the research data and lining the quantitative and qualitative data in section 5.2.
Twenty-four structured questions were analysed independently using single variable statistics suitable for ordinal, nominal and Likert data. Each of the 24 questions in annexure A also provided for unstructured commentary feedback which turned out to be very helpful in identifying patterns and trends in the respondent feedback. The research questions relate to a research hypothesis and the hypothesis relates to the research questions in section 1.2.1.
The research questions in turn relate to the research problems as listed in section 1.4.

Bivariate analysis between the dependent and independent variables results in identifying the association between the variables, strength of the association as well as significance testing by means of the chi-squared cross-tab tests.

Hypothesis A resulted in a partial acceptance and significance as the positive volatile conditions do interfere with the relation between the dependent and independent variables. In the case of negative volatile conditions the Hypothesis is significant and H0 is rejected.

Hypotheses B to G were all significant as the Null hypothesis was rejected and $p < 0.05$ as can be seen in Table 103.

Hypothesis	H1	Finding	Significance
A	**H1**: There is **a negative association** between new technology adoption/procurement and periods of exogenous volatility in the business environment.	(Chi-square sum = 24.78696462, df=9, p<0.05) (Chi-square sum = 11.64207431, df=12, p>0.05)	Partially significant
B	**H1**: The 3 elements of a clear understanding of • customer requirements • customer operational impact as a result volatility as well as • One-on-one customer	(Chi-square sum = 37.54347188, df=12, p<0.05), (Chi-square sum = 42.60763069, df=12, p<0.05), (Chi-square sum =	Significant

Hypothesis	H1	Finding	Significance
	interaction activities have a **positive association** on IT business IT projects and supporting product development growth.	21.44486032, df=9, p<0.05).	
C	**H1**: A business's strategic focus towards change is **positively associated** with its market intelligence (client requirements) at the time of significant volatility	(Chi-square sum = 21.33267851, df=12, p<0.05)	Partially Significant since visual inspection does not support full positive association in bivariate analysis.
D	**H1**: There is a **positive association** between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.	(Chi-square sum = 26.2962276, df=16, p<0.05)	Significant
E	**H1**: New high technology product development selection is **more dependent** on project portfolio selection during periods of volatility.	(Chi-square sum = 36.98701919, df=16, p<0.05)	Significant
F	**H1**: There is an **increased association** between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment, (i.e. whether positive or negative in level, project portfolio changes are more strongly related to capacity planning during periods of volatility).	Chi-square sum = 45.26936013, df=16, p<0.05)	Significant

Hypothesis	H1	Finding	Significance
G	**H1**: IT businesses balance their order intake with ability to deliver **more** focused work during periods of volatility than in stable periods of trade.	(Chi-square sum = 51.20687157, df=16, p<0.05)	Significant

Table 103: Conclusion on hypotheses findings

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6. CHAPTER VI - CONCLUSIONS AND RECOMMENDATIONS

6.1 WHAT THE RESEARCH IS AND HOW WAS IT DONE

The research thesis started off with a view of defining specific research objects in section 1.3 namely:

- Research objective 1: The study combines aspects of business, management and market research.
    - By performing market research the aim is to understand quantitative and qualitative aspects of IT consumer and client behaviour in volatile economic and trade conditions.
    - The impact of volatility may influence work behaviour of people in the service of IT businesses. During volatile conditions business may require more efficiency, effectiveness and focussed productivity. These aspects need to be part of the research.
    - Some organisational development aspects may require management intervention during periods of volatility since planned behavioural change efforts may impact organisational culture, human and social processes. The research needs to quantify the management intervention required.
- Research objective 2: Determine the general responses of IT businesses during periods of volatility and how the technology strategy repositioning, strategy formulation and strategy execution in the business is done.
- Research objective 3: Collect and analyse current best practice approaches in use during volatility by IT businesses for project portfolio execution in technology intensive product suppliers.
- Research objective 4: Collect and analyse the best practice approaches in use during volatility by IT businesses for new product development execution in technology intensive product suppliers.
- Research objective 5: Collect analyse the data business use to define the relationship and impact of project portfolio selection on IT product development.
- Research objective 6: Collect and analyse data to define the impact of unstable economic and trade conditions on project portfolio management and product development in IT businesses.
- Research objective 7: Determine the measures IT businesses have adopted to ensure that project portfolio selection and product development sustains future business operations profitably during volatile conditions.

After a theoretical gap had been established, new theoretical constructs formed the basis for theoretical propositions in Figure 22. These led to the seven suggested research questions:

- Research Question 1: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology?
- Research Question 2: What impact does client response have as a result of volatility shock on IT business project portfolio and new product development?
- Research Question 3: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms?
- Research Question 4: What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?
- Research Question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?
- Research Question 6: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions?
- Research Question 7: How do IT businesses balance the order and delivery books during periods of volatility?

A total of seven hypotheses were derived in relation to the research questions:

- Research Hypothesis A in relation to RQ1
  H1: There is a negative association between new technology adoption/procurement and periods of exogenous volatility in the business environment.
- Research Hypothesis B in relation to RQ2
  H1: The 3 elements of a clear understanding of
  - customer requirements
  - customer operational impact as a result volatility as well as
  - one-on-one customer interaction activities have a positive association on IT business IT projects and supporting product development growth.
- Research Hypothesis C in relation to RQ3
  H1: A business's strategic focus towards change is positively associated with its market intelligence (client requirements) at the time of significant volatility
- Research Hypothesis D in relation to RQ4
  H1: There is a positive association between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.
- Research Hypothesis E in relation to RQ5
  H1: New high-technology product development selection is more dependent on correct project portfolio selection during periods of volatility.

The “ability to deliver products to clients” is regarded as a moderating variable as it influences the projects chosen by the IT business for execution as well as the eventual products being developed. The moderating variable takes the form of an indicator variable (1=”no”, 2=”yes”)

- Research Hypothesis F in relation to RQ6

  H1: There is an increased association between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment
- Research Hypothesis G in relation to RQ7

  H1: IT businesses balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade.

The research approach subsequently followed includes a structure following:

- **Type of study:**
  - Elements of hypothesis and exploratory research types are present in the research.
- **Data acquisition techniques to be used:**
  - Data is primarily collected from survey questionnaires with structured and unstructured commentary feedback from respondents.
- **Data analysis techniques to be used:**
  - Data classification and analysis techniques
    - Ordinal/Nominal and Likert scale data.
  - Statistical data analysis techniques including:
    - Graphical data analysis (univariate Analysis)
    - Measures of centre and spread
    - Bivariate analysis, association testes and research hypothesis testing
    - Tests for significance
      - Chi-squared tests
  - Qualitative data analysis on more frequent occurring key words, concepts and families of data.

6.2 MAIN FINDINGS, RELATIONSHIPS AND SIGNIFICANCE

A detail summary of the quantitative and qualitative data obtained from the research questionnaire can be viewed first in section 5.4.1 for every hypothesis. The already summarised findings need to be related back to the research objectives and significant findings highlighted for importance.

The following sub section relates all the summarised findings in some detail to each research question. All questions referred to in brackets ex. (Question 1) indicate question members in the questionnaire used.

6.2.1 Research question 1: Main findings, relationships and significance

In relation to the original research question of:
Research Question 1: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology?

One of the more significant findings to emerge from the research data is that two unique scenarios in volatility have profound implications for the research hypothesis A:

Research Hypothesis:
H1: There is a negative association between new technology adoption/procurement and periods of exogenous volatility in the business environment.

Null Hypothesis
H0: There is not a negative association between the new technology adoption/procurement and periods of exogenous volatility in the business environment

The Univariate findings for the research variables indicate:

- IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term on a high impact level.
- IT clients adopt/procure somewhat less IT projects/products during negative conducive volatile periods.
- IT clients adopt/procure somewhat more IT projects/products during positive conducive volatile periods.

The case of negative exogenous volatility in the business environment realised rejection of the Null hypothesis. There is a negative association between new technology adoption/procurement and

periods of exogenous volatility in the business environment (Chi-square sum = 24.78696462, df=9, p<0.05). The visual association indicated a negative association between variables Exogvolatility (Question 1) and NewTechAdoptProca (Question 2) which supports the research hypothesis relation of being “negative” association. Thus H1 has significance, as H0 is rejected.
However, in the case of positive volatility, the defined research hypothesis H1 which states a negative association between new technology adoption/procurement and periods of exogenous volatility in the business environment is not accepted (Chi-square sum = 11.64207431, df=12, p>0.05). Thus H0 cannot be rejected. The measure of association indicated a positive association between variables Exogvolatility (Question 1) and NewTechAdoptProcb (Question 3) which does not support the research hypothesis relation of being “negative” associated.

The negative volatile conditions seem to have a predictive response supporting the research hypothesis H1 (a significant result) whilst conditions of positive volatility led to unpredicted response of respondents in the questionnaire where the rules for technology adoption is changed during positive volatility.

It seems that clients procure somewhat less technology during negative volatility but the behaviour is still tied to ensuring a level of business value is realised with the procurement. IT clients adopt/procure somewhat less IT projects/products during negative conducive volatile periods. When reviewing the data of the questionnaire results in relation to research question one and the research objective:

- Research objective 1: The study combines aspects of business, management and market research.
    - By performing market research the aim is to understand quantitative and qualitative aspects of IT consumer and client behaviour in volatile economic and trade conditions.
    - The impact of volatility may influence work behaviour of people in the service of IT businesses. During volatile conditions business may require more efficiency, effectiveness and focused productivity. These aspects need to be part of the research.
    - Some organisational development aspects may require management intervention during periods of volatility since planned behavioural change efforts may impact organisational culture, human and social processes. The research needs to quantify the management intervention required.

The qualitative data results from the questionnaire become relevant to understand IT consumer and customer behaviour. IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term on a high impact level. The qualitative data highlighted that skills shortage, training and up

skilling of resources remain a significant challenge in the IT industry as high turnover of personnel and less qualified personnel challenges the ability of organisations to deliver IT to customers successfully. Respondents of the questionnaire indicated that value based investment remains key during positive and negative volatile periods.

In relation to the research objective listed, IT is seen as an enabler which must reduce costs and improve productivity hence business case viability of the IT investment is always measured as well as tracked. Some delayed expenditure during negative periods leads to over expenditure during positive volatile periods to get technology investment to market required technology levels. Management intervention is focussed towards identifying growth areas where IT can facilitate business growth. Technology shifts impact social processes where collaboration by means of IT changes the way business employees as well as business to customer interfaces. Company management will again assess the business value that can be derived using these technologies prior to investment to ensure market alignment and financial business sense. Fostering an organisational culture by means of values, goals and tracking progress against the goals as well as reducing time to market is required. This will impact the organisation's ability to change and responds rapidly for changes induced by volatility.

6.2.2 Research question 2: Main findings, relationships and significance

In relation to the original research question of:
Research Question 2: What impact does the resulting client response have as a result of volatility shock on IT business project portfolio and new product development?

Within the research hypothesis B there are three sub-relations between the dependent and independent variables. Each of the relationships were tested with quantitative and qualitative data independently as well as combined.

Hypothesis B:
H1: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result of volatility as well as
- one-on-one customer interaction activities

have a positive association on IT business IT projects and supporting product development growth.

Null Hypothesis
H0: The 3 elements of a clear understanding of

- customer requirements
- customer operational impact as a result volatility as well as
- one-on-one customer interaction activities

does not have a positive association on IT business, IT projects and supporting product development growth.

The univariate quantitative data substantiates a high relation in all three cases firstly independently and also combined.

- Having a clearer understanding of IT client requirements has a high impact on assisting in growing the project portfolio and supporting product development.
- Having a clearer understanding of the impact volatility has on client operations have a high impact on assisting in growing the project portfolio and supporting product development.
- Having one on one interaction with clients has a high impact on growing the IT project and supporting product development during periods of volatility.
- The category of strongly agreement categorises the positive impact of the independent variables (customer requirements, customer operational impact as a result volatility as well as one on one customer interaction activities) have on the dependent variable (IT business IT projects and supporting product development growth).

From a main finding perspective all three relations have a high impact response from respondents as well as on combined relation level. This is a strong indication of the importance of the factors contribution in supporting project and product development growth.

The testing of a clear understanding of customer requirements having a positive association on IT business, IT projects and supporting product development growth realised a rejection of the Null hypothesis. There is positive association between clear understanding of customer requirements having a positive association on IT business IT project and supporting product development growth (Chi-square sum = 37.54347188, df=12, $p<0.05$). The visual association indicated a positive association between variables CustomerReq (Question 4) and ITProjProdGrowth (Question 7) which supports the research hypothesis relation of being “positively” associated. Thus H1 has significance, as H0 is rejected.

The testing of a clear understanding of customer operational impact as a result of volatility having a positive association on IT business IT project and supporting product development growth realised a rejection of the Null hypothesis. There is positive association between clear understanding of customer operational impact as a result of volatility having a positive association on IT business IT project and supporting product development growth (Chi-square sum = 42.60763069, df=12, $p<0.05$). The visual association indicated a positive association between variables CustomerOpImpact (Question 5) and ITProjProdGrowth (Question 7) which supports the

research hypothesis relation of being “positively” associated. Thus H1 has significance, as H0 is rejected

The testing of a clear understanding of one-on-one customer interaction activities having a positive association on IT business IT project and supporting product development growth realised a rejection of the Null hypothesis. There is positive association between clear understanding of one on customer interaction activities having a positive association on IT business IT project and supporting product development growth (Chi square sum = 21.44486032, df=9, $p<0.05$). The visual association indicated a positive association between variables CustomerIntAct (Question 6) and ITProjProdGrowth (Question 7) which supports the research hypothesis relation of being “positively” associated. Thus H1 has significance, as H0 is rejected

The qualitative data results from the questionnaire become relevant to understand IT consumer and customer behaviour. The qualitative data from section 5.2.2.6.3 indicated a conclusive range of responses from IT clients/consumers as a result of volatility:

- Mining industries cut CAPEX projects with reduced IT expenditure.
- Cost savings become a factor of continued importance.
- Process optimisations without cost increases do obtain focus from management.
- Viable business cases dictated expenditure for increased ROI.
- High risks and non-core projects are put on hold during significant volatility.
- IT resources do become available as a result of stopped projects for product development.
- Investment during positive volatility as well as negative volatility to stay current in market required technology.

These factors establish a causal response from IT business which is meaning full in project and product development growth (research question 2 and qualitative data):

- The three factors as listed for the research hypothesis B do become relevant for project and product development growth.
- Being flexible during volatile periods in the project and product development portfolio formulation and development is a requirement. Be willing to adapt the portfolios and approaches to project execution.
- IT business must be focused at client-centric innovation and delivering growth focused products/projects and not purely at integration of systems which increase running costs for the client.
- Knowing the customer and their requirements during volatile periods imply that the IT business portfolio of projects and products must lead to a customer centric culture and systems base**.** These aspects are then also related to research objective 1 where organisational development aspects require management intervention to influence the organisational culture, human and social processes.

- IT business must understand the pain areas of IT clients to assist them in identifying sweet spot areas where IT projects and products can make a difference in their business.
- Products must be operationally matured for client requirements and the strategic intent of the product suite optimised with product road mapping for future focus. These aspects are also related to research objective 1 where business may require more efficiency, effectiveness and focused productivity.
- The IT business must realise projects may be halted/cancelled by clients and proactively seek concurrent business with more customers to ensure project/product portfolio is not stagnated when projects are halted.
- Communications and mutual understanding between IT client and IT business is a pre requisite for expectation management leading to successful project and product development.
- The communications with the client identifies IT project/product opportunities or existing risks which must be solved timeously by focussed IT projects and product development.
- Joint decisions and fulfilment on the decisions with the customer leads to operational risk reduction and acceptance of new products which improve performance.

In relation to the research objective 2: Determine the general responses of IT businesses during periods of volatility and how the technology strategy repositioning, strategy formulation and strategy execution in the business is done, the following can be concluded:

IT business requires a level of flexibility in strategy formulation to enable informed changes in support of changing market and client requirements. The aspects listed here for the research question requires a close co-operation with customers to support the main qualitative finding:
The main finding for IT business is to know your customer, know your product, know your market and know competitive pricing for a suitable IT projects/products portfolio. Being able to act fast as indicated by questionnaire respondents is a requirement to ensure client requirements are timeously met. The three factors as listed for the research hypothesis B becomes relevant for project and product development growth as part of strategy repositioning, formulation and execution.

6.2.3 Research question 3: Main findings, relationships and significance

In relation to the original research question of:

Research Question 3: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients via volatility detection mechanisms?

Hypothesis C:

Research Hypothesis:

H1: A business's strategic focus towards change is positively associated with its market intelligence (client requirements) at the time of significant volatility.

Null Hypothesis

H0: A business's strategic focus towards change is not positively associated with its market intelligence (client requirements) at the time of significant volatility.

The univariate quantitative data findings include:

- Business response during volatility is still focused at obtaining market intelligence that can lead to short and longer term strategy changes.
- Business response during volatility is to increase their collection market intelligence at predominantly a medium level (category wise). The high increase categories should, however, not be ignored as respondents did offer wider spreading opinions.
- The category of somewhat agreement is the largest category of impact of the independent variables (market intelligence) on the dependent variable (a business's strategic focus towards change).

Within the research hypothesis C a contradiction arises in the association between the dependent and independent variable. The association was tested with quantitative and qualitative data independently as well as combined.

The bivariate data analysis between variables MarketIntel (Question 10) and BusStratChange (Question 9) revealed the following association between the sample data:

- There is a partial only positive association between the dependant variable (BusStratChange) and independent variable (MarketIntel).

The testing of a business's strategic focus towards change is positively associated with its market intelligence realised a rejection of the Null hypothesis in association terms. Thus a business's strategic focus towards change is positively associated with its market intelligence (Chi-square sum = 21.33267851, df=12, $p<0.05$). The visual association indicated a non-linear association with some positive relationship between variables MarketIntel (Question 10) and BusStratChange (Question 9) only, which does not fully support H1's relation of being "positively associated". Thus H1 has not full significance, as H0 has not been fully rejected.

From a main finding perspective respondents indicated that collection of market intelligence during times of volatility has a medium to high impact on business orientation towards strategy changes.

The qualitative data results from the questionnaire become relevant to understand IT business change in IT business/technical strategy. The qualitative data from section 5.2.3.4 indicated a conclusive range of responses for strategy changes in IT businesses for short vs. longer term benefit when volatility is detected:

- IT business will utilise short term market intelligence for threat/crisis management but will use the market intelligence also for longer term strategic intent and growth.
- Proactive opportunity detection should lead to action in both short vs. longer term and extend beyond volatility periods. In other words identify opportunities and retain focus whilst still being flexible in executing strategy.
- Business can be innovative/evolving or stable/reliable and this requires different types and frequencies of market intelligence. The IT business/technical strategy will dictate what market intelligence is required and what level/time frame for changes is foreseen in the strategy.
- Mature IT business will plan strategy as a result of market intelligence in such a way that resulting project/product development is already focused at periods beyond volatile periods.
- A key aspect noted in the qualitative data is that businesses in general increase market intelligence to obtain information on how to stabilise themselves operationally in the short and mid-term i.e. work with volatility to a stable state.
- Business increase market intelligence at medium level to also understand volatility impact for clients.

A main finding remains the ability of business to plan beyond volatility, stabilise itself, address crisis and retain focus on longer term strategic intent.

In relation to the research objective 2: Determine the general responses of IT businesses during periods of volatility and how the technology strategy repositioning, strategy formulation and strategy execution in the business is done, the following can be concluded:
The market intelligence must be used on a continuous basis to correlate the technical project and product strategies with the market requirements. During volatile periods it the requirement was already established to be flexible in approach to make changes in strategy and execution; however, focus should be retained to reach the strategic objectives of the technology strategy. Businesses attempt to build a level of robustness i.e. resiliency into the business and technology strategy to be able to consume volatility and work with volatility in operations. For this robust level of operations, up-to-date market intelligence is a prerequisite to understand market requirements and movement in IT client/consumer focus.

6.2.4 Research question 4: Main findings, relationships and significance

In relation to the original research question of:

Research Question 4: What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?

Hypothesis D:

Research Hypothesis:

H1: There is a positive association between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

Null Hypothesis

H0: There is not a positive association between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility.

The univariate quantitative data findings include:

- IT businesses adapt their short term technology strategy at predominantly medium levels as a result of market intelligence indicating the presence of volatility in the business environment.
- Change in the business/technology strategy as a result of volatility leads to medium level changes in the project portfolio and product development.
- The category of medium impact is the category that categorises the impact of the independent variable (of short term technology strategy definition) on the dependent variable (project/product portfolio execution).

The testing of a positive association between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility realised a rejection of the Null hypothesis in association terms. Thus there is a positive association between business value growth as a result of short term technology strategy definition and changes on project/product portfolio execution as a result of significant volatility (Chi-square sum = 26.2962276, df=16, $p<0.05$). The visual association indicated a linear association with positive relationship between variables ShortLongStratDef (Question 12) vs. ProjectProductExecChange (Question 13). Thus H1 has significance, as H0 has been fully rejected.

The qualitative data results from the questionnaire become relevant to understand IT technology strategy changes in support of business growth. The qualitative data from section 5.2.4.4 indicated a conclusive range of responses for technology strategy changes leading to project/product changes when volatility is detected:

- Technology strategy must not only follow business strategy but also assist in unlocking new business value with a short- and long-term focus.
- Clients do respond favourably if the IT supplier is willing to be flexible in modifying project/product execution and portfolio changes during periods of volatility.
- The technology strategy should subscribe to cost vs. benefit analysis whereby projects and products are removed where low margin, low long term value and high cost is visible in the portfolio.

A main finding remains that industry context specific factors do play an important role since the level of change required, the business's ability to consume volatility, budget, competition position and maturity of own project /product portfolio will determine the adaptation level required. In most cases there are medium changes required only. The technology strategy should, however, be robust enough to facilitate medium level changes in technical scope, cost, time required to mitigate risk induced by volatility.

In relation to:

- Research objective 3: Collect and analyse current best practice approaches in use during volatility by IT businesses for project portfolio execution in technology intensive product suppliers.
- Research objective 4: Collect and analyse the best practice approaches in use during volatility by IT businesses for new product development execution in technology intensive product suppliers

the following can be concluded:

The above listed aspects for the qualitative data from the respondents as well as the following findings become relevant:

- If market intelligence indicates larger volumes for similar products in the market, consider lowering pricing on already developed projects/products to retain volume sales. The product portfolio must also include low risk, already developed products with fixed costs for delivery. Ensure there is demand for products to provide continued funding for further project and product development.
- The technology strategy must make provision for roadmap planning in the project/product portfolio. This must facilitate short term extensions in the project/product portfolio to keep

the customer satisfied but also longer term client requested larger requirements into the portfolio.

- Market intelligence should be constantly reviewed to ensure the technology strategy changes in project and product development are based on best available accurate information about the business environment.
- Competitors' projects/products portfolios must be continuously assessed and compared to own projects/products portfolio. Required capabilities can be generically developed into the portfolio over time or based on urgency "forced" into the short term development tracks for the portfolio.
- Accelerate changes planned into technical strategy into the portfolio not to miss new opportunities. Slow reaction speed in IT means lost opportunities.
- The availability of skilled IT personnel has already been identified as a main finding and the implication so of technology strategy and budget changes require constant IT personnel capacity planning.

6.2.5 Research question 5: Main findings, relationships and significance

In relation to the original research question of:

Research Question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?

Hypothesis E:

Research Hypothesis:

H1: New high technology product development selection is more dependent on project portfolio selection during periods of volatility.

Null Hypothesis

H0: New high technology product development selection is not more dependent on project portfolio selection during periods of volatility.

- The "ability to deliver products to clients" is regarded as a moderating variable as it influences the projects chosen by the IT business for execution as well as the eventual products being developed. The moderating variable takes the form of an indicator variable (1="no", 2="yes") Respondents indicated a medium importance of project portfolio selection during periods of volatility has a high importance of product selection with the impact of the moderating variable included.

The univariate quantitative data findings include:

- The selection of sellable products to be developed by IT business is of higher importance during volatile periods.
- The selection of projects for the IT business as offered by clients to execute of high importance during volatile periods than non-volatile periods.
- IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects.
- The formulation of the right product portfolio in support of potential projects to clients is more critical during periods of volatility than in periods of less volatility.

The testing of new high technology product development selection is more dependent on project portfolio selection during periods of volatility, realised a rejection of the Null hypothesis in association terms. Thus new high technology product development selection is more dependent on project portfolio selection during periods of volatility (Chi-square sum = 36.98701919, df=16, $p<0.05$). The visual association indicated a linear association with the dependant variable (HighTechProdSelect) and independent variable (ProjectPortfSlect) at all levels but lower at medium level. Fewer respondents indicate that a very high importance of project portfolio selection during periods of volatility has a very high importance. Thus H1 has significance, as H0 has been fully rejected.

The qualitative data results from the questionnaire become relevant to understand how new technology product selection is more dependent on project selection during periods of volatility.
The qualitative data from section 5.2.5.5 indicated a conclusive range of criteria for the selection of products and projects. The main findings being:

- The dominant aspect listed by the respondents is that IT business must have a diversified product portfolio with lower unit cost, mature and sellable products also available to be sold off the shelf to customers. Not all products must be “in progress, but not yet available” development status.
- The portfolio must mitigate via the mix of product and services the volatile influences and focus on the overall technology strategy.
- The project and product portfolio must have business case and execution plan to generate ROI early in the project lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational process efficiencies induced, cost savings, communication, and so forth.

In relation to:

- Research objective 5: Collect and analyse the data business use to define the relationship and impact of project portfolio selection on IT product development,

the following can be concluded:

The above-listed aspects for the qualitative data from the respondents as well as the following findings become relevant:

- The complete portfolio should aim even in volatile periods to have a value propositions and competitive edge that customers favour and wish to have. Clients do demand more value and requirements from their funding provided during volatile periods.
- A major finding is that projects must have value that makes them unique, competitive and have a high ROI with low risk.
- Projects must have business case and execution plan to generate ROI early in the project lifecycle to ensure sustained commitment from customers. This ROI may also be non-financial in terms of operational process efficiencies induced, cost savings, communication, and so forth.
- Because client project budgets are tight, IT business should stick to core product features, remove “nice-to-haves”, include some customer-required features and remove unnecessary cost drivers.
- Care should be taken not have the client fall into long-term expensive maintenance financial traps. Maintenance budgets should rather also provide new innovative features during the project delivery to ensure the client gets significant operational value for money. Longer term contracts even with lower profit provide project team security and a satisfied customer

6.2.6 Research question 6: Main findings, relationships and significance

In relation to the original research question of:

Research Question 6: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions?

Hypothesis F:

Research Hypothesis:

H1: There is an increased association between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment. (i.e. whether positive or negative in level, project portfolio changes are stronger related to capacity planning during periods of volatility?)

Null Hypothesis

H0: There is not an increased association between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment.

The univariate quantitative data findings include:

- There is medium to high increased risk in product development as a result of changes in project execution for clients when volatility is present.
- IT business increases with medium to high importance focus in capacity planning for project execution during volatile periods.
- The increased focus in capacity planning and product portfolio changes in support of potential projects to clients is more critical during periods of volatility than in periods of less volatility.

The testing of an increased association between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment realised a rejection of the Null hypothesis in association terms. Thus there is an increased association between product portfolio changes and organisational capacity planning to ensure delivery projects to clients while changing the business during times of volatility in the business environment (Chi-square sum = 45.26936013, df=16, $p<0.05$). The visual association indicated positive association between the dependent variable (CapacityPlanDelivery) vs. independent variable (ProdProjChanges) at low to high levels. Thus H1 has significance, as H0 has been fully rejected.

The qualitative data results from the questionnaire become relevant to understand how organisations adopt their product portfolio and plan capacity for the changes during periods of volatility.

The qualitative data from section 5.2.6.4 indicated a conclusive range of criteria for product changes and capacity planning for project deliveries. The main findings being:

- The risk associated with changes required in product development as a result of project execution must be detected, tracked, mitigated on a continuous basis to ensure product road map implementation remains on track for the overall project/product portfolio.
- The scope changes, risk/mitigation plans, unforeseen delays and budgets should be managed under proper project management principles with stakeholders (both internal and external).

- The product portfolio should be optimised for client requirements both in the short- term (contract specific but re-usable) and longer term strategic product features.
- Product functional specialising developers must be retained with human resource management intervention, personal growth and career initiatives since new developers will place lengthy delays on development.
- All internal stakeholders must regularly (weekly) prioritise project/product development focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management.
- Clients do demand more project/product requirements during periods of volatility. The client requirements should be planned into roadmap (if time allows) and a commitment for delivery made to the customer. This ensures key resources remain focused toward road map based development of products.
- Capacity planning should speed up delivery of projects/products and its value should exceed the time/cost to maintain the function. Slow reaction speed to client requirements can place projects on risk to the point where clients delay or cancel them
- Simple cost vs. benefit rules still apply. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting the project successfully signed off, then do expect focus pressure from IT business management to implement the changes. Roadmap focussed development is in those cases not a priority.

In relation to:

- Research objective 6: Collect and analyse data to define the impact of unstable economic and trade conditions on project portfolio management and product development in IT businesses

The following may be concluded:

The above-listed aspects for the qualitative data from the respondents as well as the following findings become relevant:

- A main finding is risk associated with changes required in product development as a result of project execution must be detected, tracked, mitigated on a continuous basis to ensure product roadmap implementation remains on track for the overall project/product portfolio realisation.
- Capacity planning should speed up delivery of projects/products and its value should exceed the time/cost to maintain the function. Slow reaction speed to client requirements may place projects at risk to the point where clients delay or cancel them.
- All internal stakeholders should regularly (weekly) prioritise project/product development focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management.

- Simple cost vs. benefit rules still apply. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting the project successfully signed off, then do expect focus pressure from IT business management to implement the changes. Roadmap focussed development is in those cases not a priority.

6.2.7 Research question 7: Main findings, relationships and significance

In relation to the original research question of:
Research Question 7: How do IT businesses balance the order and delivery books during periods of volatility?

Hypothesis F:

Research Hypothesis:

H1: IT businesses balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade.

Null Hypothesis

H0: IT businesses do not balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade.

The univariate quantitative data findings include:

- There is high to very high importance for IT businesses to increase focus on their order book as a result of volatility.
- There is medium to high importance for IT business to increase focus on delivery of projects successfully as a result of volatility.
- IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade. This are, however, only three respondents more than the “No” category for the sample of data.

The testing of IT businesses balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade realised a rejection of the Null hypothesis in association terms. Thus IT businesses balance their order intake with ability to deliver more focused work during periods of volatility than in stable periods of trade realised a rejection of the Null hypothesis in association terms (Chi-square sum = 51.20687157, df=16, $p<0.05$). The visual association indicated a positive association between the dependent variable (BalanceAbilityDelivery) and independent variable (OrderIntake) at low to high levels. Thus H1 has significance, as H0 has been fully rejected.

The qualitative data results from the questionnaire become relevant to understand IT businesses ensure they have an order volume and capacity to deliver the ordered projects and products during periods of volatility.

The qualitative data from section 5.2.7.4 indicated a conclusive range of criteria for retaining focus on the orders received as well as executing the subsequent project work. The main findings being:

- During volatility IT business still need to do what they do best and ensure the solutions are delivered faster, working and meeting client expectations. Successful projects mean customer is satisfied, IT business (including shareholders) is satisfied and project/product participants are satisfied.
- Successful projects very often lead to more work for the same IT business hence during volatile periods with fewer projects this is even more important.
- Quicker turnover and hand-over of projects during volatile periods to customers as a result of successful capacity planning leads to reduced risk for the IT business as well as increased profit margin.
- Capacity planning must prior to and during volatile periods ensure that a predefined business strategy of standardised products are implemented. Clients tend to procure more standardised products and less of high cost custom solutions due to budget constraints.
- Orders are not invoices: Many businesses non-sales management, realise that an order for a project does require the ability to deliver on the order quicker during volatile periods. In this area there is risk as the visibility of order intake vs. fulfilment lacks in project personnel teams.
- Capacity planning during volatile periods has to be clear on the impact of volatility on order book as well as the delivery book (project/product deliveries) to ensure the full value chain may be stabilised. This is done more successfully in large business. Mitigation plans for volatility must be in place.
- Since there are often budget constraints during volatile periods, less expensive projects are realised which use standardised products. More products are developed during stable periods and sold in volume during volatile periods. The order book and project delivery schedule will reflect this more during volatile periods.
- According to respondents South African Companies have a business drive of taking up all possible orders, and then quickly adapting capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable!

In relation to:

- Research objective 7: Determine the measures IT businesses have adopted to ensure that project portfolio selection and product development sustains future business operations profitably during volatile conditions

the following may be concluded:

The above-listed aspects for the qualitative data from the respondents as well as the following findings become relevant:

- Orders are not invoices: Many businesses non sales management, realise that an order for a project does require the ability to deliver on the order quicker during volatile periods. In this area there is risk as the visibility of order intake vs. fulfilment lacks in project personnel teams.
- Capacity planning during volatile periods has to be clear on the impact of volatility on order book as well as the delivery book (project/product deliveries) to ensure the full value chain may be stabilised. This is done more successfully in large business. Mitigation plans for volatility should be in place.
- Since there are often budget constraints during volatile periods, less expensive projects are realised which use standardised products. More products are developed during stable periods and sold in volume during volatile periods. The order book and project delivery schedule will reflect his more during volatile periods.
- According to respondents South African Companies have a business drive of taking up all possible orders, and then quickly adapting capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable!

6.3 RESEARCH CONTRIBUTION TOWARDS THEORY AS WELL AS COMPARISON TO EXISTING THEORY

In evaluating the findings of the study it is suggested to compare the findings with the original:

- Need for new theory established in section 2.3. Consideration should be provided also for the existing published theory as well as the theoretical base for hypothesis in section 3.3.
- The theoretical propositions in section 3.2.2 should measure the outcome of the tested research hypothesis vs. the 4 main original theoretical propositions in Annexure B. Findings of the research are linked to the theoretical propositions used in new theory.

6.3.1 The need for new theory

Some inductive reasoning and theory building (Mouton, 2001) that relies on inference from specific observations for example questionnaire responses are used in building this research thesis value. The feedback from the questionnaires in the study was used to formulate comprehensive conclusions from specific instances of responses and builds general theory. This is also substantiated by Page & Meyer (2006) where conclusions are drawn from a number of specific instances to form general theory.

It is suggested that previous theory from literature must be compared with the results from the research study and gaps identified. The quantitative data and qualitative data are used in conjunction with the hypotheses to establish gaps from the theory used in this study report. The theoretical gap also assists in formulating new theoretical propositions for new theory.
The tables Table 104 to Table 110 depict

- The original theory used for the research question
- The research findings from the quantitative and qualitative data and
- Possible gaps between the findings and the original theory.

The tables are useful in that they establish the research findings value to the existing theory and which areas in the theory need to be extended for the obtained research data.

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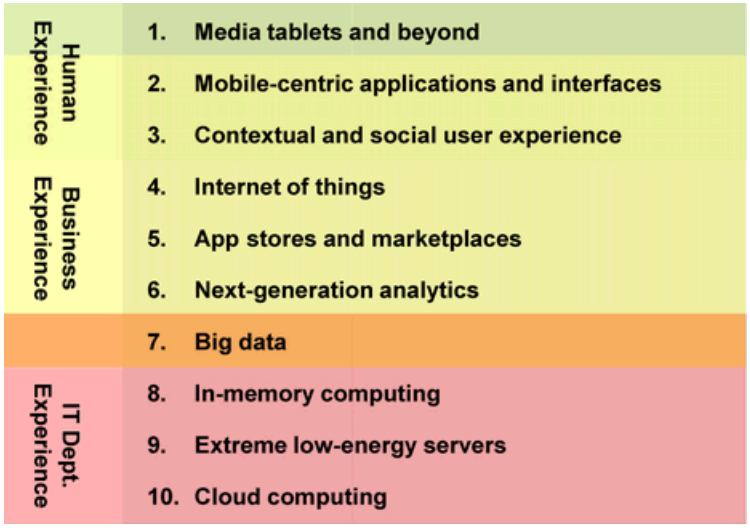
6.3.1.1 Resolving the theory gap for research question 1

In relation to research question 1; Hypothesis A, the theory is compared to the research study findings in **Table 104**.

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
Cearly & Claunch (2012) highlights the top 10 strategic technology trends in Figure 19 that have potential to affect business individuals, businesses and IT organisations.  	The quantitative and qualitative data for hypothesis A is relevant in assessing the theory from Cearly & Claunch (2012). New requirements from the market for innovative IT products (like mobile portable IT devices) are discussed with clients, refined for their processes and this may likely realise in new innovative IT applications. Together IT business and clients unlocks competitive opportunities. IT clients also need to provide service and satisfy their client's needs. The interaction capabilities of new technologies like social media, email, Voice over internet protocol (VOIP) products unlocks opportunities to link back end systems with client interaction possibilities. This can grow the IT	Within the South African context, data communications and connectivity remains a focus point for business as poor IT infrastructure outside major urban areas restrict internet technologies according to BMI (Business Monitor International, 2011, p.8). The essence of many new IT technologies rely on seamless inexpensive data communications, where South Africa is not on the same level as countries having low-cost very fast data communication services. The evidence from this study suggests certain missing elements in the theory of Cearly & Claunch: • **The transformation of IT**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	project/product portfolio irrespective of volatility. Rapid growth in use of social networking, tablet mobility computing, online purchases and cloud computing is, however, prevalent in South Africa. New market required technologies require IT clients to upgrade product/projects even when negative volatility is present since they should remain efficient in delivery of their products and services.	**spending habits to reduce running costs of IT and increased ROI will on a high level impact the adoption of new technology.** Cloud computing is only one dimension thereof as listed by Cearly & Claunch. Hypotheses A, B, E, F and qualitative data confirms this extension. • **A much higher focus on customer centric requirements is required in the theory on technology selection as internal systems collaboration with external client engagements is foreseen.** Hypothesis B and qualitative data confirms this extension.

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
		• IT should unlock new business opportunities requiring more acceleration in innovation, development, capacity planning and delivery. **This is relevant tot theory extension as new technologies should unlock new business to be viable for future business investment**. Hypotheses D, E and qualitative data confirms this extension.

Table 104: Comparison of research findings with theory for research question 1

6.3.1.2 Resolving the theory gap for research question 2

In relation to research question 2; Hypothesis B, the theory is compared to the research study findings in Table 105**:**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
According to Cooper (2001) the following should be done when presenting a new product /project concept to the customer: • The customer's interest in the product should be measured. • Facets of the concept that the customer likes and dislikes should be measured. • How the customer rates your product against the competition should be measured. • What the customer expects to pay needs to be ascertained. • The customer's purchase intent at a specific price needs to be determined. • Information useful in finalising the positioning strategy should be gathered.	The quantitative and qualitative data for hypothesis B is relevant in assessing the theory from Cooper (2001). Key aspects from the research study obtained correlate well with the suggested theory from Cooper but suggests some gaps: • Understanding client operations and impact of volatility can be used to promote project and supporting product features during proposal stage. • IT business should be focused at client centric innovation and delivering growth focused products/projects and not purely at	The evidence from this study suggests certain missing elements in the theory of Cooper (2001): • IT business should understand the pain areas of IT clients to assist them in identifying sweet spot areas where IT projects and products can make a difference in their business. **The pain area identification is reason for theory extension**. Hypothesis B and qualitative data confirms this extension. • Customers are seeking return on investment (ROI)

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	integration of systems which increase running costs for the client. • Knowing the customer and their requirements during volatile periods imply the IT business portfolio of projects and products must lead to a customer centric culture and systems base. • IT business must understand the pain areas of IT clients to assist them in identifying sweet spot areas where IT projects and products can make a difference in their business. • Customers are seeking return on investment (ROI) improvement during volatile periods with a refocus of IT budgets in support of the ROI optimisation. The already defined product suite can be optimised and stage validated to be aligned to client requirements via project based applications.	improvement during volatile periods with a refocus of IT budgets in support of the ROI optimisation. **The theory needs to be extended so customer return on investment (ROI) forms part of the theory.** Hypothesis B and qualitative data confirms this extension.. • Clients focus on internal process optimisation more frequently during volatile periods and IT should support process optimisation without inducing and increasing running costs overheads. **The theory should be extended to make provision for clarification of benefits customer wish to achieve**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	• Clients focus on internal process optimisation more frequently during volatile periods and IT should support process optimisation without inducing and increasing running costs overheads. • Know your customer, know your product, know your market and know competitive pricing for a suitable IT projects/products portfolio.	**in procuring projects/products**. Hypothesis B and qualitative data confirms this extension.
Successful business cycles of management businesses will according to Navarro (2009) cut product inventories in anticipation of a recession and build inventories in anticipation of an expansion or economic growth period. The research questions proposed as part of the study may be measured in terms of Figure 16 from a pure practical application perspective. The consumer approach to consumption is according to Navarro (2009) based upon three dimensions: • How much is a consumer willing to spend? – The consumer mood and confidence.	The quantitative and qualitative data for hypothesis B is relevant in assessing the theory from Navarro (2009). Key aspects from the research study obtained correlate well with the suggested theory from Navarro (2009) but suggests some gaps: • Knowing the customer and their requirements during volatile periods imply the IT business portfolio of	The evidence from this study suggest certain missing elements in the theory of Navarro (2009): • Understanding client operations and impact of volatility can be used to promote project and supporting product features during proposal stage. **The theory should be extended**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
• How much can the consumer afford to spend? – The consumer budget constraints is dependent on current income and longer term wealth. • What is the consumer actually spending? - Large asset capital expenditure focus vs. shorter term operational and non-durable goods.	projects and products should lead to a customer-centric culture and systems base. • IT business should understand the pain areas of IT clients to assist them in identifying sweet spot areas where IT projects and products can make a difference in their business. • Products should be operationally matured for client requirements and the strategic intent of the product suite optimised with product road mapping for future focus. • During negative volatile periods clients will slow down or halt higher risk IT projects. The IT business must realise this can happen and proactively seek concurrent business with more customers to ensure project/product portfolio is not stagnated when projects are halted.	**as it could assist in planning with the project/product portfolio priorities and focus development efforts during business cycle management.** Hypothesis B and qualitative data confirms this extension. • Turning the IT proposal to the client into a successful sale very often requires close co-operation with the customer to refine scope, pricing/budgeting, quality requirements, commercial conditions and operational requirements. This creates demand for project and the product portfolio to grow. **This is relevant to Navarro (2009) in that business can**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	• Clients focus on internal process optimisation more frequently during volatile periods and IT should support process optimisation without inducing and increasing running costs overheads.	**assign weighted success values on the order book impacting focus on the business cycle for capacity planning to fulfil expected orders.** Hypothesis B and qualitative data confirms this extension. • Slow response speed kills IT initiatives as value is not realised when users wish to have just that. The communications with the client identifies IT project/product opportunities or existing risks which should be solved timeously by focused IT projects and product development. **This is relevant to Navarro (2009) in that the slow delivery of projects delay the next**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
		product development funding, hence the business cycle response is affected by successful fast delivery of projects. Hypothesis B and qualitative data confirm this extension.

Table 105: Comparison of research findings with theory for research question 2

6.3.1.3 Resolving the theory gap for research question 3

In relation to research question 3; Hypothesis C, the theory is compared to the research study findings in Table 106:

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
Grant (cited in Wu & Lin p.76) builds a theory that indicates uncertainty requires that strategy focuses less on specific actions and more on establishing a clear direction, within which short term flexibility can be reconciled with the overall co-ordination of strategic decisions. This duality requires that long-term strategic goals are established and that the firm commits to them through strategic intent and growing of	The quantitative and qualitative data for hypothesis C is relevant in assessing the theory from Grant (cited in Wu & Lin p.76). Key aspects from the research study obtained correlate well with the suggested theory from Grant (cited in Wu & Lin p.76)	The evidence from this study suggest certain missing elements in the theory of Grant (cited in Wu & Lin p.76): • Understanding customer responses to volatility requires constant collection and analysis of

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
competencies (Hamel & Prahalad, 1989).	but suggests some gaps: • Market intelligence is collected for short-term collection for crisis/threat management and longer term collection for strategic intent and growth are indicated by several respondents. • Proactive opportunities identified during volatile periods should be capitalised on over the short and longer terms—Look beyond volatility. • Business utilises market intelligence as part of formal risk plans for time periods immediate, 1 year or 3 years or 5 years. • Businesses increase market intelligence to obtain information on how to stabilise itself operationally in the short and mid-term. • IT strategies in larger businesses are set annually and not frequently	market intelligence. **This is relevant for theory extension as a longer term as well as shorter tem view requires constant market intelligence.** Hypothesis C and qualitative data confirms this extension. • Business may be innovative/evolving or stable/reliable and this requires different types and frequencies of market intelligence. **This is relevant for theory extension as the short vs. longer term perspective will depend on the strategic intent of the company being innovative or reliable**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	adapted to ensure reaching planned IT scope is achieved and business cases promises realised.	**only.** Hypothesis C and qualitative data confirms this extension. • Being flexible in approach to do business implies use of constant accurate market intelligence collected constantly to be able to adapt to changing customer behaviour as a result of volatility. **This is relevant for theory extension as flexibility even in longer term focus is required depending the situation at hand**. Hypothesis C and qualitative data confirms this extension.
Nocco and Stulz (2006) argue that in using the theory of enterprise risk management, businesses measure and	The quantitative and qualitative data for hypothesis C is relevant in assessing the	The evidence from this study suggest certain missing elements in the theory

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
manage their risk consistently and systematically. By giving the business manager the information and incentives to optimise the trade-off between risk and return, a business strengthens its ability to carry out its strategic plan. If the IT business takes on a project that increases the firm's total risk, the project should be sufficiently profitable to provide an adequate return on capital after compensating for costs associated with the increase in risk. The theory of enterprise risk management (Nocco and Stulz, 2006) dictate that • Management needs to determine the firms risk appetite which includes the probability of financial distress that is expected to maximise the business value. • Given the target level of risk, management estimate the amount of capital it requires to support the risk of its operations. • Management then determines the optimal combination of capital and risk that is expected to yield the target risk rating. Project portfolio selection may influence the risk level though. Alternatively, for a given amount	theory from Nocco and Stulz (2006). Key aspects from the research study obtained correlate well with the suggested theory from Nocco and Stulz (2006) but do suggest some gaps: • Business utilise market intelligence as part of formal risk plans for time periods immediate, 1 year or 3 years or 5 years. • Being flexible in approach to do business implies use of accurate market intelligence collected constantly to be able to adapt to changing customer behaviour as a result of volatility. • IT strategies in larger businesses are annually set and not frequently adapted to ensure reaching planned IT scope is achieved and business cases promises realised. (Typical key performance indicator approach to management).	of Nocco and Stulz (2006): • IT strategies are in larger businesses annually set and not frequently adapted to ensure reaching planned IT scope is achieved and business cases promises realised. **This is relevant for theory extension as risk is then managed in relation to strategic focus and not operational fire-fighting only.** Hypothesis C and qualitative data confirm this extension. • Many businesses focus on core business during volatility which requires stable working IT functions without

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
of risk, the business can increase capital to achieve the target risk rating. • Risk is decentralised in the business with the help of capital allocation and performance evaluation that motivate business managers to make investment and operating decision that optimise this trade-off.	• Many businesses focus on core business during volatility which requires stable working IT functions without operational risk of changes in the short term. • Market intelligence indicating customer operational IT/business changes, requires potential short term changes in own IT project/products. This is done to improve delivery of services, communication and client engagements.	operational risk of changes in the short term. **This is relevant for theory extension as business IT continuity planning should for part of the risk plan.** Hypothesis C and qualitative data confirms this extension. • Market intelligence indicating customer operational IT/business changes, requires potential short-term changes in own IT project/products. **This is done to improve delivery of services, communications and client engagement but may impact the risk list**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
		of the business as additional project execution risk is induced. Hypothesis C and qualitative data confirms this extension.
Similarly "Resiliency Management" embodies both a proactive and reactive approach to face unprecedented, unexpected and unforeseen events that influence the organisational operational activities. Executives and managers need to ensure that the underpinning values, beliefs, norms and expectation that give rise to a culture of resiliency are woven into the day-to-day interaction and extensive dialog (Weeks, 2009).	The quantitative and qualitative data for hypothesis C and D is relevant in assessing the theory from Weeks (2009). Key aspects from the research study obtained correlate well with the suggested theory from Weeks (2009) but suggests some gaps: • Business increases focus on short term survival (due to insecurity/threats) and management of the business variables influenced by volatility. Business use increased market intelligence to plan strategy and increase action for post volatility	The evidence from this study suggest certain missing elements in the theory of Weeks (2009): • The technology strategy should also be robust to facilitate medium changes in technical scope, cost, time required to mitigate variables induced by volatility for example release versions based functional products with interim IT product deliveries. **This is relevant for theory**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	cycles of down turn or upturn. • Business increase market intelligence to obtain information on how to stabilise itself operationally in the short and mid-term. • IT strategies are in larger businesses annually set and not frequently adapted to ensure reaching planned IT scope is achieved and business cases promises realised. • Many businesses focus on core business during volatility which requires stable working IT functions without operational risk of changes in the short term. • The technology strategy should make provision for roadmap planning in the project/product portfolio. This should facilitate short term extensions in the project/product portfolio to keep the	**extension as a sense of flexibility is required to adjust to the underpinning volatility if required.** Hypothesis D and qualitative data confirms this extension. • The technology strategy must make provision for roadmap planning in the project/product portfolio. This should facilitate short term extensions in the project/product portfolio to keep the customer satisfied but also longer term client requested larger requirements into the portfolio. **This is relevant in extending theory as road map planning will**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	customer satisfied. Longer term client requested larger requirements are also implemented into the portfolio.	**require product owners to depict the development plan. The product should be mature and leading in the market requiring little further adjustment.** Hypothesis D and qualitative data confirms this extension. • Competitors' projects/products portfolios should be continuously assessed and compared to own projects/products portfolio. Required capabilities can be generically developed into the portfolio over time or based on urgency "forced" into the short-

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
		term development tracks for the portfolio. **This is relevant for extending theory as own product must be superior to competitor products by default. Product specification should be superior to competitors yet be price competitive.** Hypotheses C, D and qualitative data confirms this required extension.
"Pattern-based strategy" is the discipline to enable business leaders to actively seek, amplify, examine and exploit new or novel business patterns. To support pattern-based strategy, organizations must begin to understand in which activities they are investing, and how these investments need to be changed or adjusted to enable them to exploit new patterns within their own businesses. They should also be able to understand new patterns of signals coming from external sources that indicate	The quantitative and qualitative data for hypothesis B, C and D are relevant in assessing the theory from Burton et al (2009). Key aspects from the research study obtained correlate well with the suggested theory from Burton et al (2009) but suggests	The evidence from this study suggests certain missing elements in the theory of Burton et al (2009): • The technology strategy should make provision for road map planning in the project/product portfolio. This should facilitate

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
a business opportunity or threat. Chief executive officers and strategy officers need to expand their investment analysis beyond the two investment categories (defined and creative) (Burton et al, 2009).	some gaps: • IT business should understand the pain areas of IT clients to assist them in identifying sweet spot areas where IT projects and products can make a difference in their business. • Products should be operationally matured for client requirements and the strategic intent of the product suite optimised with product road mapping for future focus. • Understanding customer responses to volatility requires constant collection and analysis of market intelligence. • Businesses use increased market intelligence to plan strategy and increase action for post volatility cycles of downturn or upturn. • The technology strategy must make provision for roadmap planning in the project/product portfolio. This	short-term extensions in the project/product portfolio to keep the customer satisfied. Longer term client requested larger requirements are developed into the portfolio. **This is relevant in extending theory as road map planning will require product owners to depict the development plan of the product with features (patterns) that are present in the market and requiring updates of the products.** Hypotheses C, D and qualitative data confirms this required

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	should facilitate short-term extensions in the project/product portfolio to keep the customer satisfied. Longer term client requested larger requirements also implemented into the portfolio. • Competitors' projects/products portfolios should be continuously assessed and compared to own projects/products portfolio. Required capabilities can be generically developed into the portfolio over time or based on urgency "forced" into the short-term development tracks for the portfolio.	extension. • Competitors' projects/products portfolios should be continuously assessed and compared to own projects/products portfolio. Required capabilities may be generically developed into the portfolio over time or based on urgency "forced" into the short-term development tracks for the portfolio. **This is relevant for extending theory as the competitors' products do also stimulate the market with features and capabilities that may be required by**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
		clients in upcoming projects. Hypotheses D and qualitative data confirm this required extension.

Table 106: Comparison of research findings with theory for research question 3

6.3.1.4 Resolving the theory gap for research question 4

In relation to research question 4; Hypothesis D, the theory is compared to the research study findings in Table 113:

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
Aizeman and Pinto (2005) formulated theory that economic volatility is more than the study of business cycles and the composition of economic growth in cyclical and trend components. They postulated that volatility is allied to risk in that it provides a measure of the variation or movement of a particular variable for example economic variables or some function of the variable. Aizeman and Pinto (2005) further distinguish between normal	The quantitative and qualitative data for hypothesis D is relevant in assessing the theory from Aizeman and Pinto (2005). Key aspects from the research study obtained correlate well with the suggested theory from Aizeman and Pinto (2005) but do suggest some gaps:	The evidence from this study suggest certain missing elements in the theory of Aizeman and Pinto (2005): • The answer is context specific since the level of change required, the business's ability to consume volatility, budget, competition

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
volatility and extreme volatility. With extreme volatility being a significant change in an economic variable resulting where the movement exceeds a threshold resulting in economic shock. Normal volatility may be cyclical business conditions or events of lower magnitudes events where the economy can absorb the changes without severe negative impact.	• Changes (medium or drastic) in the technology strategy must have business value attached to it extending beyond short-term revenue focus to longer term strategic intent. • The answer is context specific since the level of change required, the business's ability to consume volatility, budget, competition position and maturity of own project /product portfolio will determine the adaptation level required. In most cases only medium changes are required. • The technology strategy should also be robust to facilitate medium changes in technical scope, cost, time required to mitigate variables induced by volatility for example release versions based functional products with interim IT product	position and maturity of own project /product portfolio will determine the adaptation level required. In most cases there are medium changes required only. **The theory should be extended to indicate that consuming volatility also depends on context specific factors like** ○ **Level of impact** ○ **Level of organisational change required** ○ **Budget required for change or sustainment** ○ **Competition position** ○ **Maturity of project and product portfolio**.

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	deliveries.	Hypotheses D and qualitative data confirm this required extension.
Ulrich and Eppinger (2008) report five measures which are commonly used to assess the success of product development: • Product quality: The product quality is ultimately reflected in the market share and price customers are willing to pay for a product. • Product cost: The product cost determines how much profit accrues to the firm for a particular sales volume and particular sales price. • Development time: The development time determines how responsive a firm can be to competitive forces and technological developments, as well as how quickly the firm receives the economic returns from the team's effort. • Development cost: The development cost is usually a significant fraction of the investment required to achieve the profits.	The quantitative and qualitative data for hypothesis D is relevant in assessing the theory from Ulrich and Eppinger (2008). Key aspects from the research study obtained correlate well with the suggested theory from Ulrich and Eppinger (2008) but suggests some gaps: • Competitors' projects/products portfolios should be continuously assessed and compared to own projects/products portfolio. Required capabilities can be generically developed into the portfolio over time or based on urgency "forced" into the short term development tracks for the portfolio.	The evidence from this study suggests certain missing elements in the theory of Ulrich and Eppinger (2008): • Competitors' projects/ products portfolios should be continuously assessed and compared to own projects/products portfolio. **The theory needs to be extended to take cognisance of the feature maturity, price/cost, maintainability and quality of own vs. competition products. This has a profound impact on a**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
• Development capability: The development capability of a team as a result of experience determines the capability of a firm to develop products in future more effectively and economically.	• The technology strategy should make provision for road map planning in the project/product portfolio. This should facilitate short-term extensions in the project/product portfolio to keep the customer satisfied. Longer term client requested larger requirements are also developed into the portfolio. • Accelerate changes planned into technical strategy into the portfolio not to miss new opportunities. Slow reaction speed in IT means lost opportunities. • The project/product portfolio maturity should be market leading maturing level to be changed a maximum of medium level, extended and scaled for flexible deliveries.	**product being successful in the market**. Hypotheses D and qualitative data confirm this required extension.

Table 107: Comparison of research findings with theory for research question 4

6.3.1.5 Resolving the theory gap for research question 5

In relation to research question 5; Hypothesis E, the theory is compared to the research study findings in Table 108:

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
Cooper and Edgett (2006) build theory stating that picking the right portfolio of projects is paramount to maximising new product development (NPD). They identified several best practices to aid in improvement of project portfolio management. • Focusing on data integrity: The best project selection is worthless unless data used for project selection is sound. • Install a systematic idea-to-launch process to identify key tasks should be undertaken at every stage of the project and what information is really needed at each selection gate. • Adopt an incremental commitment or options-based approach. Limit risk by taking small investment steps before committing fully for the project execution. • Know when to walk away. The correct kill can also be a success since money is saved and trouble is limited.	The quantitative and qualitative data for hypothesis E is relevant in assessing the theory from Cooper and Edgett (2006) Key aspects from the research study obtained correlate well with the suggested theory from Cooper and Edgett (2006) but do suggest some gaps: • The dominant aspect listed by the respondents is IT business should have a diversified product portfolio with lower unit cost, mature and sellable products also available to be sold off the shelf to customers. Not all products should be "in progress, but not yet available" development status.	The evidence from this study suggest certain missing elements in the theory of Cooper and Edgett (2006): • Be in close contact with customers where relationship can expose key product attributes required for the existing and new products. **The theory should be extended to make provision for proof-testing products with customers and align core features with client requirements.** Hypotheses E and qualitative data confirm this required extension. • Projects should have business case and execution

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any

• Categorise your developments projects into buckets to identify differences such as
  ○ New products.
  ○ Platform and technology developments.
  ○ Improvements, modifications and extensions.
  ○ Customer requests.
• Utilise multiple selection methods in combination to hone in on the correct project selection decision.
• Utilise score cards to rate and rank projects: The development funnel is a method proposed by Wheelwright and Clark (1992), to select between different product development proposals. Proposed products are reviewed to see which fit the business strategy best. Products of lesser fit are eliminated earlier in the product selection process. Successful product development results in products that can be produced and sold profitably.
• Utilise success criteria at every stage in the project selection process to evaluate if projects meet agreed criteria for success and agreed expectations.
• Utilise the right financial approach to select projects including, net present value (
	• A proactive product management/planning (with commercial and sales skill) function must ensure the products have features, functions and price to be able to be sold in volatile/non-volatile environments.
	• Be in close contact with customers where relationships can expose key product attributes required for the existing and new products. This should focus limited budgets at reusable, key client requirements and a competitive edge to be implemented into product development during volatile periods.
	• Projects must have business case and execution plan to generate ROI early in the project lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational
		plans to generate ROI early in the project lifecycle to ensure sustained commitment from customers. **The theory need to be extended to ensure the stage gate process does create visible value early in development for stakeholders and clients as long delays may lower client commitment and increase pricing for the product.** Hypotheses E and qualitative data confirm this required extension.
		• Care should be taken not have the client fall into long-term expensive maintenance financial traps. Maintenance budgets should rather also provide new innovative features during the project

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
NPV), sales-to-cost ratio, and probability adjusted NPV and productivity index. • Build periodic portfolio reviews to rank projects ensuring that business has ○ The correct set of projects in execution. ○ The right mix of projects. ○ The right balance of projects. ○ The right priorities of projects, and ○ Sufficient resources to undertake approved projects. Le (2004) suggests that 3 factors affect the quality outcome of the new product performance and highlights the impact of project portfolio management on new product performance as a result of successful product development: The corner stones of new product performance include: • The project screen process refers to the discipline of	process efficiencies induced, cost savings, communication, and so forth . • Care should be taken not have the clients fall into long-term expensive maintenance financial traps. Maintenance budgets should rather also provide new innovative features during the project delivery to ensure the client gets significant operational value for money. Longer term contracts even with lower profit provide project team security and a satisfied customer. The quantitative and qualitative data for hypothesis E is relevant in assessing the theory from Le (2004). Key aspects from the research study obtained correlate well with the suggested theory from Le (2004) but suggests some	delivery to ensure the client gets significant operational value for money. **The theory needs to be extended to make provision for cost and maintainability in the project and product portfolio as these factors will also impact the acceptance and lifespan of the projects and products.** Hypotheses E and qualitative data confirm this required extension. The evidence from this study suggests certain missing elements in the theory of Le (2004): • Be in close contact with customers where relationship can expose key product attributes required for the

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
selection of projects and further execution accordance with expected quality requirements. • The portfolio management process ensures the business prioritises projects in such a way as to ensure the new product development resources capability is not exceeded. Over utilisation of new product development resources capability can lead to the fire-fighting syndrome according to Repenning, Congapues & Black (cited in Le p.1013). • The new product strategy ensures that the long-term developments receive strategic direction and align with the business's objectives.	gaps: • A proactive product management/ planning (with commercial and sales skill) function should ensure the products have features, functions and price to be able to be sold in volatile/non-volatile environments. • Be in close contact with customers where relationship can expose key product attributes required for the existing and new products. This should focus limited budgets at reusable, key client requirements and a competitive edge to be implemented into product development during volatile periods. • The dominant concept is that projects should have value that makes them unique, competitive and have a high ROI with low risk. • Larger businesses with more formal processes tend to have more formal	existing and new products. **The theory should be extended for a customer focus in the screening, development and management function to ensure product is market required.** Hypotheses E and qualitative data confirm this required extension. • Many IT businesses utilise best practice industry frameworks like TOGAF®, PRINCE II ®, ZACHMAN®, ITIL®, COBIT® and Industry frameworks like eTOM®, EMMMV®, HPUM® for capacity planning and process maturity assessments. **The theory should be extended to make provision for the**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	capacity planning since they execute more project and product development with large but limited teams of people and resources. • Smaller IT businesses tend to scope capacity on a per project only with little excess capacity or overhead plan. • Many IT businesses utilise best practise industry frameworks like TOGAF®, PRINCE II ®, ZACHMAN®, ITIL®, COBIT® and Industry frameworks like eTOM®, EMMMV®, HPUM® for capacity planning and process maturity assessments.	**application of best practices in project and product development as more than the three listed dimensions determine the overall product/project success.** Hypotheses E and qualitative data confirm this required extension.

Table 108: Comparison of research findings with theory for research question 5

6.3.1.6 Resolving the theory gap for research question 6

In relation to research question 6; Hypothesis F, the theory is compared to the research study findings in Table 109:

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
Cooper and Kleinschmidt (2007:6) investigated the critical factors in product development that drive performance at business unit level. They found 9 factors which distinguished better performing businesses: • A high quality new product process • A defined new product strategy for the business unit • Adequate resources of people and money • Research and development spending for new product development • High quality new product project teams • Senior management committed to and involved in new products • An innovative climate and culture • The use of cross functional project teams • Senior management accountability for new product results	The quantitative and qualitative data for hypothesis F is relevant in assessing the theory from Cooper and Kleinschmidt (2007:6). Key aspects from the research study obtained correlate well with the suggested theory from Cooper and Kleinschmidt (2007:6) but do suggest some gaps: • The product portfolio should be optimised for client requirements both in the short-term (contract specific but re-usable) and longer term strategic product features. • Product functional specialised developers should be retained with human resource management intervention to ensure personal growth and career initiatives since training new developers will place lengthy delays on development. • All internal stakeholders must	The evidence from this study suggests certain missing elements in the theory of Cooper and Kleinschmidt (2007:6): • The product portfolio must be optimised for client requirements both in the short term (contract specific but re-usable) and longer term strategic product features. **The theory should include a client focus and verification of project and product development at different stages with the customers.** Hypotheses F and qualitative data confirm this required extension. • All internal stakeholders should regularly (weekly) prioritise project/product

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	regularly (weekly) prioritise project/product development focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk-reduction management. • Clients do demand more project/product requirements during periods of volatility. The client requirements should be planned into the product road map (if time allows) and a commitment for delivery made to the customer. This ensures key resources remain focused toward road map-based development of products. • Simple cost vs. benefit rules still apply. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting	development focus to ensure ALL customer requirements for service, projects and products are met. This forms part of proactive risk reduction management. **The theory should include also communication and prioritisation sessions on frequent basis to focus limited resources at business priorities.** Hypotheses F and qualitative data confirm this required extension. • Clients do demand more project/product requirements during periods of volatility. The client requirements should be planned into road map (if time allows) and a commitment for delivery

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	the project successfully signed off, then do expect focus pressure from IT business management to implement the changes. Roadmap focussed development is in those cases not a priority.	made to the customer. **The theory should be extended to ensure key resources remain focused toward road map-based development of products and not de-focused unnecessarily**. Hypotheses F and qualitative data confirm this required extension.
Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43) plot the portfolio of projects along two specific dimensions: The extent to which project involves a change in the product line and the extent to which the project involves a change in production processes called a product-process change matrix (Figure 13). This perspective can be useful to illuminate imbalances in the portfolio of projects under consideration and in assessing the consistency between a portfolio of projects and the competitive strategy needed for changing economic and volatile conditions. A business may identify that it has essentially no	The quantitative and qualitative data for hypothesis F is relevant in assessing the theory from Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43). Key aspects from the research study obtained correlate well with the suggested theory from Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43) but do suggest some gaps: • The product portfolio should be	The evidence from this study suggests certain missing elements in the theory of Wheelwright and Clark (cited in Ulrich and Eppinger, p. 43): • The client requirements should be planned into roadmap (if time allows) and a commitment for delivery made to the customer. This ensures key resources remain focussed toward

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
breakthrough opportunities or that it has no projects aimed at incremental improvements.	optimised for client requirements both in the short-term (contract specific but re-usable) and longer term strategic product features. • Clients do demand more project/product requirements during periods of volatility. The client requirements should be planned into road map (if time allows) and a commitment for delivery made to the customer. This ensures key resources remain focused toward road map-based development of products. • Simple **cost vs. benefit rules still apply**. If changes in product development in the context of a project provide the benefit in terms of revenue/cash flow timing/getting the project successfully signed off, then do expect focus pressure from IT business management to	roadmap based development of products. **The theory should be extended to allow for a larger portion of product derivatives and enhancements as clients will require some additions/changes to complete projects successfully. The theorised model depict incremental changes as the smallest factor of change, yet the research study findings depict this not be a small factor of change.** Hypotheses F and qualitative data confirm this required extension.

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	implement the changes. Road map focused development is in those cases not a priority.	

Table 109: Comparison of research findings with theory for research question 6

6.3.1.7 Resolving the theory gap for research question 7

In relation to research question 7; Hypothesis G, the theory is compared to the research study findings in Table 110:

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
Cooper and Edgett (2001) indicate five goals of project and product portfolio management: • Maximise the value of the portfolio via selecting new product projects so as to maximise sum of the values or commercial worth of all active projects supporting a business objective. • Seek balance in the portfolio in parameters of short vs. long-term projects, high vs. low risk, markets, technologies, product categories, project types.	The quantitative and qualitative data for hypotheses G and E are relevant in assessing the theory from Cooper and Edgett (2001). Key aspects from the research study obtained correlate well with the suggested theory from Cooper and Edgett (2001) but do suggest some gaps:	The evidence from this study suggests certain missing elements in the theory of Cooper and Edgett (2001): • Proactive marketing to work closely with customers, potential customers and industry ensures that product

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
• The portfolio must be strategically aligned and spending across projects areas, markets etc. must mirror strategic objectives. • Pick the right number of projects with limited resources available. • Ensure the revenue (or profit) goals set out in the product innovation strategy are achievable given the projects currently underway. Project portfolio selection should according to Cooper and Edgett (2001) include: • Value attainment in project portfolio selection. • Balance in the project portfolio of short vs. longer term projects. • Strategy in the project portfolio. • Right number of projects to balance organisational resource capacity. • Ensure revenue/profit goals in the product innovation strategy are achievable.	• Proactive marketing to work closely with customers, potential customers and industry ensures that product launches are done at the right price, right feature level, timing and meeting client expectations. During volatile periods clients may buy even less hence the product should be on par with expectations from the market. • During volatility IT business still need to do what they do best and ensure the solutions are delivered faster, working and meeting client expectations. Successful projects mean customer is satisfied, IT business (including shareholders) is satisfied and project/product participants are satisfied. • Orders are not invoices: Many businesses non-sales management, realise that an order for a project	launches are done at the right price, right feature level, timing and meeting client expectations. **The theory should be extended to include customer participation to understand and manage the true risk in introducing projects/ products into the market.** Hypotheses G and qualitative data confirm this required extension. • Return on investment (ROI) in the short-term is important for cash flow yet product road map should also fit into short time to delivery to customers. **The theory only mentions achieving revenue targets yet the short-term payment milestones in projects can**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	does require the ability to deliver on the order quicker during volatile periods. In this area there is risk as the visibility of order intake vs. fulfilment lacks in project personnel teams. • A proactive product management/planning (with commercial and sales skill) function should ensure the products have features, functions and price to be able to be sold in volatile/non-volatile environments. • Be in close contact with customers where relationship can expose key product attributes required for the existing and new products. This should focus limited budgets at reusable, key client requirements and a competitive edge to be implemented into product development during volatile periods.	**over several projects/products also add up to revenue targets**. Hypotheses E and qualitative data confirm this required extension. • According to respondents South African Companies have a business drive of taking up all possible orders, and then quickly adapt capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable! **The theory needs to make provision for the scenario**

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	• Return on investment (ROI) in the short term is important for cash flow yet product roadmap must also fit into short time to delivery to customers. • According to respondents South African Companies have a business drive of taking up all possible orders, and then quickly adapt capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then worry about execution or volatility is acceptable! • Projects should have business case and execution plan to generate ROI early in the project lifecycle to ensure sustained commitment from customers. This ROI can also be non-financial in terms of operational	**where a business attempts to get all possible orders and then reactively refines, extends and optimises the product portfolio. This tends to be a less structured, pressured response.** Hypotheses G and qualitative data confirm this required extension.

Original Theory and relation to research questions	The research findings in this study	Potential gaps in the original theory if any
	process efficiencies induced, cost savings, communication, and so forth.	

Table 110: Comparison of research findings with theory for research question 7

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6.4 IN CONCLUSION AN ASSESSMENT OF WHAT HAS BEEN ACCOMPLISHED TOWARDS CONTRIBUTION AND SIGNIFICANCE

Cooper and Schindler (2008) state good business research is a systematic inquiry that provides information to guide managerial decisions. It is more specifically a process of planning, acquiring, analysing, disseminating relevant data and information, and insights to decision makers in ways that mobilise the business to take appropriate action that in turn maximise performance.

The journey during the research for this thesis has been insightful, meaningful and created a practical base for future research. The feasibility of this research relies on creating new knowledge in business and technology management science. In times of volatility as currently experienced globally, businesses still excel today and should thus be detecting volatility to adjust their business strategy correctly to influence project portfolio and new product developments.

During the theory investigation for the proposed research theories from literature were found on volatility impact on project portfolio management and new product development creating a theoretical gap that forms the basis for the proposed research. The core of the gap resided in:

- An understanding of smaller volatility vs. extreme volatility and how IT business (supplier and client) work with volatility.
- Understanding the impact of volatility on IT project portfolio management and products being developed as part of the projects or in support of larger projects as part of research and development.
- Create a base for IT business to balance their capacity for sale order growth with the ability to execute the respective IT project and product development whilst still maintaining support for the business and technology strategy.

A structured research approach and methodology were followed to gather empirical evidence for the research findings. The main conclusive findings are already summarised in section 6.2 and include the research objectives, research questions, hypotheses, quantitative and qualitative data.
Empirical evidence for findings were collected using the online social networking Linkedin® service and structured data analysis techniques. The questionnaire included both structured questions and unstructured commentary fields which assisted with a wider geographical response of IT-informed suppliers and clients. The experienced professionals who responded provided informed responses based on several years applied field experience after formal IT training.
In conclusion the original contribution of the thesis and supported research included findings for the IT industry which originate in the research objectives are listed in Table 111. The relevant findings in the thesis are by paragraph number linked to the research objectives. The contribution of the findings is listed for reference with the research objectives:

Item	Research objective	Finding and contribution
1	Research objective 1: The study combines aspects of business, management and market research. • By performing market research the aim is to understand quantitative and qualitative aspects of IT consumer and client behaviour in volatile economic and trade conditions. • The impact of volatility may influence work behaviour of people in the service of IT businesses. During volatile conditions business may require more efficiency, effectiveness and focused productivity. These aspects need to be part of the research. • Some organisational development aspects may require management intervention during periods of volatility since planned behavioural change efforts may impact on organisational culture, human and social processes. The research needs to quantify the management intervention required.	Detailed research findings are listed in paragraphs 5.4.1.1, 6.2.1 and 6.3.1.1. The contribution from the research findings reside in : • An understanding of customer behaviour amidst volatility and aspects requiring attention amidst volatility. • The specific volatile factors impact IT business on a high level. • Determining the organisational change in operations and culture that are required to work with volatility.
2/3	Research Objective 2: Determine the general responses of IT businesses during periods of volatility and how the technology strategy repositioning, strategy formulation and strategy execution in the business is done.	Detailed research findings are listed in paragraphs 5.4.1.2, 5.4.1.3, 6.2.2, 6.2.3, 6.3.1.2 and 6.3.1.3 The contribution from the research findings resides in an understanding of the impact a client-centric focus has on the formulation and execution technology strategy. Industry context specific factors do play an important

Item	Research objective	Finding and contribution
		role since the level of change required, the business's ability to consume volatility, budget, competition position and maturity of own project /product portfolio will determine the adaptation level required.
4	Research objective 3: Collect and analyse current best practice approaches in use during volatility by IT businesses for project portfolio execution in technology intensive product suppliers. Research objective 4: Collect and analyse the best practice approaches in use during volatility by IT businesses for new product development execution in technology intensive product suppliers.	Detailed research findings are listed in paragraphs 5.4.1.4, 6.2.4 and 6.3.1.4. The contribution from the research findings reside in creating a sensitivity of factors that that enhances project and product portfolio creation, development and execution during periods of volatility.
5	Research objective 5: Collect and analyse the data business uses to define the relationship and impact of project portfolio selection on IT product development.	Detailed research findings are listed in paragraphs 5.4.1.5, 6.2.5 and 6.3.1.5. The contribution from the research findings resides in understanding the relationship between project and product development and how the relationship should be managed during periods of volatility. For the purpose of the research, products are typically delivered as part of projects to clients. The products may be developed as part of projects or by means of research and development initiatives.
6	Research objective 6: Collect and analyse data to define the impact of unstable economic and trade conditions on project portfolio management and product development in IT businesses.	Detailed research findings are listed in paragraphs 5.4.1.6, 6.2.6 and 6.3.1.6. The contribution from the research findings resides in strategy as well as project management aspects of project and product development that are planned and executed when volatility is detected.
7	Research objective 7: Determine the measures IT businesses have adopted to	Detailed research findings are listed in paragraphs 5.4.1.7, 6.2.7 and 6.3.1.7.

Item	Research objective	Finding and contribution
	ensure that project portfolio selection and product development sustains future business operations profitably during volatile conditions.	The contribution from the research findings resides in identifying and managing important factors that assist businesses to manage capacity in relation to sales order intake and executing project / product development during periods of volatility.

Table 111: Research objective and findings contribution

When reviewing the functional flow items in Figure 22 the following main ideas are significant and can be linked as per diagram:

- "Economic and trade volatility" linked to "client responses to volatility"
  - An acknowledgement from both IT Business (suppliers) and IT clients that volatility has a high impact on their IT projects and product developments. The qualitative data indicated especially the availability of skilled human resources in the longer term is a risk as the industry is prone to high personnel turnover
  - Hypothesis A with a significant result for periods of negative volatility.
- "Client responses to volatility" linked to "Business detecting volatility and client responses"
  - Hypothesis B with a significant result.
- "Business detecting volatility and client responses" linked to "Adapt Project/new product development portfolio and still service current clients"
  - Hypothesis C with partially significant and D with significant results
- "Adapt Project/new product development portfolio and still service current clients" linked to "Balance order and delivery book"
  - Hypothesis E with significant result.
- "Balance order and delivery book" linked to "Business detecting volatility and client responses"
  - Hypothesis F and G with significant results.

When reviewing the research model the hypothesis and findings logically link the overall decision points in the model as per Figure 75.
When interpreting the research as a whole some key thoughts become prevalent: Tough trade circumstances induced by volatility in the business environment should not deter the business from retaining focus in strategy execution, task execution and productive output.

The business's ability to anticipate and respond to changes induced by volatility that can impede it to generate earnings, will define the level of robustness and resiliency of the business. As indicated in the findings of the study the business needs to be aware of the market it operates in, know its products, how these products can be deployed in projects, know its clients, competition and how it will secure business. When volatile conditions arise the business should be able to

have sufficient skill, resources and willingness to change to work with the volatility. The business should adjust its business and technology strategy to be able to capitalise on opportunities, realise and implement trends as well as consume threats to retain focus in its core goals and vision.

From a practical view point, the business and technology management in the business need to be open minded to:

- Be witness to changes, willing to adjust strategy and realise change is part of normal business.
- Be constantly aware of competition that is also reviewing, responding and interfering in the market place with existing and new customers.
- Have a short and longer term focus with the future viewed as an opportunity and provide channels of communication with employees who can provide worthwhile input into the future business strategy of the company.
- The business strategy focus towards realising sales orders from customers is the starting point of business. Ensure sufficient resources are focused on collaboratively realising orders. During volatile periods having sufficient sales orders ensures sufficient resources to continue project and product portfolio development.
- Be practical and realistic in executing these orders with sufficient resources (people, time, funding and infrastructure) to ensure quickest possible delivery to customers during volatile periods. Prioritise focus on specific deliveries on a weekly basis and address customer unique requirements without losing project and product portfolio focus.

Managing the effect of volatility effectively and efficiently in project and product development should extend beyond best practices and also become part of the organisation culture for organisation to overcome negative volatility and capitalise on opportunities created as a result of volatility.

The statement from theory:
“Recession teaches businesses to be prepared even during the good times, because a recession is like a battle- When you are in it, it is almost too late start training for it; if you are not prepared for it, you will pay for it!” (Navarro, 2009)

Need not be a threat or warning but rather an opportunity to have a “can do” attitude, an aptitude to become resilient yet flexible to achieve focus on the fulfilment of the goals in business strategy and technology management.

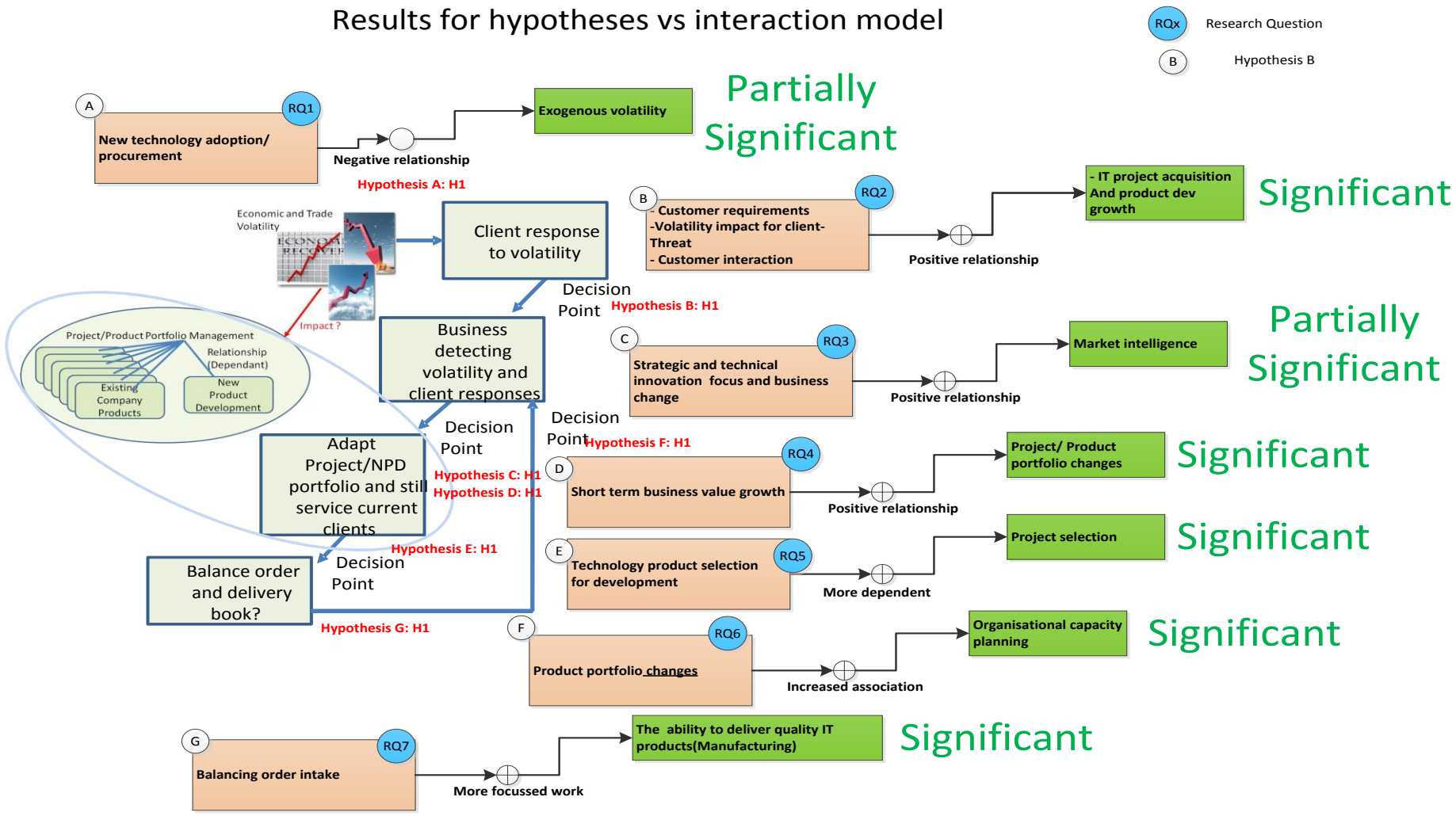

Figure 75: Conclusive overall diagram linking research hypotheses vs. original impact model and significant results

6.5 RECOMMENDATIONS FOR FUTURE RESEARCH

The research in this thesis was narrowed down in scope to ensure sufficient depth could be unlocked for key topics during the investigation, analysis and presentation of new findings.

As a result several research areas of interest could build upon the results of this research to create more useable and practical information for management to work with conditions induced by volatility.

These areas for potential research include several possibilities:

- The building of resiliency practices into the management of product development where different scenarios of factors may be adjusted in relation to variables that are changing as a result for volatility. A study could simulate the variables such as, reduced demand, timing, financing, competitor progress vs. own products, and so forth and measure corrective management action taken. Valuable insight by means of systems dynamic modelling could be reached in generic models for IT business if industry case studies are analysed.
- In the qualitative feedback of this thesis reference was made to the association of risk management and volatility management. Smaller variable changes as part of business cycles vs. significant volatility events will likely have different risk management responses as a consequence. A suitable research project would be to determine the inference between risk and volatility. What measures are typically tracked in volatility and form part of risk management programs. The theory of risk and volatility could be analysed in depth and tested with questionnaires or interviews with risk managers in IT.
- Resiliency during volatile periods in business requires organisations to be able to create capacity for continuous reinvention and adjustment to their volatile environments. Research focusing on the ability to know what is the winning strategy for the future IT business, what changes are required by the market in IT business, and when changes should be completely implemented may assist the IT business to grow and not just survive volatility. For information technology companies to stay market leaders, core aspects or resiliency would require continuous attention. The research would need to focus on innovative changes to business strategy, technology strategy, values, functions of people and processes should be possible continuously to build business value over time.
- The increased demand for collaboration and social media enable possibilities of extending information technology systems like enterprise resource planning systems to customers via social media and email for direct communications. This implies that internal execution processes of a business interfaces directly with customers. Innovative project and products which are in development and tracked with enterprise resource planning systems

may now in near real-time gain customer insights, engagement and refinements in product features. This is useful during volatile periods where customer focus is increased while developments are speeded up for deliveries. A possible research initiative would be how business can establish relationships with customers using information technology during project and product development to ensure a better end-product for the customer. This relationship building with clients would replace linear customer transactions to achieve more value. The existing capability of business product development processes must gain value when being extended to customers.

- During the research for this thesis the qualitative data feedback from respondents provided a stronger support for customer focused product development to enable growth oriented innovation. For this to happen it may be required to break down legacy practices of product development for low value returns. Rather spend time on new innovative customer focused products than wasting time on low return value integration of older products. Faster reaction time during volatile periods is the key as established in this research. This would imply users would still want certain key aspects from information technology products to also operate faster and cost efficiently in their business. Research could be formulated to investigate what attributes should customer focused information technology products contain to realise value in the shortest period of time for IT clients.
- Alternative data analysis techniques of using factor analysis, multiple regression or development of a structural equation model can also be applied to the data but the focus to this depth is not required for the level of analysis to derive meaningful answers.. Qualitative data techniques of fuzzy cognitive or analytical hierarchical maps could also be considered in future research.
- Data analysis could also be divided per job level and participating users for example educational sector. For this to realise a detail understanding of every respondent should be made in the research sample to ensure respondents are categorised in the correct job level. Analysis using multiple linear regression for categories relative to weighted groups of values and job levels may provide perspectives on research results.

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7. ACRONYMS

Acronym	Explanation
BEE	Black economic empowerment
CCMPM	Goldratt's critical chain multi-project management
CMMI®	Capability Maturity Model Integration
COTS	Commercial over the shelf
COBIT®	Control Objectives for Information and Related Technology
CRT	Current reality trees
EBIT	Earnings before interest and tax
eTOM®	Enhanced Telecom Operations Map- Business Process Framework
EMMMv®	Open Group Exploration, Mining, Metals, Minerals Vertical.
HPUM®	High Performance Utility Model
IPPM	Innovation project portfolio management
ISO	International Standards Organisation
IT	Information Technology
ITIL®	Information Technology Infrastructure library
MMI	Marketing Manufacturing Integration
NPD	New product development
NPV	Net present value
OEM	Original equipment manufacturer
PRINCE II®	**Pr**ojects **in** **c**ontrolled **e**nvironments process based project management methodology
ROI	Return on investment
R&D	Research and Development
TOC	Theory of constraints
TOGAF®	The Open Group architecture framework
VOIP	Voice Over Internet Protocol
ZACHMAN®	An enterprise architecture framework is a structured framework for defining and viewing an enterprise.

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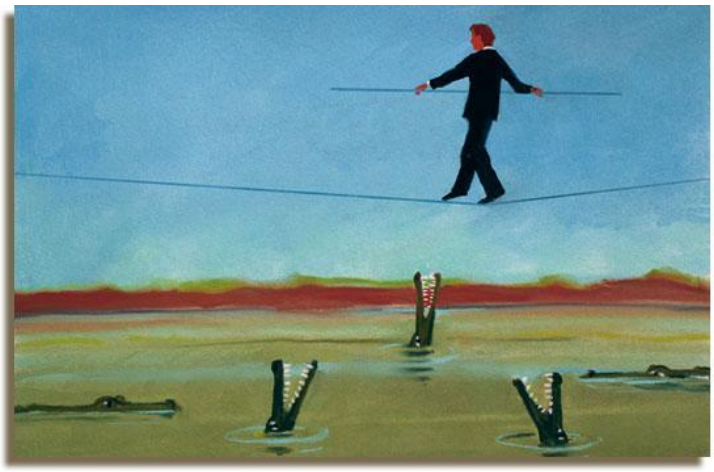
9. ANNEXURE A: QUESTIONNAIRE FOR SURVEY DISTRIBUTION

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Graduate School of Technology Management

Questionnaire

THE EFFECT OF VOLATILE BUSINESS CONDITIONS ON NEW PRODUCT DEVELOPMENT IN THE INFORMATION TECHNOLOGY INDUSTRY



Survey Facilitator:

DJ Janse van Rensburg (Manie): Studying towards PHD at the Graduate School of Technology Management.

Mobile Number: 083 286 3962

Email: djjvrensburg@gmail.com

Supported by:

Professor Leon Pretorius

Graduate School of Technology Management

University of Pretoria

Survey Status:

As part of a PhD study at the Graduate School of Technology of the University of Pretoria, a questionnaire comprising 24 questions is circulated to knowledgeable industry participants. The survey is circulated amongst ICT professionals (Chief Executives, Senior Executives, Managers, Consulting Services Companies, Programme Managers, Project Managers, IT Sales and Marketing Managers) in the IT industry to contribute valuable practical information as to the particular research topic.

The questionnaire should take no longer than 30 minutes to complete. Respondents need to submit the completed questionnaire by 28 February 2013.
Questionnaires are distributed via e-mail and further clarifications may be followed up with telephonic or personal interviews. Any questions may be submitted to Manie Janse van Rensburg at: djjvrensburg@gmail.com.

Respondents are encouraged to distribute the questionnaire in their organisations to senior team members for further possible responses. Respondents' personal, contact, and business details will be treated as strictly confidential.

Once the results have been received, collated and finalised, respondents to the questionnaire will receive a consolidated and interpreted report via e-mail.

Thank you for your valued contribution.
DJ (Manie) Janse van Rensburg
Study Leader: Professor Leon Pretorius from University of Pretoria

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Reference Number:

Questionnaire protection of information

Respondents' personal, contact and business details will be treated as strictly confidential.

.

Contact Information of Respondent:

Name:

Position at business:

Work Telephone Number:

Mobile Number:

Email:

Date questionnaire completed:

Company Details

Company Name:

Company address: **Nature of business:** **Does the business conduct business internationally: Y/N**
Questionnaire Routing: The questionnaire is published on SurveyMonkey and further clarifications may be followed up with telephonic or personal interviews. Respondents are encouraged to distribute the questionnaire in their organisations for further possible responses.

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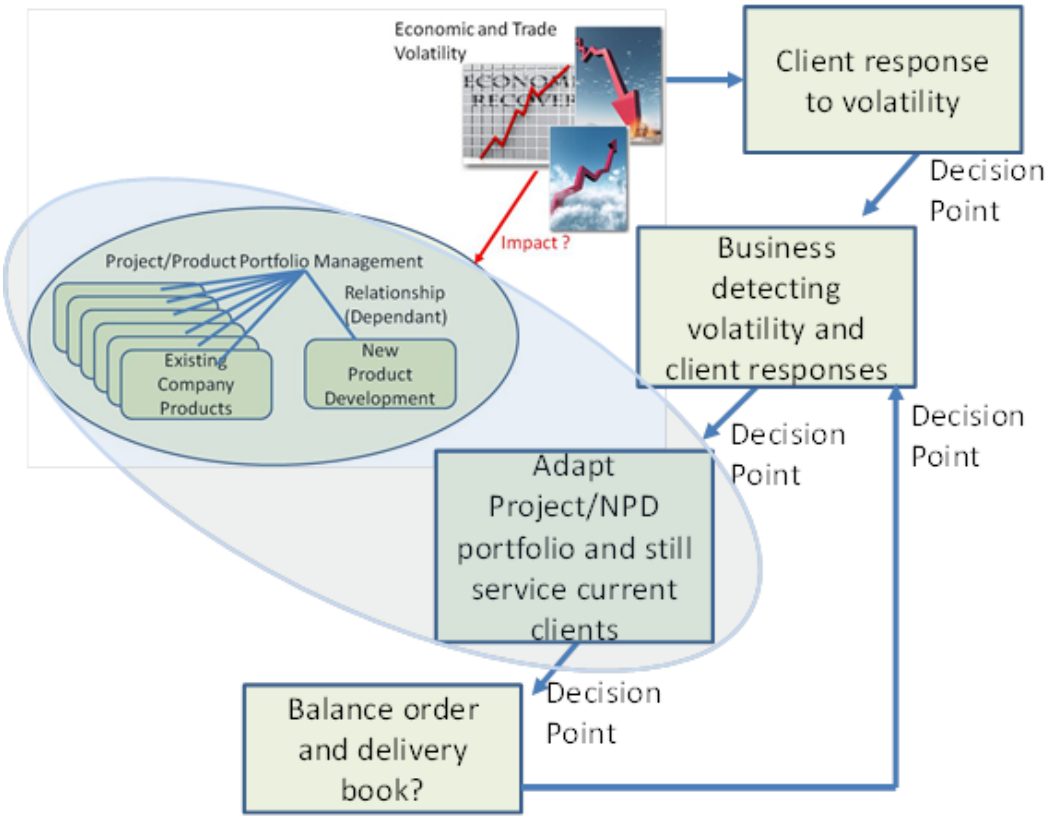
Definitions:



Volatility:

Volatility may be described as variables that change the business environment or shocks that may influence the IT business environment. These shocks may have a positive or negative impact on the ICT business.

Different types of shocks include: interest rates, natural catastrophes, exchange rates, unstable policies (for example BEE charters that are not finalised), the financial sector crisis of 2007-2010, irregular spending of IT clients, irregular governmental IT adoption and spending, weak and expensive communications infrastructure, increased demand for IT skills in a limited skills pool, brain drain, global economic slowdown et cetera.

The fundamental reasons for the research are:

1) IT clients in the formal corporate sector are also in the same business environment as IT businesses and they experience the same shocks as a result of volatility. They change their short - and long- term business strategies as well as requirements for IT systems, products and services.

2) The IT business adapts its business strategy to adopt for the changing economic and trade conditions. Although businesses attempt to understand their industry and technology products they

can potentially not have sufficient detection mechanisms for volatile conditions and respond too late with too little!

3) As business strategy changes it impacts on the project and product portfolio selection. Changes in the output of new product conceptualisation, design, development, production and delivery processes are required in response to changes in project/production portfolio selection. The changed project/product portfolio should be done whilst business operations are executed. Businesses thus need to change and still get current products to clients. The transitional change state requires detailed planning for internal process changes and remains risky.

4) In high technology product/project environments products may already be ordered before they exist. The IT business orders are impacted on by changing economic conditions and this means the business needs to adapt its resource allocation and utilisation. Balancing the product/project order book with the limited organisational resources is a constant risk for businesses. This study reviews mechanisms businesses use to balance the order book and delivery schedule in light of increasing changes in economic conditions.

The importance of the business decisions in response to volatility reside in:

1) Understanding what IT customers do when volatile conditions impact on their operations.

2) Understanding how businesses sense the volatility and create an urgent demand for change internally.

3) Understanding if business takes a structured approach to work with and adjust to the impact volatility has on the business: how is risk managed to ensure maximum business value with acceptable levels of technology, project and product development investment?

4) Understand what businesses need to do to balance their order and delivery books when the results of volatile conditions hit the business.

Questionnaire procedure

A scale for answer selection has been provided. One response per question is required.

A general commentary area is provided for further clarification of answer given

Select one option per question.

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<table>
<tr><th>Question number</th><th>Question</th><th>Rating scale for response</th></tr>
<tr><td>1</td><td>Do IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term?</td><td><table><tr><td>No Impact</td><td></td></tr><tr><td>Low Impact</td><td></td></tr><tr><td>Medium Impact</td><td></td></tr><tr><td>High Impact</td><td></td></tr><tr><td>Very High Impact</td><td></td></tr></table>Comment:</td></tr>
<tr><td>2</td><td>a) What is the level of impact on the adoption/procurement of new IT technology in negatively conducive volatile periods?</td><td><table><tr><td>Clients adopt/ procure much less IT projects/products</td><td></td></tr><tr><td>Clients adopt/ procure somewhat less IT projects/products</td><td></td></tr><tr><td>Clients adopt/ procure the same level IT projects/products</td><td></td></tr><tr><td>Clients adopt/ procure somewhat more IT projects/products</td><td></td></tr><tr><td>Clients adopt/ procure significantly more IT projects/products</td><td></td></tr></table>Comment:</td></tr>
</table>

<table>
<tr><th>Question number</th><th>Question</th><th>Rating scale for response</th></tr>
<tr><td>3</td><td>b) What is the level of impact on the adoption/procurement of new IT technology in positively conducive volatile periods?</td><td>
<table>
<tr><td>Clients adopt/ procure much less IT projects/products</td><td></td></tr>
<tr><td>Clients adopt/ procure somewhat less IT projects/products</td><td></td></tr>
<tr><td>Clients adopt/ procure the same level IT projects/products</td><td></td></tr>
<tr><td>Clients adopt/ procure somewhat more IT projects/products</td><td></td></tr>
<tr><td>Clients adopt/ procure significantly more IT projects/products</td><td></td></tr>
</table>
Comment:
</td></tr>
<tr><td>4</td><td>Does a clearer understanding of customer requirements during periods of volatility assist in growing project portfolio and supporting product development?</td><td>
<table>
<tr><td>No Impact</td><td></td></tr>
<tr><td>Low Impact</td><td></td></tr>
<tr><td>Medium Impact</td><td></td></tr>
<tr><td>High Impact</td><td></td></tr>
<tr><td>Very High Impact</td><td></td></tr>
</table>
Comment:
</td></tr>
</table>

<table>
<tr><th>Question number</th><th>Question</th><th>Rating scale for response</th></tr>
<tr><td></td><td></td><td>List and discuss what techniques are used to obtain customer requirements.</td></tr>
<tr><td>5</td><td>Does an understanding of the impact of volatility on customer operations assist in growing IT business, project portfolio and supporting product development?</td><td><table><tr><td>No Impact</td><td></td></tr><tr><td>Low Impact</td><td></td></tr><tr><td>Medium Impact</td><td></td></tr><tr><td>High Impact</td><td></td></tr><tr><td>Very High Impact</td><td></td></tr></table>Comment:

List and discuss what type of operational impact customers experience as a result of volatility?</td></tr>
<tr><td>6</td><td>Does one-on-one interaction with clients during periods of volatility assist in growing project portfolio and supporting product development?</td><td><table><tr><td>No Impact</td><td></td></tr><tr><td>Low Impact</td><td></td></tr><tr><td>Medium Impact</td><td></td></tr><tr><td>High Impact</td><td></td></tr><tr><td>Very High Impact</td><td></td></tr></table>Comment:</td></tr>
</table>

<table>
<tr><th>Question number</th><th>Question</th><th>Rating scale for response</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>7</td><td>Has client response to volatility impacted on IT business project development and supporting product development?</td><td><table><tr><td>No Impact</td><td></td></tr><tr><td>Low Impact</td><td></td></tr><tr><td>Medium Impact</td><td></td></tr><tr><td>High Impact</td><td></td></tr><tr><td>Very High Impact</td><td></td></tr></table>
Comment:</td></tr>
<tr><td>8</td><td>The combined impact of an understanding of customer requirements, impact of volatility on customer operations and one-on- one interaction have a <u>more</u> positive impact on growing IT projects and supporting product development during the presence of volatility.</td><td><table><tr><td>Strongly disagree</td><td></td></tr><tr><td>Disagree somewhat</td><td></td></tr><tr><td>Neutral</td><td></td></tr><tr><td>Agree somewhat</td><td></td></tr><tr><td>Strongly disagree</td><td></td></tr></table>
Comment:</td></tr>
<tr><td>9</td><td>Does IT Business gather market intelligence for shorter or longer term strategy changes during periods of volatility?</td><td><table><tr><td>Shorter Term IT changes</td><td></td></tr><tr><td>Longer term IT changes</td><td></td></tr><tr><td>Both short and longer It term changes</td><td></td></tr></table></td></tr>
</table>

Question number	Question	Rating scale for response
		Remain with original IT planning in support of business changes irrespective of short and longer term. ☐ ☐ Comment: List techniques used to gather market intelligence of clients that lead to IT business strategy changes • • • •
10	Do businesses increase their collection of market intelligence during periods of volatility?	No Increase ☐ Low Increase ☐ Medium Increase ☐ High Increase ☐ Very high Increase ☐ Comment:
11	Businesses adapt their IT business /IT strategy during periods of volatility based on market intelligence for short-term	Strongly disagree ☐ Disagree somewhat ☐

<table>
<tr><th>Question number</th><th>Question</th><th>Rating scale for response</th></tr>
<tr><td></td><td>benefit.</td><td><table><tr><td>Neutral</td><td></td></tr><tr><td>Agree somewhat</td><td></td></tr><tr><td>Strongly disagree</td><td></td></tr></table>
Comment:</td></tr>
<tr><td>12</td><td>To what extent do IT businesses adapt their short-term technology strategy to induce business value growth as a result of using market intelligence of volatility?</td><td><table><tr><td>No Changes</td><td></td></tr><tr><td>Minimal Changes</td><td></td></tr><tr><td>Medium Changes</td><td></td></tr><tr><td>High amount of changes</td><td></td></tr><tr><td>Very high levels of changes</td><td></td></tr></table>
Comment:</td></tr>
<tr><td>13</td><td>When the IT business/technology strategy is adapted for volatile reasons, are major adaptations required in the project portfolio and supporting product development?</td><td><table><tr><td>No Changes</td><td></td></tr><tr><td>Minimal Changes</td><td></td></tr><tr><td>Medium Changes</td><td></td></tr><tr><td>High amount of changes</td><td></td></tr><tr><td>Very high levels of changes</td><td></td></tr></table>
Comment:</td></tr>
</table>

Question number	Question	Rating scale for response
14	What is the resulting impact these market intelligence mechanisms have on technology strategy (in terms of project and product development in the short vs. longer term)?	<table><tr><td>No Impact</td><td></td></tr><tr><td>Low Impact</td><td></td></tr><tr><td>Medium Impact</td><td></td></tr><tr><td>High Impact</td><td></td></tr><tr><td>Very High Impact</td><td></td></tr></table> Comment:
15	Is the selection of sellable products to be developed by IT business of more importance during volatile periods?	<table><tr><td>Not important</td><td></td></tr><tr><td>Low importance</td><td></td></tr><tr><td>Medium importance</td><td></td></tr><tr><td>High importance</td><td></td></tr><tr><td>Very high importance</td><td></td></tr></table> Comment:
16	Is the selection of projects for the IT business as offered by clients to execute of more importance during volatile periods than non-volatile periods?	<table><tr><td>Not important</td><td></td></tr><tr><td>Low importance</td><td></td></tr><tr><td>Medium importance</td><td></td></tr><tr><td>High importance</td><td></td></tr><tr><td>Very high importance</td><td></td></tr></table> Comment:

Question number	Question	Rating scale for response
17	Do IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects?	No ☐ Yes ☐ Comment:
17A	Is the formulation of the right product portfolio in support of potential projects to clients more critical during periods of volatility than in periods of less volatility?	No ☐ Yes ☐ Comment: List mechanisms used by IT business's to adapt project/product portfolio changes in scope/timing/features and still maintain the ability to deliver projects to clients. • • • • •
18	Do IT businesses succeed in their ability to deliver projects on time, with agreed scope and budget	No ☐

Question number	Question	Rating scale for response
	during periods of volatility?	Sometimes ☐ Yes ☐
19	Is there increased risk in product development as a result of changes in project execution for clients when volatility is present?	Not Risk ☐ Low Risk ☐ Medium Risk ☐ High Risk ☐ Very high Risk ☐ Comment: List mechanisms used by IT businesses to balance project and product development • • • • •
20	Do IT businesses increase focus in capacity planning for project execution during volatile periods?	Not important ☐ Low importance ☐ Medium importance ☐ High importance ☐ Very high importance ☐ Comment: List common mechanisms used for project capacity planning in IT business.

Question number	Question	Rating scale for response
		• • • • •
21	Is there an increased focus in capacity planning and product portfolio changes (to reduce risk) to support project deliveries during periods of economic/trade volatility?	<table><tr><td>No</td><td></td></tr><tr><td>Yes</td><td></td></tr></table> Comment:
22	How important is it for IT businesses to increase focus on their order book as a result of volatility?	<table><tr><td>Not important</td><td></td></tr><tr><td>Low importance</td><td></td></tr><tr><td>Medium importance</td><td></td></tr><tr><td>High importance</td><td></td></tr><tr><td>Very high importance</td><td></td></tr></table> Comment:
23	Do IT businesses increase focus on delivery of projects successfully as a result of volatility?	<table><tr><td>Not important</td><td></td></tr><tr><td>Low importance</td><td></td></tr><tr><td>Medium importance</td><td></td></tr><tr><td>High importance</td><td></td></tr><tr><td>Very high importance</td><td></td></tr></table> Comment:

Question number	Question	Rating scale for response
24	Do IT businesses balance their order intake with ability to deliver focused work during periods of volatility more than in stable periods of trade?	<table><tr><td>No</td><td></td></tr><tr><td>Yes</td><td></td></tr></table> Comment: What techniques do IT businesses use to execute the: 1) Forecast of order intake? 2) To understand available capacity in the organisation to service orders? 3) Balance the order and delivery book? • • • • • • • • • •

Questionnaire Return:
Completed questionnaires should be returned to:

- djjvrensburg@gmail.com or
- faxed to: 012-421-6241

Respondents need to return the completed answer sheet by 26 February 2013.

Feedback:

- Once the results have been received, collated and finalised, respondents to the questionnaire will received a consolidated and interpreted report via e-mail.
- Further clarification on the results set may also be requested and will be attended asap.
- The final comprehensive study report will be published in 2014 and available from:

  Graduate School of Technology Management
  University of Pretoria
  Email: chantelle.jansevanrensburg@up.ac.za

General Comments and Feedback from respondents:

Thank you for your valued contribution.

Manie Janse van Rensburg
University of Pretoria

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10. ANNEXURE B: THEORY PROPOSITIONS LINKED TO RESEARCH DATA

Four theory propositions defined early in the study should be substantiated and accepted or rejected in support via the research findings. The research goals have already been validated in the main findings in section 6.2.

10.1 THEORY PROPOSITION 1: CHANGING CONSUMER BEHAVIOUR AMIDST VOLATILITY

- Changing IT consumer behaviour plus
- Volatility and its impact on client business plus
- Having detection mechanisms for volatility in IT organisations

predict that:

- IT businesses should respond faster in having both shorter term risk mitigation and longer term vision focused business, project and product strategy to cope with volatility.
- Reduced time to market projects and products is required to stay ahead of competition. Product differentiation factors which are of value for businesses including specification and price with a clear market penetrating strategy that should be formulated and tracked.
- One-on-one customer communication, relationship building and retention of customers are essential for longer term sustainable business value.

This proposition is related to research question(s):

- Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?
- Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients and volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?

The research findings for quantitative and qualitative data in relation research question 1, 2, 3, 4 are used to substantiate the theory preconditions in Table 112:

Theory pre condition	Research finding
Changing IT consumer behaviour plus	Quantitative data: IT clients adopt/procure **somewhat less** IT projects/products during negatively conducive volatile periods. IT clients adopt/procure **somewhat more** IT projects/products during positively conducive volatile periods. Relevance: Hypothesis A
Volatility and its impact on client business plus	Quantitative data: IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts on their business in the longer term on a **high impact level**. Relevance: Hypothesis A
Having detection mechanisms for volatility in IT organisations	Quantitative data: Business response during volatility is still focused at obtaining market intelligence that can lead to short and longer term strategy changes. Business response during volatility may likely be to increase their collection market intelligence at predominantly a **medium level** (category wise). The high increase categories should, however, not be ignored as respondents did offer diverse opinions. Relevance: Hypotheses B and C

Table 112: Theory 1 precondition substantiation

The research findings for quantitative and qualitative data in relation research question 1, 2, 3, 4 are used to substantiate the theory predictions in Table 113:

Prediction	Research finding
IT businesses should respond faster in having both shorter term risk mitigation and longer term vision focused business, project and product strategy to cope with volatility.	Qualitative data: Time to market products is reduced in general. Quantitative data: Business response during volatility is still focused at obtaining market intelligence that may lead to short and longer term strategy changes. Relevance: Hypothesis B
Reduced time to market projects and products is required to stay ahead of competition. Product differentiation factors which are of value for businesses including specification and price with a clear market penetrating strategy should be formulated and tracked.	Qualitative data: Understanding client operations and impact of volatility may be used to promote project and supporting product features during proposal stage. Customers are seeking return on investment (ROI) improvement during volatile periods with a refocus of IT budgets in support of the ROI optimisation. The already defined product suite can be optimised and stage validated to be aligned to client requirements via project-based applications. Client business goals need to translate to requirements to be serviced by the IT businesses with project and product portfolio even more flexible during volatile periods. Relevance: Hypothesis B
One-on-one customer communication, relationship building and retention of customers are essential for longer term sustainable business value.	Qualitative data: Knowing the customers and their requirements during volatile periods implies the IT business portfolio of projects and products should lead to a customer-centric culture and systems base. Communications and mutual understanding between IT client and IT business is a prerequisite for expectation management leading to successful project and product development.

Prediction	Research finding
	Relevance: Hypothesis B

Table 113: Theory 1 prediction substantiation

Thus support for the theory: "Theory proposition 1: Changing consumer behaviour amidst volatility" is provided via the research findings.

10.2 THEORY PROPOSITION 2: VOLATILITY IMPACT ON PROJECT / PRODUCT DEVELOPMENT

- Endogenous volatility factors for example poor IT infrastructure outside urban areas, irregular IT spending on the part of government and businesses, skills shortages, evolving BEE laws plus:
- Stage gated project and product development practices in use in IT organisations plus
- The availability of qualified, experienced and committed IT development personnel plus
- A focus on IT organisational process maturity and quality focus

predict that:

- IT business leadership and technical product managers should anticipate business cycle changes and adapt product development strategies accordingly on a more focused basis using industry proven techniques.
- A robust, mature and quality driven IT project and product development process aids product success substantially more than merely high R&D budgets. Industry proven techniques aid IT organisations in resource planning and balancing as well as process-driven project executions.
- Product, project and product development strategists should adjust their portfolios in anticipation of volatility and work with the volatility impact once the result of volatility presents itself.

This proposition is related to research question(s):

- Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client response as a result of volatility shock have on IT business project portfolio and new product development?
- Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?

- Research question 6 and 7: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

The research findings for quantitative and qualitative data in relation research question 5, 6, 7 are used to substantiate the theory preconditions in Table 114:

Theory pre condition	**Research finding**
Endogenous volatility factors for example poor IT infrastructure outside urban areas, irregular IT spending from government and businesses, skills shortages, evolving BEE laws plus	Quantitative data: IT clients experience volatility as a result of interest rates, commodity process skills shortage in their business environment which impacts their business in the longer term on a high impact level. Qualitative data: Skills shortage was listed as a significant factor. External recruitment of personnel remains under pressure with lower than expected availability of resources in the market. Weak regulatory environment and continuing controversy about the BEE charter (Business Monitor International, 2011). Relevance: Hypothesis A
Stage-gated project and product development practices in use in IT organisations plus	Qualitative data: Customers are seeking return on investment (ROI) improvement during volatile periods with a refocus of IT budgets in support of the ROI optimisation. The already defined product suite can be optimised and state validated to be aligned to client requirements via project-based applications. Relevance: Hypothesis B
The availability of qualified, experienced and committed IT development personnel plus	Qualitative data: Skills shortage was listed as a significant factor. External recruitment of personnel remains

Theory pre condition	Research finding
	under pressure with lower than expected availability of resources in the market. Training and up skilling is seen as a risk due to reduce turnover of personnel. According to the respondents, South African companies have a business drive of taking up all possible orders, and then quickly adapt capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then be concerned about execution and volatility is acceptable. Relevance Hypotheses E, F, G
A focus on IT organisational process maturity and quality focus	Quantitative data: The increased focus in capacity planning and product portfolio changes in support of potential projects to clients is **more critical** during periods of volatility than in periods of less volatility. Qualitative data: The increased focus in capacity planning should mitigate risks induced by volatility to the point where maximum quality and output is achievable with the available resources. Relevance Hypothesis F

Table 114: Theory 2 precondition substantiation

The research findings for quantitative and qualitative data in relation research question 5, 6, 7 are used to substantiate the theory predictions in Table 115:

Prediction	Research finding
IT business leadership and technical product managers should anticipate business cycle changes and adapt product development	Quantitative data: Business response during volatility is to increase their collection of market intelligence at

Prediction	Research finding
strategies accordingly on a more focused basis using industry proven techniques.	predominantly a medium level (category wise). The high increase categories should. However, not be ignored as respondents did offer wider spreading opinions. Qualitative data: Business use increased market intelligence to plan strategy and increase action for post-volatility cycles of downturn or upturn. Relevance: Hypothesis B/C
A robust, mature and quality-driven IT project and product development process aids product success substantially more than merely high R&D budgets. Industry-proven techniques aid IT organisations in resource planning and balancing as well as process-driven project executions.	Quantitative data: IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects. Qualitative data: Many IT businesses utilise best practise industry frameworks like TOGAF®, PRINCE II ®, ZACHMAN®, ITIL®, COBIT® and Industry frameworks like eTOM®, EMMMV®, HPUM® for capacity planning and process maturity assessments. Relevance: Hypothesis E
Product, project and product development strategists should adjust their portfolios in anticipation of volatility and work with the volatility impact once the result of volatility presents itself.	Quantitative data: IT businesses adapt their short-term technology strategy at predominantly medium levels as a result of market intelligence indicating the presence of volatility in the business environment. Change in the business/technology strategy as a result of volatility leads to medium level changes in the project portfolio and product development. Market intelligence indicating customer operational IT/business changes, requires potential short-term changes in own IT

Prediction	Research finding
	project/products. This is done to improve delivery of services, communications and engagement. The medium changes in the portfolio are usually split between short-term benefit realisation but still having longer term focus and strategic intent to grow the portfolio. The technology strategy should also be robust to facilitate medium changes in technical scope, cost, time required to mitigate variable changes induced by volatility for example release versions based functional products with interim IT product deliveries. Relevance: Hypotheses D, E, F and G

Table 115: Theory 2 prediction substantiation

Thus support for the theory: "Theory proposition 2: Volatility impact on project / product development" is provided via the research findings.

10.3 THEORY PROPOSITION 3: RISK AND IMPACT OF VOLATILE CONDITIONS

- Establishing only an acceptable risk level profile for the IT organisation to deal with volatility is not enough. The early detection volatility induced risk, response strategy as well as the formulation and tracking of mitigation plans plus
- The impact of volatile conditions on Porters 5 competitive forces impacting IT strategy plus
- A thorough understanding of the IT organisations ability and capacity to execute concurrent project and product development with limited resources plus
- Increased communications, career development and focus on high-quality key value contributing personnel

predicts that

- IT businesses will not limit order intake but will rather post order create capacity to deal with delivery constraints. This implies gearing and building IT organisations to a next level of resources, people and financial controls to be able to fulfil order book commitments.

- IT business risk must be formally managed to ensure sustained business and technical operations during volatility.
- IT businesses' ability to deliver acceptable quality of products and projects the first time is a critical element of success since reworking can raise risk beyond acceptable levels for the business.
- IT businesses experience constant challenges in retaining a pool of skilled, qualified and committed personnel during project and product development. The impact of exogenous and endogenous volatile conditions may impact employees' personal priorities significantly.

This proposition is related to research question(s):

- Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?
- Research question 6 and 7: How do businesses adapt their IT project with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

The research findings for quantitative and qualitative data in relation research question 5, 6, 7 are used to substantiate the theory pre conditions in Table 116:

Theory pre condition	**Research finding**
Establishing an acceptable risk level profile alone for the IT organisation to deal with volatility is not enough. The early detection volatility induced risk, response strategy as well as the formulation and tracking of mitigation plans plus	Detecting volatility by means of market intelligence forms the basis of Hypothesis C but market intelligence is not the only way to detect volatility i.e. news media, clients' information , and so forth. Quantitative data: Business response during volatility is still focused at obtaining market intelligence that can lead to short and longer term strategy changes. Qualitative data: Businesses use increased market intelligence to plan strategy and increase action for post-volatility cycles of downturn or upturn. The scope changes, risk/mitigation plans, unforeseen delays and budgets should be

Theory pre condition	Research finding
	managed under proper project management principles with stakeholders (both internal and external). Reference: Hypotheses C and F
The impact of volatile conditions on Porters 5 competitive forces impacting IT strategy plus  	Qualitative data: IT businesses often make use of external IT businesses to provide products or services in their own project / product portfolio. Furthermore, the nature of IT products is a higher turnover of products for new technology replacements; hence substitute products are always a threat which market intelligence need to highlight. IT project/product portfolio is typically more upgraded during these positive volatile periods to be current and competitive. Well-defined business cases for IT projects are subject to volatile conditions but may still grow the project/product portfolio if the focus is retained to realise promised value from executing the business case (price vs. quality vs. competitive advantage). Be in close contact with customers where relationship can expose key product attributes required for the existing and new products. This should focus limited budgets at re-usable, key client requirements and a competitive edge to be implemented into product development during volatile periods. Reference: Hypotheses A, B, D, E and G
A thorough understanding of the IT organisations ability and capacity to execute concurrent project and product development with limited resources plus	Qualitative data: IT businesses have mature processes in place for planning what organisational capacity (people, infrastructure, financial resources) is required to execute projects. Larger businesses with more formal processes

Theory pre condition	Research finding
	tend to have more formal capacity planning since they execute more project and product developments with large but limited teams of people and resources. Smaller IT businesses tend to scope capacity on a per project basis only with little excess capacity or overhead plans. Budget constraints have a significant impact on capacity planning since the ideal available resources may often not fit into the budget. Capacity planning functions around people, infrastructure, resources, budgets and client expectations. For maximum value the focus must ensure near full utilisation of the listed functions and client communication updates to ensure maximum value add and risk mitigation. Capacity should be retained for short-term risk mitigation as well. The increased focus in capacity planning should mitigate risks induced by volatility to the point where maximum quality and output is achievable with the available resources. Reference: Hypotheses E and F
Increased communications, career development and focus on high quality key value contributing personnel	Qualitative data: Product functional specialising developers must be retained with human resource management intervention to ensure personal growth and career initiatives since training new developers will place lengthy delays on development. Reference: Hypothesis F

Table 116: Theory 3 precondition substantiation including Porter five forces model

The research findings for quantitative and qualitative data in relation research question 5, 6, 7 are used to substantiate the theory predictions in Table 117:

Prediction	Research finding
IT businesses will not limit order intake but will rather post order create capacity to deal with delivery constraints. This implies gearing and building IT organisations to a next level of resources, people and financial control to be able to fulfil order book commitments.	Qualitative data: According to respondents, South African companies have a business drive of taking up all possible orders, and then quickly adapting capacity (resources, personnel, infrastructure|) to fulfil execution to balance the order book or lose some projects later as a result of client cut backs. The attitude of first get the business then only be concerned about execution of fulfilment and volatility is acceptable! Orders are not invoices: Many businesses non-sales management, realise that an order for a project does require the ability to deliver on the order quicker during volatile periods. In this area there is risk as the visibility of order intake vs. fulfilment lacks in project personnel teams. Reference: Hypothesis G
IT business risk must be formally managed to ensure sustained business and technical operations during volatility.	Qualitative data: During negative volatile periods clients will slow down or halt higher risk IT projects. The IT business should realise this can happen and proactively seek concurrent business with more customers to ensure project/product portfolio is not stagnated when projects are halted. Business utilise market intelligence as part of formal risk plans for time periods immediate, one year or three years or five years. The technology strategy should be adaptable with medium level changes for being able to successfully fulfil many small orders (contracts) to make up large amounts. If a repeatable project/product solution can be delivered at low technical risk and low non-recurring engineering cost, profit may quickly be realised. Training and up skilling is seen as a risk due to turnover of personnel.

Prediction	Research finding
	Quicker turnover and hand-over of projects during volatile periods to customers as a result of successful capacity planning leads to reduced risk for the IT business as well as increased profit margins. Quantitative data: There is medium to high increased risk in product development as a result of changes in project execution for clients when volatility is present. References: Hypotheses B, C and F
IT businesses' ability to deliver acceptable quality of products and projects the first time is a critical element of success since reworking may raise risk beyond acceptable levels for the business.	Qualitative data: There is an increased focus in the delivery of projects to ensure timing, scope, quality and budget expectations are met. During volatility IT business still need to do what they do best and ensure the solutions are delivered faster, working and meeting client expectations. Successful projects very often lead to more work for the same IT business hence during volatile periods with fewer projects this is even more important. Failure on first delivery will reduce the probability of follow-up work for the IT business with the same customer. Quicker turnover and hand-over of projects during volatile periods to customers as a result of successful capacity planning leads to reduced risk for the IT business as well as increased profit margins. Reference: Hypothesis G
IT businesses experience constant challenges in retaining a pool of skilled, qualified and	Qualitative data: Product functional specialised developers

Prediction	Research finding
committed personnel during project and product development. The impact of exogenous and endogenous volatile conditions may impact on employees' personal priorities significantly.	should be retained with human resource management intervention to ensure personal growth and career initiatives since training new developers will place lengthy delays on development. Reference: Hypothesis F

Table 117: Theory 3 prediction substantiation

Thus support for the theory: “Theory proposition 3: Risk and impact of volatile conditions” is provided via the research findings.

10.4 THEORY PROPOSITION 4: VOLATILITY AND NEW TECHNOLOGICAL PRODUCTS IN THE IT MARKET OR INDUSTRY

- New IT technological products are introduced into the market and business managers realise the value of these IT products in business execution plus
- Increased focus on lower cost and easy connectivity of users plus
- Cyclical business conditions amidst volatility plus
- Users of IT products are shifting focus to online web hosted IT services and potentially in favour of less product purchasing. Shifting user focus/requirements is becoming a more important contributor in IT industry strategy formulation

Predict that:

- IT businesses need to provide new projects and products constantly into the market since the competition will not stop product introductions into the market even when volatility is present or IT business market cycles change.
- A closer participation of end users in project and product portfolio formulation as well as a clearer constant tracking of IT market trends can assist project and product portfolio managers in creating products that have potentially higher demand in the market.
- New technological trends in inexpensive connectivity, portable communication devices such as tablets and social media services are becoming prevalent in the IT industry. The provision of IT as services and not products will impact IT business strategies significantly in future as businesses buy more services to aid in business process execution.

This proposition is related to research question(s):

- Research question 1 & 2: How do IT clients respond during periods of trade volatility with the adoption/procurement of new technology? What impact does the resulting client

response as a result of volatility shock have on IT business project portfolio and new product development?

- Research question 3 and 4: Do IT businesses change their IT business/technical strategy for shorter or longer term benefit during periods of volatility with the market intelligence gathered from clients and volatility detection mechanisms? What is the resulting impact these market intelligence mechanisms have on IT business strategy in terms of project and product development changes/operations in the short vs. longer term when volatility is present?
- Research question 5: How do businesses balance their internal capabilities for IT project portfolio changes with new product development in conditions of economic / trade volatility?
- Research question 6 and 7: How do businesses adapt their IT projects with resulting product portfolio selection and still maintain product delivery to clients during volatile conditions? How do IT businesses balance the order and delivery books during periods of volatility?

The research findings for quantitative and qualitative data in relation research question 1, 2, 3, 4, 5, 6, 7 are used to substantiate the theory preconditions in Table 118:

Theory pre condition	**Research finding**
New IT technological products are introduced into the market and business managers realise the value of these IT products in business execution plus	Qualitative data: New requirements from the market for innovative IT products (like mobile portable IT devices) are discussed with clients, refined for their processes and this may likely realise in new innovative IT applications. Together IT businesses and clients unlock competitive opportunities. IT clients also need to provide service and satisfy their clients' needs. The interaction capabilities of new technologies like social media, e-mail, Voiceover Over Internet Protocol (VOIP) products unlock opportunities to link back end systems with client interaction. This can grow the IT project/product portfolio irrespective of volatility. New market-required technology will alter the business strategy with medium level changes in technology strategy and subsequent development in the projects as well as supported products.

Theory pre condition	Research finding
	New market-required technologies in the market require IT clients to upgrade product/projects even when negative volatility is present since they must remain efficient in delivery of their products and services. Reference : Hypotheses A, B and D
Increased focus on lower cost and easy connectivity of users plus	Qualitative Data: A proactive product management/planning (with commercial and sales skill) function should ensure the products have features, functions and price to be able to be sold in volatile/non-volatile environments. Proactive marketing to work closely with existing customers, potential customers and industry ensures that product launches are done at the right price, right feature level, timing and meet client expectations. During volatile periods clients may buy even less hence the product should be on a par with expectations from the market. The technology strategy should be adaptable with medium level changes for being able to successfully fulfil many small orders (contracts) to make up large amounts. If a repeatable project/product solution can be delivered at low technical risk and low non-recurring engineering cost, profit may be realised more quickly. Reference: Hypotheses D, E and G
Cyclical business conditions amidst volatility plus	Existing literature: Aizeman and Pinto (2005) formulated the theory that economic volatility is more than being the study of business cycles and the composition of economic growth in cyclical and trend components. They postulated that volatility is alligned to risk in that it provides a measure of the variation or movement of a particular variable for

Theory pre condition	Research finding
	example economic variables) or some function of the variable. Aizeman and Pinto (2005) further distinguish between normal volatility and extreme volatility. With extreme volatility being a significant change in an economic variable resulting where the movement exceeds a threshold resulting in economic shock. Normal volatility may be cyclical business conditions or events of lower magnitude where the economy can absorb the changes without severe negative impact.
Users of IT products are shifting focus to online web- hosted IT services and potentially in favour of less product purchasing. Shifting user focus/requirements are becoming a more important contributor in IT industry strategy formulation	Qualitative data : IT industry refocuses as a result major technology shifts like mobile IT products for users. These shifts may likely motivate more funding from clients as well during periods of positive volatility. Clients are shifting focus to high ROI IT projects/product which can induce cost savings. Market intelligence indicating customer operational IT/business changes, requires potential short-term changes in own IT project/products. This is done to improve delivery of services, communications and engagement. Reference: Hypotheses A, B and C

Table 118: Theory 4 precondition substantiation

The research findings for quantitative and qualitative data in relation to research questions 1, 2, 3, 4, 5, 6, 7 are used to substantiate the theory predictions in Table 119:

Prediction	Research finding
IT businesses needs to provide constant new projects and products into the market since the competition will not stop product introductions into the market even when volatility is present or IT business market cycles change.	Quantitative data: The selection of sellable products to be developed by IT business is of higher importance during volatile periods Qualitative data: Technology strategy must not only follow business strategy but unlock new business

Prediction	Research finding
	value with a short- and long-term focus. Accelerate changes planned into technical strategy into the portfolio not to miss new opportunities. Slow reaction speed in IT means lost opportunities. Be in close contact with customers where relationship can expose key product attributes required for the existing and new products. This should focus limited budgets at re-usable, key client requirements and provide a competitive edge to be implemented into product development during volatile periods. New market required technology will alter the business strategy leading with medium level changes in technology strategy and subsequent development in the project and supported products. Reference: Hypotheses D and E
A closer participation of end users in project and product portfolio formulation as well as a clearer constant tracking of IT market trends can assist project and product portfolio managers in creating products that have potentially higher demand in the market.	Quantitative data: Having a clearer understanding of IT client requirements has a high impact on assisting in growing the project portfolio and supporting product development. Having a clearer understanding of the impact volatility has on client operations have a high impact on assisting in growing the project portfolio and supporting product development. Having one-on-one interaction with clients has a high impact on growing the IT project and supporting product development during periods of volatility. Qualitative data: IT business should be focused on client-centric innovation and delivering growth-focused products/projects and not purely at integration of systems which increase running costs for the

Prediction	Research finding
	client. Customers are seeking return on investment (ROI|) improvement during volatile periods with a refocus of IT budgets in support of the ROI optimisation. The already defined product suite can be optimised and stage validated to be aligned to client requirements via project based applications. Communications and mutual understanding between IT client and IT business is a prerequisite for expectation management leading to successful project and product development. New requirements from the market for innovative IT products (like mobile portable IT devices) are discussed with clients, refined for their processes and this may likely realise in new innovative IT applications. Together IT business and clients unlock competitive opportunities. Know your customer, know your product, know your market and know competitive pricing for a suitable IT projects/products portfolio. Reference: Hypothesis B:
New technological trends in inexpensive connectivity, portable communication devices such as tablets and social media services are becoming prevalent in the IT industry. The provisions of IT as services and not products will impact on IT business strategies significantly in future as businesses buy more services to aid in business process execution.	Qualitative data: New requirements from the market for innovative IT products (like mobile portable IT devices) are discussed with clients, refined for their processes and this may likely realise in new innovative IT applications. Together IT business and clients unlock competitive opportunities. IT clients also need to provide service and satisfy their clients' needs. The interaction capabilities new technologies like social media, e-mail, Voiceover Internet Protocol (VOIP) products unlock opportunities to link back end-

Prediction	Research finding
	systems with client interaction. This has the potential to grow IT project/product portfolio irrespective of volatility. Reference: Hypothesis B

Table 119: Theory 4 prediction substantiation

Thus support for the theory: “Theory proposition 4: Volatility and new technological products in the IT market or industry” is provided via the research findings.

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