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# The nature of alignment/fit between business strategy and maintenance strategy in industries in South Africa.

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

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# ABSTRACT

Maintenance has traditionally been viewed as an unavoidable part of the manufacturing function. It is often identified as an opportunity to wantonly reduce costs, whenever the need to reduce manufacturing cost arises. Its potential to contribute to an organisation's competitive advantage and business sustainability, has not received significant attention, and consequently formulation and execution of maintenance strategies have been poor, inconsistent or unfocused. Alignment of business strategy and maintenance strategy should help an organization to achieve or improve upon its business performance. Likewise, maintenance performance measures should be linked to an organization's strategy, in order to provide useful information for making effective decisions. This fit or alignment, can only be achieved when maintenance is viewed as a critical business function, integrated with other business functions in support of business strategy.

The impact of alignment between maintenance strategy and business strategy - on business strategy - is studied empirically in this thesis. The results confirm  that alignment between maintenance and business strategy is strongly positively correlated with business performance.

# 1 Keywords

Alignment, maintenance strategy, business strategy, defenders, prospectors, analysers

## 2 Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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**Nevushoma Sununguko Mateko** **Date**

## 3 Acknowledgements

For my children, Tatenda and Tanyaradzwa for enduring the time, and to Almighty God for guiding me through.

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# CHAPTER 1

# INTRODUCTION

## 1. Background – maintenance, unavoidable evil or strategic lever

Maintenance is a critical part of an asset's lifecycle and its importance in industry is a well researched subject. It has been viewed as an inevitable source of cost (Bamber, Hides & Sharp, 1999), source of competitive advantage and part of manufacturing overhead (Pinjala, Pintelton, & Vereecke, 2005) and the largest single manageable expenditure in the plant (Jabar, 2003). All these views point to maintenance being a critical part of an organisation's business which should be directly linked to the overall strategy. It has been argued that maintenance costs can form as high as 25% of manufacturing costs (Jabar, 2003). This supports the assertion that a good maintenance strategy, properly formulated and executed, can be a source of competitive advantage.

Today's typical industry is characterized by huge capital investments in assets (Tsang, 1998), increased sophistication of assets and drives to achieve even higher returns on investments (Coetzee, 1999). Typical maintenance functions are largely driven by simple generic goals like maximizing uptime by reducing reactive maintenance, reducing costs and adopting world class third generation strategies like Reliability Centred Maintenance (RCM) and Total Productive Maintenance (TPM). According to Tsang (1998), maintenance is usually a prime target for cost reduction because it is viewed just as an unavoidable expense. This is further evidenced by the now frequent appearance of the "best cost producer" (Gonzalez, 2008) clause in most mature industrial companies' mission statements and strategies.

This view of maintenance has resulted in increased pressure on maintenance expenditure, directly impacting effective execution of maintenance strategies. It has also left maintenance departments losing the battle to reduce reactive maintenance, which often claims as much as 80% of maintenance resources (budget, man hours) (Gonzalez, 2008). Maintenance expenses are seen as largely fixed, with an insignificant variable portion; hence every cent saved reports directly to the bottom line, or reduces product unit costs without reducing total production volumes. This view is obviously short-sighted, and wanton reduction of maintenance costs sacrifices future production efficiencies, often resulting in large, unplanned and unbudgeted expenses when equipment breaks down.

## 2. The cost of breakdowns

The cost of unplanned equipment failures should not only be viewed through low availabilities. Unplanned breakdowns result in low production volumes, therefore high production cost per unit as fixed costs (overheads) are not reduced in proportion to lower running hours. Other costs include warm-up times (energy consumption, low production volume, poor product quality and poor raw material usage) and low production as the process rumps up to optimum production levels.

## 3. The need for maintenance strategies

Several researches have been published on the need for maintenance strategies and world class or modern generation strategies. In his research Norden (2003) found that it was critical for South African coal mines to adopt maintenance strategies to enhance equipment productivity. Observations in industries however show that maintenance strategies are non-existent in most plants and where they have been formulated, they are poorly executed and reactive maintenance carries the day. Some of the factors blamed for such a situation include lack of resources (skills and budget), poor understanding of maintenance strategies, too little maintenance training, maintenance strategies poorly aligned to business strategies and failure to justify the need to improve practices and processes (Gonzalez, 2008).

The scenario described above explains why companies have failed to derive cost advantage through their maintenance strategies, or more precisely, why maintenance strategies have failed to contribute to competitive advantage and business sustainability. Implementation of world class maintenance strategies and systems alone has failed to enable companies to compete competitively on cost. This research aims to explore maintenance strategy design and execution in the South African mining, mineral processing and manufacturing industries with a view to draw insights on the alignment of maintenance strategies to business strategies. The assertion that aligning maintenance strategies to business strategies enables maintenance to contribute to competitive advantage and business sustainability is tested at an empirical level. The research also aims to expose underlying factors causing poor strategy design and execution.

## 4. Strategy

### *4.1 Business Strategy*

Johnson, Scholes and Whittington (2008) define strategy as the direction and scope of an organization over the long term, which matches its resources to its changing environment and in particular its markets and customers, so as to meet stakeholder expectations. Strategy exists at three main levels in an organization – corporate, business and functional. Corporate strategy is the pattern of decisions in a company that determines and reveals its objectives and goals, produces the principal policies and plans for achieving those goals, and defines the range of business the company is to pursue, the kind of economic and human organization it is or intends to be, and the nature of economic and non-economic contribution it intends to make to its shareholders, employees, customers and communities (Andrew, 2003). Business level strategy is mainly concerned with competing with others in the products and services that should be offered in the markets defined at the corporate level (Greasley, 2009). At the functional level, functions of the business are tasked with crafting strategies that support and reinforce the competitive advantage set out in the business strategy. Maintenance strategies are functional strategies, hence they need to contribute to the company's competitiveness as defined in the business strategy. Greasly (2009) identifies quality, speed, dependability, flexibility and cost as the five basic performance objectives for operations strategy. Generic corporate strategies adopted by organisations include cost, diversification and growth. Such generic strategies will not, by themselves, give a company competitive advantage. Likewise, the implementation of world class maintenance systems like Reliability Centred Maintenance (RCM), Total Productive Maintenance (TPM) and Six Sigma Maintenance (SSM), Computerised Maintenance Management System (CMMS) will not translate into competitive advantage from maintenance. Like other generic strategies given above, they can easily be duplicated by any company at minimal cost.

### *4.2 Maintenance Strategy*

The need for companies to formulate and execute appropriate maintenance strategies to increase the productivity of maintenance, often defined by such metrics as cost, plant availability and overall equipment effectiveness, is a well researched subject. However, it appears that lack of consistency and clarity between maintenance strategy, function, philosophy, methodologies, principles, etc. has led to confusion on what really constitutes maintenance strategy and at what level should it be formulated and executed.

Most researchers classify preventive maintenance, breakdown maintenance and condition-based maintenance as types of maintenance strategies (Cooke, 2003; Swanson, 2001; Jabar 2003). Such classification only focuses on a few elements that make up maintenance strategy. Pintelon & Pinjala (2006) argue that maintenance should be defined at a functional hierarchy level similar to manufacturing, and the above elements are defined as maintenance philosophies, not strategies. Maintenance philosophies should then be applied, in the right mix with other maintenance strategy elements, in defining a maintenance strategy.

## 5. Alignment

According to Porter (1996), strategy involves creating "fit" among a company's activities, where fit defines the way a company's activities interact and reinforce each other to drive both competitive advantage and sustainability. He argues that alignment between a company's functional and business strategies becomes a source of competitive advantage and sustainability because it is difficult to imitate, and it creates a "*strong chain which is as strong as its strongest link*". This research aims to explore the nature of fit between maintenance strategy, which has been defined as a functional strategy, and business strategy and the effect of such alignment on business performance.

## 6. Research Objectives

The research aims to:

- Draw insights into the type of maintenance practice mixes (functional maintainance strategies) adopted by companies following different business strategy profiles.
- Determine the level of perception of business strategy at the maintenance practitioner level in business units.
- Investigate the nature of alignment/fit between business strategy and maintenance strategy and the impact of this on performance.
- Understand the nature of relationship between maintenance effectiveness measurement metrics and business strategy types.

# CHAPTER 2

# LITERATURE REVIEW

## 1. Introduction - Maintenance Strategy

As discussed in Chapter 1, literature on maintenance strategy has not clearly and consistently defined the level of maintenance strategy in strategy hierarchies. Consequently, it has failed to differentiate between maintenance strategy, policies and procedures, philosophies and methodologies. These terms are used indiscriminately to refer to different things. Cooke (2003), Swanson (2001), Jabar (2006), Bevilacqua and Braglia (2000) all classify maintenance strategies as either reactive strategy (breakdown maintenance) or proactive strategy (preventive and predictive maintenance). Swanson adds a third strategy type, which he calls aggressive maintenance strategy, characterized by third generation practices like Total Productive Maintenance (TPM) and Reliability Centred Maintenance (RCM). Pinjala, Pintelton & Vereecke (2006), however, define the above as maintenance policies and argue that, as a group, they only form one element of maintenance strategy. They therefore define maintenance strategy at functional hierarchy level, as a:

> "coherent, unifying and integrative pattern of decisions in different maintenance strategy elements in congruence with manufacturing, corporate and business level strategies; (which) determines and reveals the nature of economic and non-economic contributions it intends to make to the organization as a whole".

### *1.1 Maintenance strategy formulation and execution*

It is therefore imperative to define maintenance as a standalone process closely related to manufacturing strategy. Normatively, the strategy formulation process should start on business strategy, then lead on to manufacturing strategy and maintenance strategy in support of the business and manufacturing strategy. Norden (2003) emphasizes the need to identify and monitor a set of relevant maintenance performance metrics, in addition to ensuring that the strategy consists of applicable, coherent building blocks that flow in a logical sequence, reinforcing each other in contributing to competitive advantage and sustainability of the business unit.

In a study of four companies in the United Kingdom, Cooke (2003) found the lack of alignment between maintenance and business strategies as a common problem of formulation of maintenance strategies. Execution was found to be poor, characterised by reactive processes with little planning, high costs with little control, and low levels of awareness of modern third generation maintenance techniques. The primary goal of maintenance strategy formulation should be to support business strategy in achieving competitive advantage and sustainability in identified products and market. Maintenance strategy elements, like business strategy elements, must be derived from goals set by manufacturing and business strategy, trends in plant performance (actual and desired), technological trends and trends in the business environment (service providers, suppliers and contractors, cost of service, legislation and organised labour). The strategy must aim to achieve superior capability to deliver the maintenance service in support of the business strategy.

### *1.2 Reasons for failures to articulate maintenance strategies*

Several reasons have been cited for failure to formulate and execute maintenance strategies. The lack of alignment between maintenance strategy and business strategy has often led to maintenance strategies relying heavily on history. Strategy formulation involves adding the current wish list to the previous year's document, without any reference to the business strategy and changes in the external and internal environment. This results in misaligned resource allocation, which is detrimental to achievement of business objectives. Gonzalez (2008) ranks other contributing factors as:

- Limited personnel
- Budgetary constraints
- Too busy doing breakdown maintenance
- Management does not understand maintenance strategies
- Too little maintenance training
- Not sure how to quantify gains of improved practices

According to Porter (1996) the drive to achieve superior operational effectiveness has also led managers to vigorously pursue best practices and continuous improvement tools at the expense of strategic alignment. Such tools include benchmarking, outsourcing, aggressive maintenance, etc. While these systems are necessary, they are not sufficient in creating and sustaining a competitive advantage for an organization.

### *1.3 Maintenance strategy elements*

Just as the definition of maintenance strategy in literature is either narrow or confusing, so is the identification of maintenance strategy elements. The effectiveness of maintenance can be known only if one is able to identify a given maintenance strategy. Maintenance strategy should be aligned to manufacturing and business strategy. Alignment and effectiveness are therefore best measured by identifying maintenance strategy elements and matching them to corresponding business strategy elements. Several researchers have attempted to do this. Swanson (2001) identifies reactive, preventive and aggressive strategies as strategy elements, and labels them maintenance strategy types. Tsang (2002) identifies four maintenance strategy elements, and calls them “strategic dimensions”. These are:

- Service delivery options
- Organisation and work structuring
- Maintenance methodology, and
- Support systems.

Most of these are narrow, focusing on only a few of the real elements of modern day maintenance. Subsequently, recent attempts to study maintenance strategy (Pintelon & Pinjala, 2006; Mill *et al*., 2002) have been based on Hayes and Wheelwright’s decision elements of manufacturing strategy. Refer to Table 2.1. Pintelon and Pinjala (2006) argue that, while the decision elements given above were specifically meant for manufacturing, it is worthwhile to consider similar elements for maintenance as a function on its own. They proceeded to derive the decision elements given in Table 2.2, which can, in effect, be referred to as maintenance strategy elements, and can be used as a framework for maintenance strategy development and evaluation. The level of execution of these elements will impact, either negatively or positively, the business's performance in terms of quality, cost and flexibility. Choice of strategic elements should however be done with a view to achieve alignment with business strategy, without solely focusing on improving operational effectiveness (Porter, 1996).

| **Structural decision elements** | |
|---|---|
| Capacity | Production capacity, shift patterns, temporary subcontracting policies. |
| Facilities | Size, location and specialization of resources. |
| Technology | Production equipment, automation and configuration of equipment. |
| Vertical integration | In-house production versus outsourcing, and relationship with suppliers. |
| **Infrastructure decision elements** | |
| Organization | Structure and design. |
| Quality policy | Quality assurance, control practices and policies. |
| Production control | Production planning and inventory control systems. |
| Human resources | Policies and practices, including management selection and training policies. |
| New product development | Process and organizational aspects. |
| Performance measurement and reward | Performance recognition and reward systems. |

**Table 2.1 Summary of manufacturing strategy decision elements by Hayes and Wheelwright**

| **Structural decision elements** | |
|---|---|
| Maintenance capacity | Capacity in terms of work force, supervisory and management staff. Shift patterns of work force, temporary hiring of work force. |
| Maintenance facilities | Tools, equipment, spares, workforce specialization (mechanics, electricians, etc.), location of workforce. |
| Maintenance technology | Predictive maintenance, or condition monitoring technology, expert systems, maintenance technology (intelligent maintenance). |
| Vertical integration | In-house maintenance versus outsourcing and relationship with suppliers. |
| Infrastructure decision elements | |
| Maintenance organization | Organization structure (centralized, de-centralized, or mixed), responsibilities. |
| Maintenance policy and concepts | Policies like corrective, preventive and predictive maintenance. Concepts like Total Productive Maintenance (TPM), Reliability Centered Maintenance (RCM). |
| Maintenance planning and control systems | Maintenance activity planning, scheduling. Control of spares, costs etc. Computerized Maintenance Management Systems (CMMS). |
| Human resources | Recruitment policies, training and development of workforce and staff. Culture and management style. |
| Maintenance modifications | Maintenance modifications, equipment design improvements, new equipment installations and new machine design support. |
| Maintenance performance measurement and reward systems | Performance recognition, reporting and reward systems. |

**Table 2.2 Summary of maintenance strategy decision elements**

### 1.3.1 Structural decision elements

#### *1.3.1.1 Maintenance facilities – workforce specialization*

Multi skilling, an increasingly popular organization and work structuring strategy, is one of the maintenance strategy elements chosen for assessment. Trade specialization, the opposite to multi-skilling, is usually a characteristic of plants requiring special skills due to high levels of complexity (which results in longer troubleshooting time and a wider range of problems encountered) and where the workload can be made relatively smooth (Tsang, 2002). Most maintenance work requires a range of skills, with one predominant skill. Such work can be executed through multi-skilled tradesmen or teams. Maintenance departments have invested in training over significantly long periods to enable their tradesmen to adopt other skills. A more advanced variation of multi-skilling is autonomous maintenance where operators are trained to carry out first line maintenance.

*1.3.1.2 Maintenance technology – automation*

The use of automated manufacturing plants reduces labour cost, decreases production cycle times and increases product quality and consistency (Groover, 2007). In addition, automation affects maintenance workforce location by allowing some dispersed activities to be performed centrally to improve performance (Tsang, 2002). While automation may be viewed as a manufacturing (or operations) strategy element, its impact on the type and nature of equipment installed, interface to maintenance systems (CMMS) for data acquisition and built in diagnostic, protection and condition-monitoring systems renders it relevant to be considered as a maintenance strategy element. Pintelon, Pinjala and Vereecke (2005) add automation and AMT (Advanced Manufacturing Systems) to the Hayes & Wheelbright maintenance decision elements in their assessment.

*1.3.1.3 Vertical integration – outsourcing*

Traditionally, outsourcing was associated with non-core and so-called non-strategic functions, and was more popular in Information Technology, supply chain and logistics systems. Burdon & Bhalla (2005) and Pinjala, Pintelon & Vereecke (2005) all concur that outsourcing of core processes can be exploited to enhance competitive advantage through cost, quality or flexibility. In their investigation on the relationship between maintenance strategy and business strategy, Pintelon, Pinjala & Vereecke (2005) found that it was difficult to evaluate the prevalence of the outsourcing strategy element in the different maintenance strategy types because different businesses outsource for different reasons. Burdon & Bhalla (2005) ranked reducing costs, enhancing reliability, improving quality and access to best practice as the most sought after benefits. They labeled them primary benefits. Secondary benefits include flexibility to changes, focus on core competencies, achieving innovation and continual improvement and being the catalyst for transformational change. Different maintenance strategy types are therefore likely to outsource for different reasons.

### 1.3.2 Infrastructural decision elements

#### *1.3.2.1 Maintenance organization*

Maintenance functions are either centralized or decentralized, depending on the size of the organization and business strategy.

#### *1.3.2.2 Maintenance policy and concepts*

The following popular maintenance philosophies are generally combined with other maintenance strategy elements, in defining a maintenance strategy:

**Reactive maintenance**: Reactive or breakdown maintenance is a fire fighting approach to maintenance (Swanson, 2001) which consists of carrying out corrective actions only when equipment fails or is in the process of failing. This philosophy requires minimum amounts of resources (manpower and money) to keep equipment running.

**Preventive maintenance**: This philosophy consists of time dependant schedules when equipment is taken offline for inspection and repairs. This process is typically very expensive (Jabar, 2003) and is sometimes enforced by legislation for some equipment such as boilers. Manufacturers often install dual redundancy systems to enable offline maintenance of critical equipment. This however increases the value of the asset base and reduces return on assets.

**Proactive maintenance**: In this philosophy breakdowns are avoided by monitoring equipment deterioration and undertaking minor corrections to restore equipment to proper conditions.

**Predictive maintenance or Condition Based Maintenance**: This approach is based on measurement of the equipment condition in order to assess potential to fail in some future period, leading to action to avoid consequences of such failure (Jabar, 2003).

**Aggressive maintenance:** Swanson (2001) adds aggressive maintenance, driven by such best practice strategies as Total Productive Maintenance (TPM) and Reliability Centred Maintenance (RCM) as a fifth philosophy. These systems emphasize continuous improvement in addition to normal maintenance functions

*1.3.2.3 Maintenance planning and control systems – CMMS*

Computerised Maintenance Management Systems (CMMS) are a critical tool in the execution of modern maintenance strategies. However, their effectiveness and level of utilisation rests on the overall strategy they are supporting and how well they have been configured to support the strategy. The requirement for CMMS's to interface and exchange data with other business management systems has led to the proliferation of systems bundled in Enterprise Resource Programs (ERP) as compared to stand-alone best of breed systems (Labib, 1998).

*1.3.2.4 Human resources*

Basic strategies in business human resource strategies are based on building, acquiring or allocating human resources (Miles & Snow, 1985). Different business strategy types pursue different basic strategies which should align to their business strategies. Maintenance departments, likewise, inherit the same business strategies in their quest to build capability to deliver in support of the business strategy. This research will explore the extent to which maintenance staff training and development are executed to achieve alignment.

*1.3.2.5 Maintenance modifications*

**New product development support:** Maintenance systems need to be designed to quickly adapt to changes in products, processes and equipment.

**Benchmarking:** Benchmarking for continuous improvement is the process of comparing one's work methods, equipment, processes and performance metrics to competitors, industry leaders and/or best practice with the goal of revealing opportunities to continuously improve targeted aspects of the maintenance process. By its nature, benchmarking can only add value when there is little change happening in the product portfolio and manufacturing system. Benchmarking is an important tool for improving operational effectiveness, but its contribution towards competitive advantage and sustainability should be viewed cautiously. The more organizations benchmark, they more they become similar, or achieve competitive convergence (Porter, 2006).

*1.3.2.6 Maintenance performance and reward systems*

An effective strategy is one that fits the needs of the business (Pintelton, Pinjala & Vereecke, 2005). The effectiveness of any maintenance strategy should be measured as the level to which it satisfies the objectives of the strategy. Effective strategy execution should therefore include continuous evaluation of whether the strategy meets its objectives, as measured by a set of metrics, and whether it aligns to and supports other business strategies and functions. Lofsten (1998) lists some of the major metrics used to define performance of maintenance departments as availability, maintenance cost, and maintenance cost per unit. He argues that any metric chosen should be able to effectively guide management in making resource allocation decisions and measuring the performance of maintenance after resources have been committed.

Cholauke, Bhardwa and Anthony (2004), after carrying out a pilot study on UK organisations, categorised maintenance effectiveness measures into nine areas, which are policy deployment and organization; human resources management; financial aspects; continuous improvement; contracting out maintenance; maintenance approach; task planning and scheduling; information management and Computerised Maintenance Management System (CMMS) usage and spare parts management. This is a good delineation of the concept of maintenance strategy and a good checklist for judging effectiveness of maintenance strategy execution. A bad strategy executed effectively will not assist the business in achieving its objectives. Tsang (2002) classifies the performance measures given by Lofsten (1998) into measures of equipment performance (availability, reliability and overall equipment effectiveness), measures of cost performance, (labour and material costs of maintenance) and measures of process performance (ratio of planned and unplanned work, schedule compliance). He labels them generic performance measures and argues that, while they are useful for judging operational support and benchmarking, they are largely retrospective and introspective in nature and do not provide information for predicting maintenance's ability to create future value needed to support business goals of the organisation. These are typical measures of operational effectiveness (Porter, 1996). Lofsten (1998) recommends the use of the Balanced Score Card method, where performance is measured from financial, customer, internal processes, and learning and growth perspectives. Strategy is broken down into specific long term targets and objectives, performance measures and action plans, providing a checklist for directly evaluating the extent to which the maintenance strategy is executed in support of the business strategy.

Tsang, Jardine and Kolodny (1999) support the above view and argue the Balanced Scorecard (BSC) system provides a framework for translating strategy into operational measures that collectively capture the critical requirements for sustaining the organization's success. In addition to the BSC system and Operational Effectiveness, they also propose three other approaches to maintenance performance measurement:

- The value-based performance measure, which evaluates the impact of maintenance activities on the future value of the organization.

- System audits as a tool for measuring organizational culture, which in turn determines the appropriate approach to the organization of maintenance functions.

This research aims to infer if there are specific metrics used by the different business strategy types in measuring maintenance effectiveness and alignment to business strategy.

## 2. Business Strategy typologies

As pointed out in Chapter One, business level strategy is mainly concerned with positioning and competing with others in the products, services and markets defined at the corporate strategy level. Research has largely relied upon established business strategy typologies as a tool to define business strategy clusters for the purposes of measuring and comparing strategy characteristics, like alignment and their effect on business unit performance. According to Porter (1985) and Miles & Snow (1978) strategy typologies have generally been used in measurement of alignment between business and functional strategies.

Porter (1985) identified three generic choices of business strategy, cost leadership, differentiation and focus. Cost leaders compete in the market based on the low price of their product. Differentiators compete based on a certain distinct competency, like quality, customer service, image, etc. Focus players compete by serving the needs of a particular market or product segment. Subsequent literature (Hax and Majluf, 1991) has however reclassified these strategy types as generic competitive strategies. Porter (1996) later reinvented this strategy typology to focus on defining a company's position, making tradeoffs and forging fit among activities (Porter, 1996). A significant drift towards the concepts of core competencies, key focus areas and key resources (Porter, 1996) appear to be dominating recent literature on the subject. Pinjala, Pintelon and Vereecke (2005) used Porter's business strategy typologies as their basis for investigating the link between business and maintenance strategies.

Miles & Snow (1978) identified four business strategy types: Defenders, Prospectors, Analysers and Reactors. The fourth business strategy type, Reactors, has largely been ignored in several researches on the basis that, instead of representing a cluster of businesses following a certain strategy characterized by a common mix of strategy elements, it points to the absence of strategy. This strategy cluster has not been considered in this research for the same reasons.

## *2.1 Miles and Snow's Business strategy typologies: Defenders, Analysers, Prospectors and Reactors*

### 2.1.1 Defenders

#### *2.1.1.1 Cluster Characteristics*

The Defender is characterized by narrow and relatively stable product-market domains, often dominating a specific niche in its industry and sealing off competition by offering high quality and low prices on standard products. Emphasis is placed on achieving operational efficiency and building economies of scale. Its organizational structure is usually mechanistic. It has greater fixed-asset intensity than the other strategic types, with investments in highly cost-efficient but few core technologies. However, the Defender does not tend to search outside its domain for new opportunities, and rarely makes major adjustments in its structure or technology. Primary attention is devoted to improving efficiencies in existing operations using existing core technologies (Miles & Snow, 1985).

*2.1.1.2 Ideal maintenance strategy profile for Defenders*

**Automation:** The Defender is characterized by high volumes, high quality but standard products for a specific but stable market (Miles & Snow, 1978). The level of automation is high to drive high efficiency, low cost, high and consistent quality on high volumes, hence using economies of scale to lock out competitors and sealing the niche.

**Organisation structure of the maintenance function:** The structure is largely highly centralized (Sabherwal & Chan, 2001) to drive quality, standardization and economies of scale.

**Maintenance philosophies and CMMS usage:** High capital intensity and the criticality of high plant availability (capacity and quality) means the assets are not always available for preventive and predictive maintenance. Maintenance functions therefore rely on dual redundancy systems to enable maintenance of standby facilities on the run, automation systems to trend key parameters for condition-based monitoring and shutdowns for major plant maintenance. The emphasis on continuous production with few interruptions means there is little breakdown or corrective maintenance. Levels of preventive and predictive maintenance are high. Defenders are likely to use aggressive maintenance systems to compensate for unavailability of the plant for preventive and predictive maintenance and to achieve high efficiencies (long runs result in lower costs and consistent quality). The large capital intensity of such facilities also calls for high usage of aggressive maintenance philosophies. Such systems, coupled by the complexity of highly automated production lines, high demand on machine uptime and quality, are supported by high usage of Computerised Maintenance Management Systems (CMMS) in maintenance decision support, resource allocation, work planning and control. CMMS are also critical in keeping costs under control (Pinjala, Pintelon & Vereecke, 2005) and supporting aggressive maintenance management systems.

**Outsourcing:** Reliance on major shutdowns results in peak demands of resources within short, time-dispersed periods, a condition which favours outsourcing. Defenders are most likely to outsource for primary reasons (reducing costs, enhancing reliability, improving quality and access to best practice) and some secondary reasons (focus on core competency and continuous improvement) as given by Burdon and Bhalla (2005).

**Human resources**: Due to the stability of the market and processes, Defenders are characterized by low multi-skilling and enough training and development to maintain skills for existing assets. They are more likely to invest in staff retention and skill depth, than acquisition of new skills. The levels of multi-skilling are therefore low while the level of training and development is high.

**New product development support and benchmarking**: The stability of the market and products calls for little experimentation and new product development. The narrow focus on improving efficiencies in current technologies and limited changes to core technologies do not support huge benchmarking initiatives. However, benchmarking in processes and technology has increasingly become an important tool to boost operational efficiencies in modern day manufacturing (Porter, 1996).

### 2.1.2 Prospectors

#### *2.1.2.1 Cluster Characteristics*

Prospectors differ greatly from analysers and are characterized by a continuous search for new products and market opportunities, thereby creating change in the market. Emphasizing innovativeness, the Prospector invests heavily in product research and development, experimentation and environmental scanning. Their product-market domain is a broad and dynamic domain, and to function in such an environment, they seek flexibility in technology (as reflected in low fixed-asset intensity) and use an organic organization structure. However, the concern with flexibility and innovativeness often leads to a lack of controls and low operational efficiency (Miles & Snow, 1978).

#### *2.1.2.2 Ideal maintenance strategy profile for Prospectors*

**Automation:** Prospectors are characterized by rapid product development for new markets, and hence their maintenance strategy should reflect a high level of flexibility. The level of automation can be low due to the low level of capital intensity. Automation can however be used as a tool to enhance flexibility. Modern production has relied heavily on automation to ensure high productivity and consistent quality in highly competitive markets. The level of automation for Prospectors is therefore high.

**Organisation structure of the maintenance function:** The maintenance function is typically small, favouring a decentralized structure to manage it.

**Maintenance philosophies, CMMS usage:** The emphasis on flexibility means that technical complexity is low, typical for job and batch production processes (Pinjala, Pintelon & Vereecke, 2005). Interdependency of equipment is low, meaning that maintenance is not very critical. Prospectors therefore do more corrective maintenance compared to predictive and preventive maintenance. CMMS usage remains high as a decision support and resource usage tracking system.

**Outsourcing:** Most of the jobs can easily be outsourced since the skills and resources are generally available, shared by all players in the market, and are not used as a base for competitive advantage. Prospectors are therefore likely to outsource for secondary reasons (flexibility to changes, achieving innovation and continual improvement) (Burdon & Bhalla, 2005), but can also benefit from outsourcing for primary reasons by building efficiency.

**Human resources:** The small maintenance teams are likely to favour mult- skilling to handle corrective maintenance of technically less complex technologies. Levels of training and development are generally high, in line with the continuously changing technology and products, despite the low complexity of the plant and high levels of outsourcing. Emphasis is on acquisition of skills.

**New product development support and benchmarking:** By their nature, maintenance philosophies for Prospectors will call for high levels of experimentation, new product development support and medium levels of benchmarking.

### 2.1.3 Analysers

#### *2.1.3.1 Cluster Characteristics*

The Analyser operates in both stable and changing product market domains. Combining the strengths of the other two types, it seeks to simultaneously minimize risk while maximizing opportunities for growth. It maintains a stable domain of core products, while seeking new product/market opportunities. It does not usually initiate new products but often follows the Prospector by very quickly introducing competitive, and occasionally better, products. Thus, unlike the Defender, it does not eschew change, but unlike the Prospector, it does not create change. To address conflicting demands of efficiency and innovation, the Analyzer uses a matrix organization structure, and a dual technological core, with stable and flexible components. Of course, these conflicting demands are difficult to address simultaneously, and the organization may fail to address one or both (Miles & snow, 1978). The dual focus may also imply larger organization size (Doty, Glick & Huber, 1993).

#### *2.1.3.2 Ideal maintenance strategy profile for Analysers*

**Automation:** To achieve the requirement of maintaining core products and markets while at the same time developing new products, the Analyser is likely to rely heavily on automation to build efficiency and cost advantage on established products. As soon as the Analyser establishes a product, often following a Prospector in its market domain, it rapidly builds up scale by investing in resources and assets, building cost and quality competitiveness, hence capturing market share and enhancing sustainability.

**Organisation structure of the maintenance function:** According to Miles & Snow (1985), Analysers follow mostly centralized control processes, but decentralized processes in marketing and brand management. The same should apply to maintenance. Levels of centralization are likely to be low to allow focus on individual product lines.

**Maintenance philosophies and CMMS usage:** The combination of high capital intensity and new product development calls for a mix of appropriate maintenance strategies. Analysers are most likely to follow a combination of high preventive, predictive and corrective maintenance strategies. The view will be to ultimately reduce costly corrective maintenance. However, uncertainty in manufacturing ensures that there is always a significant level of corrective maintenance in any large complex plant. This is largely consistent with Miles & Snow's (1985) planning sequence of "evaluate, plan and then act". It follows from this argument that there is high usage of CMMS in decision-making and resource allocation.

**Outsourcing:** The need for high response speed to maintenance requirements, high complexity and relatively changing technologies, in addition to the need to maintain competitive advantage through all business functions, calls for high levels of outsourcing to benefit from scale and specialization.

**Human resources:** Analysers are likely to follow a mixed strategy of developing and acquiring human resources, hence training and development are relatively high. However, levels of multi-skilling are likely to be low as emphasis is on building teams using individuals with complimentary and highly specialized skills.

**New product development support and benchmarking:** Levels of experimentation, benchmarking and new product development support are high as Analyzers seek to develop competencies, often by replicating Prospectors' strategies at a larger scale.

Table 2.3 below shows the ideal maintenance strategy profiles of the three strategy types as analysed above.

| **Element** | **Defenders** | **Prospectors** | **Analysers** |
|---|---|---|---|
| Automation | High | High | High |
| Preventive maintenance | High | Medium | High |
| Predictive maintenance | High | Low | High |
| Breakdown maintenance | Low | High | High |
| Aggressive maintenance | High | Medium | High |
| CMMS usage | High | High | High |
| Outsourcing for primary reasons | High | High | High |
| Outsourcing for secondary reasons | High | High | High |
| New product development | Low | High | High |
| Benchmarking | High | Medium | High |
| Organisation structure – level of centralisation | High | Medium | Low |
| Multi-skilling | Low | High | Medium |
| Training & development | High | High | Medium |

Table 2.3: Ideal maintenance strategy profile for Defenders, Analysers and Prospectors as derived from theory and exploratory studies.

## *2.2 Business Strategy profiles for Defenders, Analysers and Prospectors*

Venkatraman (1989) proposed a measurement of business strategy profile, which was applied by Sabherwal and Chan (2001) in classifying business units into their business strategy clusters (Defenders, Analysers and Prospectors) based on the Miles and Snow (1978) business strategy typologies. The measured and ideal profiles were based on six attributes of business strategy (defensiveness, risk aversion, aggressiveness, pro-activeness, analysis and futurity). The ideal business strategy profile proposed by Venkatraman is given in Table 3 below.

| **Business strategy attributes** | **Defenders** | **Prospectors** | **Analysers** |
|---|---|---|---|
| Defensiveness | High | Low | Medium |
| Risk aversion | High | Low | High |
| Aggressiveness | Medium | High | Medium |
| Pro-activeness | Low | High | Medium |
| Analysis | Medium | Medium | High |
| Futurity | High | Medium | Medium |

Table 2.4: Ideal business strategy profile for Defenders, Analysers and prospectors (Sabherwal & Chan, 2001).

## 2.3Alignment

Nath & Sudharshan (1994) define strategic alignment as the consistency of strategic choices across business and functional levels. This definition agrees with other explanations given below. The words “fit”; “alignment” and “coherence” have been used interchangeably in literature to refer to the same thing.

The nature of alignment between business strategy and several functional strategies has been widely researched using different strategy typologies and methods. Most of these researches attempt to infer fit by matching a basket of functional strategy elements to defined business strategy types. Sabherwal & Chan (2001) studied alignment between business strategy and maintenance strategy, based on the Miles and Snow (1978) strategy typology. Their results point to a generally positive correlation between alignment and business performance. The correlation is statistically significant for analysers and prospectors. Bergeron, Raymond & Rivard (2004) validated the Information Technology Strategic Alignment Model, using the same strategic alignment method.

### 2.3.1 Nature of alignment or fit

The nature of alignment is best revealed by the concepts of businesses seeking competitive advantage and sustainability in their chosen markets. A company can outperform rivals only if it can establish a difference that it can preserve (Porter, 1996). Alignment drives both competitive advantage and sustainability by creating a chain that is as strong as the strongest link (Porter, 1996). It is easy for competitors to replicate strategic elements of a single function, but extremely difficult for them to replicate multiple functions aligned together and reinforcing each other in pursuit of a common goal. Porter (2006) defines three types of fit:

First order fit: Simple consistency fit between each function and the business strategy.

Second order fit: Activities or functions are reinforcing each other to entrench competitive advantage and sustainability.

Third order fit: Optimisation of effort to achieve high levels of business unit capability.

Pintelon, Pinjala and Vereecke (2005) present a slightly different but related view. They explain fit in terms of internal and external consistency between functions, strategic elements and the business environment. Maintenance strategy should therefore demonstrate:

- Internal consistency with the overall business strategy and other functional strategies, e.g. manufacturing
- Strategy elements should be internally consistent with each other. It can be inferred that this can only be achieved if they are either complimentary or reinforcing.
- Maintenance strategy should be externally consistent with the business environment. This calls for alignment to government statutory requirements, technology environment and availability of services and infrastructure.

It is therefore critical for maintenance strategy to be aligned to the overall business function so that it can contribute to competitive advantage and sustainability through supporting manufacturing, engineering, new product development and equipment lifecycle performance optimization. This research aims to measure the impact on internal fit between business and maintenance strategy on overall business strategy, and to verify preferred maintenance strategy elements for different business strategy types. Measurement of alignment is done from the basis of business strategy types, and ideal profiles derived from theory.

### 2.3.2 Measuring alignment

According to Nath and Sudharshan (2004), a good measure of alignment must be replicable, feasible and consistent for different scales and levels of complexity, and must have inter-judge reliability. A good measure can be verified using the correlation of alignment and business performance. This analysis is based on the assumption that alignment results in improved business performance for all business strategy types, an assertion which is generally accepted based on prior researches. This study used the method proposed by Sabherwal & Chan (2001) to measure alignment. The first step in this process was to classify the sample into Defenders, Prospectors and Analysers based on their profiles. Measurement of business strategy profiles was based on STROBE (strategic orientation of business enterprises) as proposed by Venkatraman (1989) and applied by Sabherwal & Chan (2001). The measured and ideal profiles are based on the six attributes of business strategy (defensiveness, risk aversion, aggressiveness, pro-activeness, analysis and futurity). The ideal business strategy profile for each business strategy type proposed by Venkatraman (1989) as given Table 2.2 was adopted together with the data collection tool. The class of the organization was determined as the class with the smallest Euclidean distance between the measured and ideal profiles. Alignment was also calculated based on the Euclidean distance between the measured and ideal maintenance strategy profiles for each business strategy class. A detailed description of this process is given in Chapter Four.

# CHAPTER 3

# RESEARCH QUESTIONS AND HYPOTHESES

## 1. Introduction

This research aims to investigate the impact of alignment between business strategy and maintenance strategy on performance and to draw further insights into maintenance strategy formulation and execution in industry. Alignment is measured based on Miles and Snow (1978) business strategy typologies and the method proposed by Sabherwal and Chan (2001).

## 2. Summary of research objectives

2.1 Draw insights into the type of maintenance practice mixes (functional maintenance strategies) adopted by companies following different business strategy profiles.

2.2 Determine the level of perception of business strategy at the maintenance practitioner level in business units.

2.3 Investigate the nature of alignment/fit between business strategy and maintenance strategy and the impact of this on performance.

2.4 Understand the nature of the relationship between maintenance effectiveness measurement metrics and business strategy types.

## 3. Hypotheses

Research objective 2.3 is further broken down into the following hypotheses:

***Hypothesis 1:*** This hypothesis tests the assertion that the alignment between maintenance strategy and business strategy is positively associated with perceived performance for the whole sample.

$H_0$: Alignment is not positively correlated with business performance.

$H_1$: Alignment is positively correlated with business performance.

***Hypothesis 2:*** This hypothesis tests the assertion that for Analysers, the alignment between MS and $MS_{Analysers}$ is positively associated with perceived business performance.

$H_0$: For Analysers, the alignment between MS and $MS_{Analysers}$ is not positively associated with perceived business performance.

$H_1$: For Analysers, the alignment between MS and $MS_{Analysers}$ is positively associated with perceived business performance.***Hypothesis 3:*** This hypothesis tests the assertion that for Prospectors, the alignment between MS and $MS_{Prospectors}$ is positively associated with perceived business performance.

$H_0$: For Prospectors, the alignment between MS and $MS_{Prospectors}$ is not positively associated with perceived business performance.

$H_1$: For Prospectors, the alignment between MS and $MS_{Prospectors}$ is positively associated with perceived business performance.

***Hypothesis 4:*** This hypothesis tests the assertion that for Defenders, the alignment between MS and $MS_{Defenders}$ is positively associated with perceived business performance.

$H_0$: For Defenders, the alignment between MS and $MS_{Defenders}$ is not positively associated with perceived business performance.

$H_1$: For Defenders, the alignment between MS and $MS_{Defenders}$ is positively associated with perceived business performance.

# CHAPTER 4

# RESEARCH METHOD

## 1. Research type

A quantitative approach was chosen for the research since the key theories and constructs on the subjects of maintenance and functional strategies alignment are well researched, as outlined in Chapters One and Two. Exploratory research, which often takes the form of a qualitative research, is conducted where there is need to clarify and define the nature of a problem (Zikmund, 2009). This research aimed to use statistical methods to explore the relationship between two variables, an independent variable (strategy alignment) and a dependant variable (business performance). It should however, be noted that existence of a correlation alone does not assume causation.

## 2. Unit of analysis

The unit of analysis was chosen as individual manufacturing plants or mines with distinct stand-alone maintenance functions, reporting to a business unit. Business unit refers to an entity which generates its own revenue and records/reports on its own balance sheet and profit and loss account. A business unit may have more than one plant, in which case the manufacturing plant's success in achieving targets set by the business unit was used to judge success. Business units should be responsible for developing or executing their own business unit level strategies guided by corporate strategy from holding companies.

# 3. Sampling

### *3.1 Target Population*

In line with the requirements set in 2.2 above, the survey target population was chosen as all plants in different industrial sectors in South Africa. Zikmund (2009) argues that it is critical to carefully and fully define the target population so that the data is collected from the proper source. He defines the target population as the complete group of specific population elements relevant to the research project. Size, as defined by the number of employees on a plant, was also used as a secondary screening characteristic. Pinjala, Pintelon and Vereecke (2005) noted that the maintenance strategy mix on smaller plants is often influenced more by their size than by systematic strategic choices. Plants with a head count above 100 were judged to be large enough for the purposes of the research. The resultant population necessitated the development of a relevant sampling frame and sampling method to obtain a fairly representative sample using a practical and cost effective method. Refer to Section 3.6.2 for further details on assumptions and research limitations emanating from the choice of population and sampling techniques.

### *3.2 Respondents*

Respondents from qualifying units of analysis were chosen on the basis of their roles in designing, defining or executing maintenance strategy, computer literacy, appreciation of engineering, and more specifically, maintenance principles and familiarity with key business strategy performance metrics. Business unit managers, Engineering Function Managers, Section Engineers, Maintenance Planners/Foremen and Operations Managers/Supervisors were deemed to satisfy the criteria.

## *3.3 Sampling method*

A non probabilistic sampling method, snowball sampling (Zikmund, 2009) was chosen for this research. Snowball sampling is usually used to obtain a statistically significant sample size from a rare population (Zikmund, 2009). While it was easy to identify plants belonging to the population, obtaining a list of maintenance practitioners or other respondents across all industries within the criteria proved to be a huge challenge. A decision was therefore made to exploit the various networks of professionals in each industry group through snowball sampling to achieve a bigger sample. According to Zikmund (2009), initial respondents in a snowball sample are selected through probability sampling. A list of companies in the mining, mineral processing and manufacturing industries was compiled from Provincial Chamber of Commerce databases. Individual plants or mines ran by the companies were then identified. Potential respondents from these companies were obtained through phone calls, internet searches and the Engineering Council of Africa (ECSA) database. These respondents were initially contacted by email, with follow-up telephone calls to speed up the response rate. They were also asked to forward the emails to other respondents within acceptable criteria. Screening questions in the questionnaire were used to weed out non-relevant responses.

## *3.4 Measurement and scaling*

### 3.4.1 Measurement tool: Questionnaire design

#### *3.4.1.1 Questionnaire design*

The questionnaire was compiled within the guidelines proposed by Saunders, Lewis and Thornhill (2003) and Zikmund (2009), based on the constructs derived from literature review (Chapter Two) and research questions and hypotheses in Chapter Three.

The main body of the questionnaire comprised four sections, each aimed at obtaining plant and/or business data to enable analysis as described in section 3.5. Section 1 covered a general introduction.

Section 2: General Questions

This section contained general questions for the purposes of:

- Screening out respondents outside the relevant target population.
- Establishing the extent to which maintenance contributes to overall production cost.
- Judging the level of business strategy and maintenance strategy penetration and awareness at the maintenance practitioner level.
- Providing a basis for evaluating variability across industries.

Sections 3 and 4: Business and maintenance strategy type classification

The main purpose of these sections was to obtain plant and business unit data to enable:

- Classification of business unit into one of the three business strategy types.
- Classification of the business unit's maintenance functions into one of the three strategy types.
- Calculation of a measure of alignment between the business unit's business strategy and maintenance strategy.

Section 5: Perceived business unit performance

This section comprised questions aimed at obtaining perceived business unit performance, which ultimately formed the dependant variable in the correlation assessment outlined in Section 4.5.

Section 6: Metrics

This section was designed to judge the relative importance and use of several performance metrics derived from literature review and exploratory studies.

The following questionnaire design improvement techniques derived from Openheim (1992), Saunders et al (2003) and Zikmund (2009) were executed to improve the questionnaire, and hence the quality of the data collected:

- Careful selection of words to eliminate ambiguity and enhance clarity.
- Removal of double barreled statements (statements covering more than one issue).
- Avoiding leading or loaded questions.
- Use of simple language comprehensible to the target population.
- Definitions were provided for terms that were deemed to be complex, ambiguous or unfamiliar or liable to misinterpretation. The pre-test exercise was used to further identify such words or statements.

*3.4.1.2 Scaling*

The questionnaire comprised a mix of multiple choice questions restricted to one response and attitude measurement type questions with a five point Likert type scale. The Likert type scale was particularly chosen to enable ranking of the perceived importance of the various constructs in the population of interest. Attitudinal scales are used to determine the attitudes of respondents to a particular issue (Kumar, 2005; Zikmund, 2009; Openheim, 1992) and the Likert type scale is popular (Zikmund, 2009) and has been proven to be one of the most effective in measuring and ranking attitude (Gob, McCollin & Ramalhoto, 2007).

*3.4.1.3 Pre-testing*

Questionnaire design was followed by a pilot phase aimed to test the effectiveness of the tool in extracting accurate data. The test involved subjecting the questionnaire to a group of four respondents. The respondents were selected through convenience sampling (Zikmund, 2009) from maintenance practitioners with appropriate attributes (Section 3.3) from the researcher's organization which falls within the target population. Pre-tests allow the researcher to detect problems with the questionnaire instructions and design (Zikmund, 2009). This excise revealed several flaws which were immediately corrected. These included evidence for ambiguity, poor clarity and signs of fatigue or loss of concentration. The time needed to complete the questionnaire was also determined. Respondents tend to be more co-operative if the questionnaire is relatively short and clear, resulting in accurate data. The results of this pre-test were:

- An appropriate questionnaire length was achieved through focusing the questions on relevant issues.
- The questionnaire was restructured by grouping questions into categories. Apart from the organization benefit, sectionalizing the questionnaire reduced the impression of length.
- Appropriate language, definitions and coding.

*3.4.1.4 Questionnaire evaluation*

The second phase of -tests involved evaluating the final version of the questionnaire in terms of reliability, validity and sensitivity (Zikmund, 2009). Content validity was verified through subjective feedback from the initial sample and review by an independent expert in the maintenance strategy field. Questionnaire reliability, which is defined as its ability to provide consistent results, was verified using the method proposed by Zikmund (2009). The questionnaire was subjected to two tests within a ten day interval using two participants. The participants were selected from two manufacturing plants in the relevant population. The testing revealed satisfactory consistency in selection of attitude scales. Minor changes were recorded which were not greater than one increment or decrement. Zikmund (2009) concurs that minor changes are acceptable as the attitudes of respondents are likely to change to a small degree over a period of time. The questionnaire was therefore accepted as reliable and valid.

### 3.4.2 Data collection

Data collection was done using a self-administered online questionnaire. The link to the online survey was first distributed by email to the list of respondents. This method was chosen based on its wider geographical reach, low cost, easy data collation and preparation for analysis. The respondents chosen were computer literate, with access to a computer with email and internet functionality. Email distribution has the advantage of speed and relatively quick response. Response rates may however be affected by respondents concerns over anonymity, especially in the highly competitive manufacturing industries. Telephone follow-ups revealed these fears, confirming that manufacturers indeed realized that their maintenance strategies either contributed to competitive advantage or were so inadequate that they posed a risk to sustainability. A commitment was made to prevent uploading of IP addresses by setting an alternative data collector for such respondents. The first collector provided for a single response per computer and IP (internet protocol) address.

## 3.5 *Data analysis*

The data was analysed using the process suggested by Zikmund (2009), which identifies the following four phases of transforming raw data into information: Editing, Coding, Data Entry and Data Analysis. These steps are in agreement with those proposed by Saunders et al (2003) which are: Preparation of data for analysis, Exploring and presenting data and describing and examining data using appropriate statistical methods.

### 3.5.1 Editing, coding and entry

The editing process aimed to check and adjust data for omissions, legibility and consistency. Three responses were found to be incomplete, with varying degrees of non response. Two decision rules for non-response items were adopted:

- Where a non-response item related to a single question or construct per section, a neutral plug value (Zikmund, 2009) was used. It was assumed that this omission was unintentional and midpoint Likert response three was allocated.
- Where a whole section was not completed, the whole response was discarded.

The categorical data from the survey was then converted to numerical data through the process of coding. Numerical scores were allocated to Likert response codes as to enable manipulation of the data through calculations. Finally, the coded data was cleaned (Zikmund, 2009) by removing coding errors and ensuring that all data fell within range.

### 3.5.2 Data analysis

Data analysis was done using a combination of spreadsheets and statistical analysis software and comprised both descriptive and inferential statistics.

*3.5.2.1 Descriptive statistics*

Descriptive statistics were used in data analysis to explore issues raised in research questions. The first stage of the analysis resulted in a simple tabulation of the frequencies of the different Likert and multiple choice responses. The mode was evaluated for each construct to reveal the most popular response. The median was calculated to reveal the middle point of the responses. Both the mode and the median were used as measures of central tendency of the response for a particular question (Albright, Winston and Zappe, 2006).

*3.5.2.2 Inferential statistics*

The method proposed by (Sabherwal & Chan, 2001) was adopted in exploring the relationship between business and maintenance strategy alignment and perceived business performance. Refer to Table 3.1 below for the process followed in the analysis. The process involved four major steps detailed below:

***Step 1:*** Normalisation of scores

All scores were normalized by expressing them as number of deviations from the sample mean. The formula given below was used:

*Normalised Score = (Raw Score – Mean Score)/Standard Deviation*

***Step 2:*** Classification into business strategy type

The business units were classified into business strategy types based on the ideal and measured business strategy profiles. High, Medium and Low values the ideal business strategy, given in Table 2.4, were operationalised as +1, 0 and -1 respectively. The Euclidian distance between each firm's measured business strategy and the group's ideal business strategy was calculated. For example, the Euclidian distance for any company from Defenders was calculated as:

$$Distance\ (Def) = \surd(\sum\{(X_j - I_{j,Def})^2\}$$

where $X_j$ is the normalized score for the $j^{th}$ business strategy attribute, $I_{j,Def}$ is the normalized score for the $j^{th}$ business attribute for Defenders and j ranges from one to six (each of the six business strategy elements). The resultant value, representing distance from each of the three business strategy classes, was used to classify the plants by identifying the class closest to them (smallest value).

***Step 3:*** Calculation of alignment between each company's business strategy and its ideal maintenance strategy

High, Medium and Low values in the ideal maintenance strategy model derived from theory and exploratory studies given in Table 2.3 were operationalised as +1, 0 and -1. The Euclidian distance between each business unit's maintenance strategy and the ideal maintenance strategy for the business strategy type to which it belongs was calculated using the formula given in Step 2. The resultant distance was subtracted from one to convert it to a measure of alignment.

***Step 4:*** Hypothesis Testing

The last step comprised testing the relationship between alignment and business unit performance using the correlation and multiple regression processes.

| Inputs | Process | Outputs |
|---|---|---|
| Raw Data | Normalisation of data: Normalised score = (Score – mean)/standard deviation<br>Elimination of variability due to industry could not be done due to the small sample. | Normalised Data |
| Raw Data<br>Ideal BS profiles of Defenders, Analysers and Prospectors | Map respondent organizations into business strategy types (Defender, Analyser, Prospector)<br>i. Identify ideal business strategy profile based on the six business strategy attributes<br>ii. Operationalise the data into High, Low and neutral (1, -1, 0) based on number of standard deviations from mean (as calculated above).<br>iii. Calculate the Euclidian distance of each company's measured data to the ideal profile data.<br>iv. Classify businesses into the closest business strategy type (smallest distance). | Distinct classes of Defender, Analyser, Prospector |
| Raw Data<br>Ideal MS for Defenders, Analysers and Prospectors<br>BS classes | Classify businesses maintenance strategies into strategy types<br>i. Identify ideal maintenance strategy profile based on the maintenance strategy attributes chosen.<br>ii. Operationalise the data into High, Low and neutral (1, -1, 0) based on number of standard deviations from mean.<br>iii. Calculate the Euclidian distance of each company's measured data to the ideal maintenance strategy profile data. | Distinct classes of maintenance strategy types |
| MS and BS profile data | Calculate Alignment of BS and MS for each business strategy type<br>i. Calculate the Euclidian distance between each firm's MS and the ideal MS for the BS type it has been classified into.<br>ii. Calculate Alignment by subtracting the distance from 1. | Alignment |
| Performance data | Hypothesis Testing<br>Correlations:<br>i. Whole sample: Alignment and Performance<br>ii. Defender: Alignment and Performance<br>iii. Analysers: Alignment and Performance<br>iv. Prospectors: Alignment and Performance | |

Table 4.1 Data preparation and analysis, adapted from Sabherwal and Chan (2001)

## *3.6 Assumptions and limitations*

### 3.6.1 Assumptions

The population, despite spanning across all industries was assumed to be homogeneous with respect to the extent to which strategic alignment influenced perceived success. The small sample did not allow data processing to eliminate variability due to industry.

### 3.6.2 Limitations

The questionnaire verification tests were restricted to a small, non-probabilistic sample due to time constraints. This may have compromised reliability, which was assumed to be of less importance to validity. A reliable but invalid instrument will yield inaccurate results (Zikmund, 2009).

Snowball sampling introduces a certain level of bias as the sample units are not independent (Zikmund, 2009). It is inappropriate to project data from such a non-probabilistic sample beyond the sample itself.

Statistically significant samples could not be obtained for each of the three business strategy types. Non- parametric tests were therefore used to evaluate the preference of maintenance performance metrics by business strategy types.

The level of respondents chosen for this survey varied from senior managers responsible for strategy design and execution to maintenance professionals responsible for strategy execution only. Awareness of business strategy is low at lower levels and this may have compromised the accuracy of the results.

# CHAPTER 5

# RESULTS

## 1. Introduction

This section presents the results obtained from the data collection and analysis phase. Data collection and analysis were designed with a view to answer the research questions and test hypotheses given in Chapter Three. A total of 39 responses were received, of which six were disqualified for either failing the organization size criterion or for having too many non-response items as per non-response items handling rules given in Chapter Four. Out of the qualifying 33 plants, 11 were classified as Prospectors, 16 as Analysers and 6 as Defenders. The results show that the calculated variable, Alignment, based on the theoretical maintenance strategy mix model developed in Chapter Two, is significant in explaining all the business performance variables for the whole sample. In particular, the Pearson Correlation Coefficient for overall business performance, an average of performance scores for all performance measures, was 0.67 ($R^2$ value of 0.45) with a very small probability value, showing that the model explains 45% of the variation of the dependant variable. The detailed results are given below.

## 2. Descriptive statistics

### *2.1 Sample size*

A total of 39 responses were received from the online survey. Of these, two were disqualified as incomplete (at least one whole section missing), three were classified as outside sample criteria (employees less than 100) and one was both incomplete and outside sample criteria. 33 responses were accepted and used for the analysis.

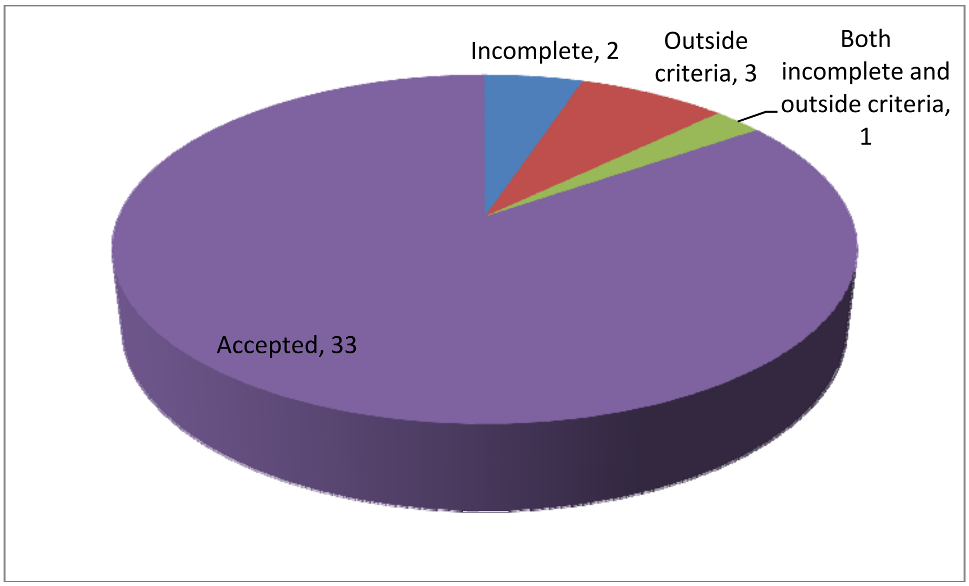


Figure 5.1: Responses received

## *2.2 Distribution of respondents*

### 2.1.2 Job description

The highest number of responses was received from Section Engineers (nine, 27%) followed by Engineering Function Managers (eight, 24%).

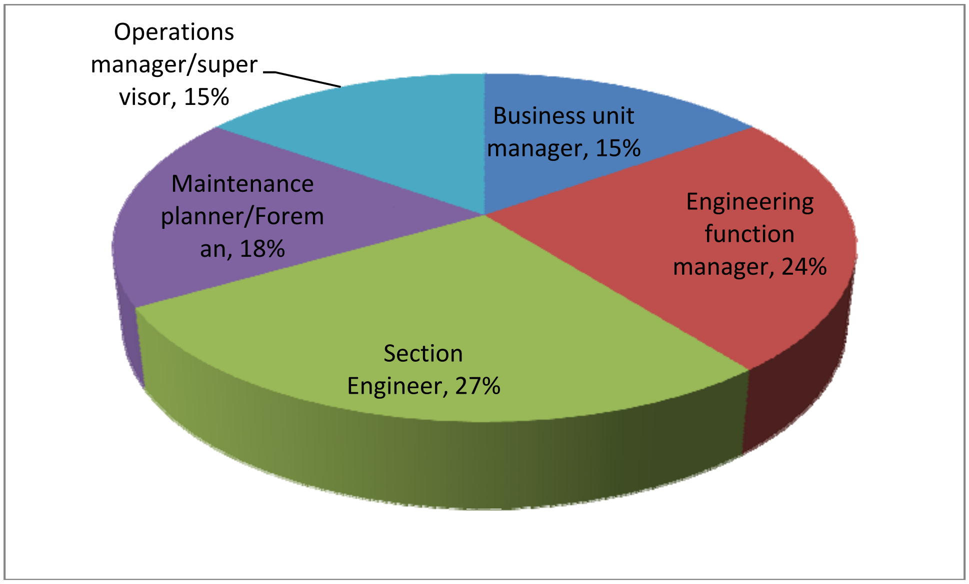


Figure 5.2: Distribution of respondents by Job Description

### 2.2.2 Industry

Responding plants were also classified by industry. Most responses were received from the mineral processing industry (27%), followed by the mining and manufacturing industries (21%). The small sample size, however, did not allow treatment of the results to account for industry variability. Such treatment could have involved normalizing the samples according to industry average and standard deviation.

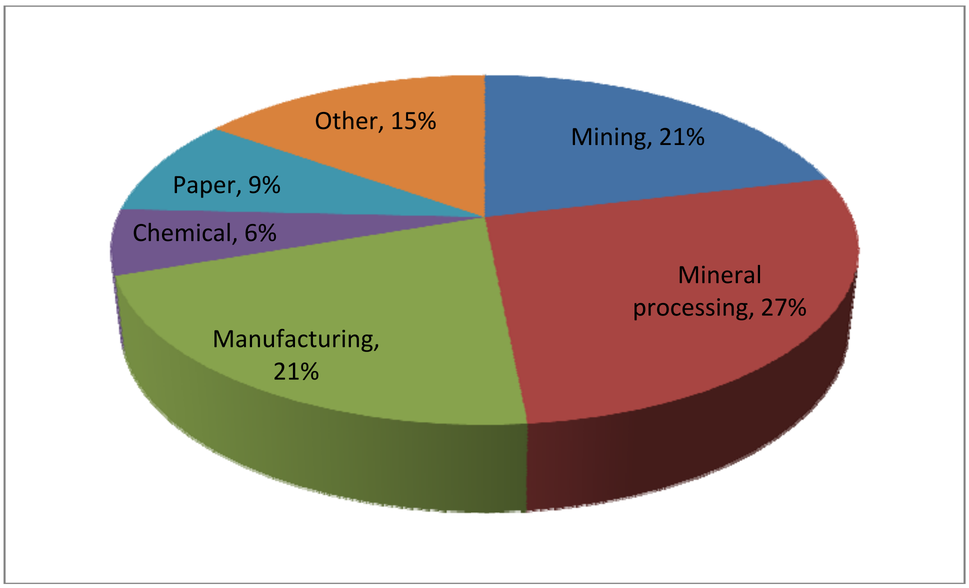


Figure 5.3: Classification of respondents by industry

### 2.2.3 Number of employees

The highest number of responding plants had more than 400 employees. Plant size, as represented by the number of employees was used to disqualify small organizations. Maintenance strategies for small organizations tend to be determined more by their size than by alignment to business goals.

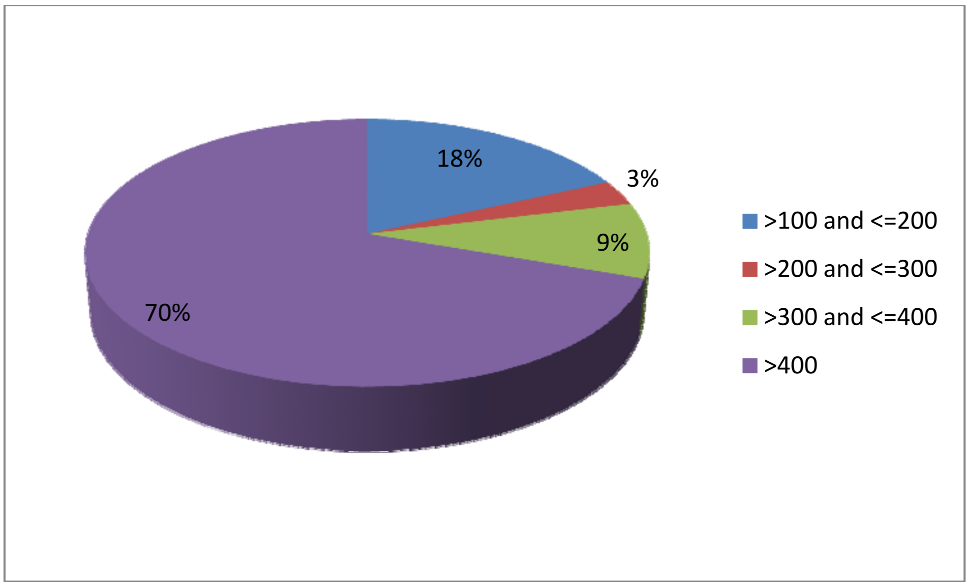


Figure 5.4: Classification by number of employees

## *2.3 Percentage of plant maintenance cost to operational expenditure*

The responses to the question regarding the direct maintenance cost as a percentage of production cost are presented in Figure 5.5. The modal, or most represented category, was the 10 -20% category with 37%. Very few respondents were of the opinion that their maintenance costs constituted more than 40% of production costs.

The presence of two open intervals in the question renders the mean unreliable as a measure of location. It is preferable to use the median or the mode. The mode, in this case, was approximately 12.72%. The modal class was the 10-20% category. The median was 15.42%.

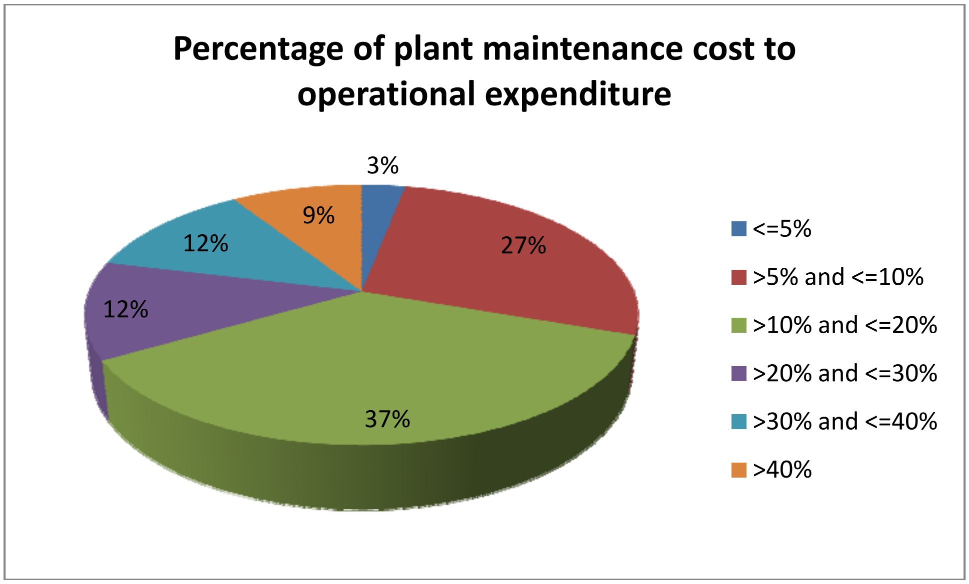


Figure 5.5: Percentage of maintenance to total production costs

## *2.4 Business and Maintenance strategy*

### 2.4.1 Maintenance strategy

Fifteen of the respondents confirmed that their plants had a written and signed off maintenance strategy. A similar number (13) indicated that their plants did not have such a strategy, while three were not sure if the strategy document was available. The distribution is represented, in percentage terms, in Figure 5.6 below. It should be noted that absence of a maintenance strategy document does not necessarily imply lack of maintenance strategy. Some organizations execute unwritten maintenance strategies which largely reside in individuals and are subject to vary inconsistently as external and internal conditions change in the view of the individuals.

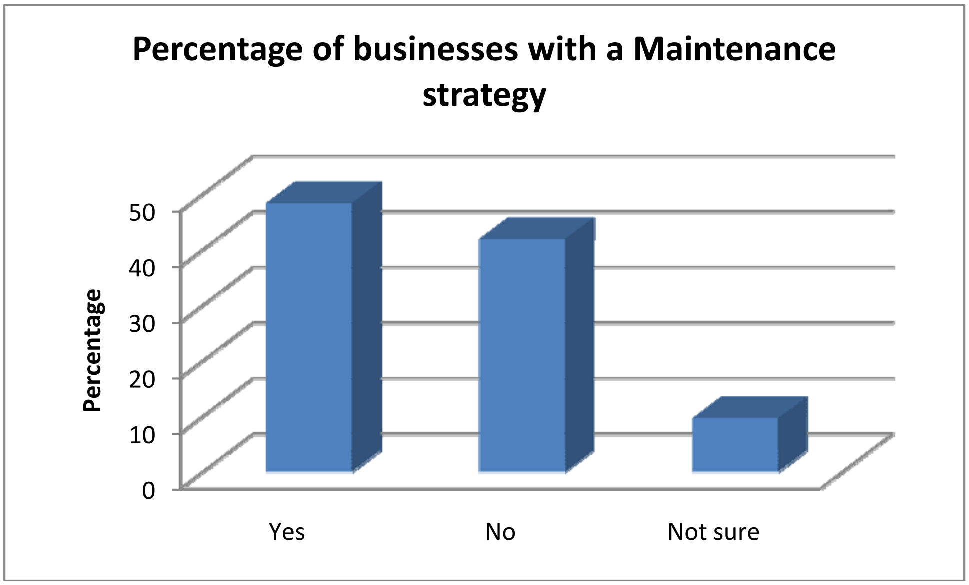


Figure 5.6: Percentage of businesses with a written and signed off Maintenance Strategy

**2.4.2 Business strategy**

Almost all respondents, except one indicated that their businesses had a written and signed off business strategy. One respondent did not respond to this question. The distribution is represented, in percentage terms, in Figure 5.7 below.

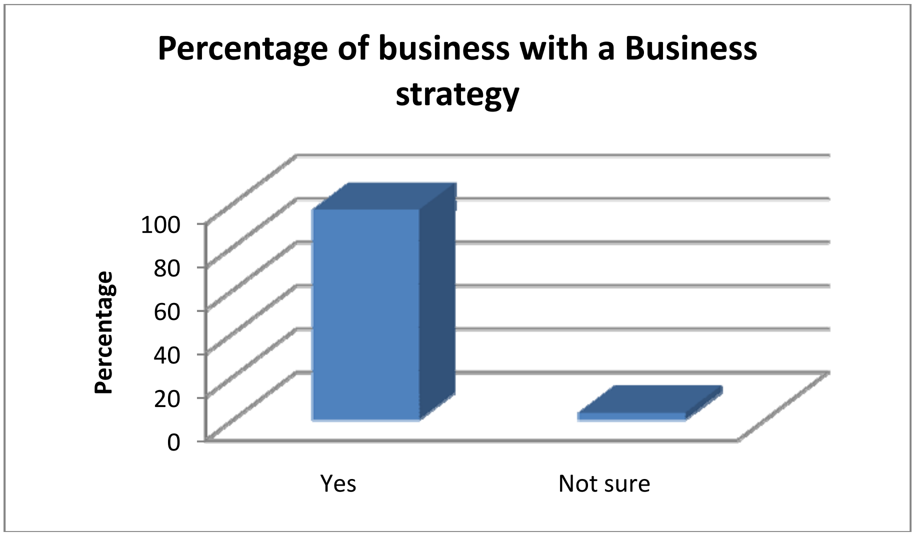


Figure 5.7: Percentage of business with a written Business Strategy

### *2.5 Maintenance systems maturity levels*

About 50% of the respondents rated their organizations as representative of the business maintenance system maturity levels. 36% were of the opinion that their plants were leading while 9% concurred that their plants were lagging others in the same organization.

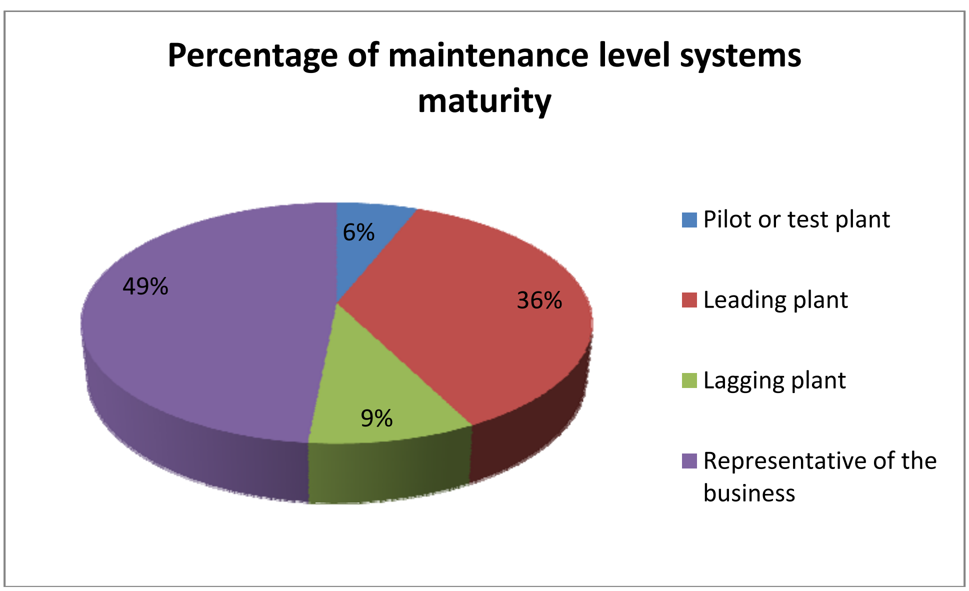


Figure 5.8: Percentage of maintenance level systems maturity

### *2.6 Awareness of business strategy*

This question aimed to judge the level of business strategy awareness at the maintenance strategy formulation functional levels in the business. 30% of the respondents were fully aware of business strategy elements. The modal class was the Moderately Aware category. Three respondents were “somewhat aware” of business strategy. The results are given in Table 5.1 below.

| Awareness of Business Strategy | | | | |
|---|---|---|---|---|
| **Category** | **Frequency** | **Percent** | **Cumulative Frequency** | **Cumulative Percent** |
| **Fully aware** | 10 | 30.30 | 10 | 30.30 |
| **Aware** | 9 | 27.27 | 19 | 57.58 |
| **Moderately aware** | 11 | 33.33 | 30 | 90.91 |
| **Somewhat aware** | 3 | 9.09 | 33 | 100.00 |

Table 5.1: Awareness of Business Strategy

## 3 Classification of plants by business strategy type

Of the qualifying sample, 16 were classified as Analysers, 11 as Prospectors and 6 as Defenders. The Analysers were therefore the modal group, with 48% of the sample.

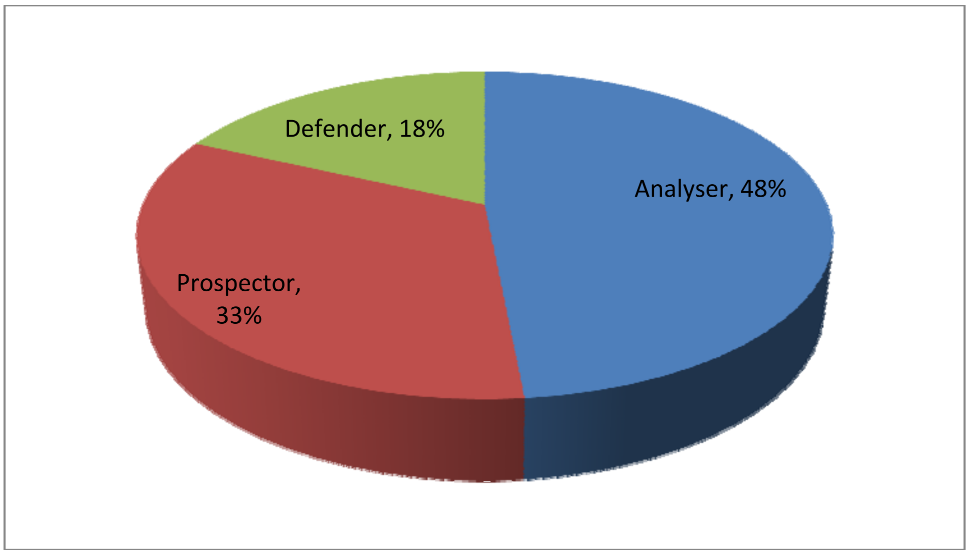


Figure 5.9: Classification by business strategy type

## 4 The correlation procedure

The Pearson correlation procedure was carried out on the sample between the calculated independent variable, "Alignment", and each of the five dependant variables linked to perceived business performance. The scores on the five performances were averaged to define a fifth dependant variable, "Overall". The analysis was repeated for each of the business strategy types of Anayser, Prospector and Defender. The results are presented below.

### *4.1 Analysis for the whole sample*

Table 5.2 below shows the correlation coefficients and probability values comprising the model for Alignment as the independent variable and each of the six perceived business performance variables as dependant variables. All correlation coefficients are both positive and significant in explaining the variation of the dependant variables. The average perceived performance, represented by the variable "Overall" has a Pearson Correlation Coefficient of 0.67, or an $R^2$ value of 0.45. This means that the model explains at least 45% of the variation of the dependant variable. The Pearson Correlation constants are positive, showing that business performance, according to the survey, increases as strategy alignment increases. The p-value is less than 0.0001, which is below 0.05, showing that the coefficient is significant at the 95% confidence interval.

The results also show that New Product Support is more positively aligned with strategy alignment compared to other dependant variables for the whole sample. The correlation coefficient is 0.79. However, overall profitability is least positively aligned with strategic alignment, with a correlation constant of 0.34.

| Pearson Correlation Coefficients, N = 33<br>Prob > \|r\| under H0: Rho=0 | | | | | | |
|---|---|---|---|---|---|---|
| | **Production Volumes** | **Unit Cost** | **Quality** | **Profit** | **New Product support** | **Overall** |
| **Alignment** | 0.51041 | 0.49632 | 0.79450 | 0.34909 | 0.44004 | 0.67117 |
| P-value | 0.0024 | 0.0033 | <.0001 | 0.0465 | 0.0104 | <.0001 |

Table 5.2: Pearson Correlation Coefficients, whole sample

## *4.2 Analysis by Business Strategy Group*

**4.2.1 Analysers**

The results for the Analysers business strategy cluster show significant positive correlation between four of the five business performance measures and strategic alignment. Production Volumes, Unit Production Cost, Product Quality and New Product Development are all significantly correlated with strategic alignment, while Profitability is not significantly correlated with strategic alignment with a probability value of 0.08 which is above 0.05. This shows that there is no evidence, at the 95% confidence interval, that this correlation constant is not equal to zero. Product Quality, New Product Development and Overall Business Performance are highly correlated to strategic alignment with correlation coefficients of 0.79, 0.78 and 0.79 respectively.

| Pearson Correlation Coefficients, N = 16<br>Prob > \|r\| under H0: Rho=0 | | | | | | |
|---|---|---|---|---|---|---|
| | **Prod_Volumes** | **Prod_Cost** | **Quality** | **Profit** | **New_Product** | **Overall** |
| **Alignment** | 0.53105 | 0.62610 | 0.78723 | 0.44586 | 0.77718 | 0.79344 |
| p-value | 0.0343 | 0.0095 | 0.0003 | 0.0835 | 0.0004 | 0.0002 |

Table 5.3: Pearson Correlation Coefficients, Analysers

**4.2.2 Prospectors**

The results for the Prospectors business strategy cluster show significant positive correlation between only one of the five business performance measures and strategic alignment. Product Quality is significantly correlated with strategic alignment, while Production Volumes, Unit Product Cost, Profitability, and New Product Support are not significantly correlated with strategic alignment with probability values above 0.05. This shows that there is no evidence, at the 95% confidence interval, that the correlation coefficients are not equal to zero. Product

Quality and Overall Business Performance are highly correlated to strategic alignment with correlation coefficients of 0.91 and 0.65 respectively.

| Pearson Correlation Coefficients, N = 11<br>Prob > \|r\| under H0: Rho=0 | | | | | | |
|---|---|---|---|---|---|---|
| | **Prod_Volumes** | **Prod_Cost** | **Quality** | **Profit** | **New_Product** | **Overall** |
| **Alignment** | 0.54537 | 0.34459 | 0.91440 | 0.42626 | 0.36691 | 0.65119 |
| p-value | 0.0827 | 0.2994 | <.0001 | 0.1911 | 0.2670 | 0.0300 |

Table 5.4: Pearson Correlation Coefficients, Prospectors

**4.2.3 Defenders**

The results for the Defender business class were severely affected by the small sample size. The results show that the independent variable Alignment did not significantly explain any of the five dependant variables, and consequently, the overall business performance variable.

| Pearson Correlation Coefficients, N = 6<br>Prob > \|r\| under H0: Rho=0 | | | | | | |
|---|---|---|---|---|---|---|
| | **Prod_Volumes** | **Prod_Cost** | **Quality** | **Profit** | **New_Product** | **Overall** |
| **Alignment** | 0.34355 | 0.54501 | 0.00942 | 0.58268 | -0.20024 | 0.38723 |
| P - value | 0.5050 | 0.2634 | 0.9859 | 0.2249 | 0.7037 | 0.4482 |

Table 5.5: Pearson Correlation Coefficients, Defenders

## *4.3 Multiple Regression Analysis*

For the purposes of the regression analysis two dummy variables were created to measure the effect of the business strategy on each of the dependent variables. The dummy variable description is given below:

Dum1=1 when Business strategy is “An”; Dum1=0 otherwise

Dum2=1 when Business strategy is "Pro"

Dum2=0 otherwise

This makes Business strategy "Def" the reference group.

All the regressions were multiple regression analyses, since the variables ***Dum1 and Dum2*** were also included to test whether there were differences between the three Business strategies involved in the analysis. In all the analyses the dummy variables were not significant, which indicates that there is no significant differences in the performance measures compared across the different Business strategies. The results of the analysis of variance and T- tests for overall business performance are given and explained in Sections 4.3.1 and 4.3.2. The results for the five business performance variables are given in Section 5.4.

### 4.3.1 Analysis of variance

The analysis of variance measures the overall model fit, with the following hypothesis:

$H_0$:Slope coefficients are simultaneously equal to zero.

$H_1$:At least one of the coefficients is not equal to zero.

The rule of thumb is that if the probability value is less than 0.05, the null hypothesis will be rejected, which will indicate that the model as a whole is regarded as a significant model.

The analysis of variance tests results for Overall business performance is given in Table 5.6. In this regression result the probability value (0.0002) is less than 0.05, and the null hypothesis can be rejected. Therefore there is enough statistical evidence to suggest that this model can be regarded as a significant model in explaining the variable Overall.

Table 5.7 shows that the $R^2$ value is 0.4814 and the adjusted $R^2$ value is 0.4277. The adjusted R-squared is interpreted in multiple regression analysis. By examining the adjusted R-squared value it can be interpreted that 42.77% of the variation in the dependent variable is explained by the explanatory variables in the model, namely alignment, Dum1 and Dum2.

| Analysis of Variance | | | | | |
|---|---|---|---|---|---|
| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| **Model** | 3 | 8.38780 | 2.79593 | 8.97 | 0.0002 |
| **Error** | 29 | 9.03765 | 0.31164 | | |
| **Corrected Total** | 32 | 17.42545 | | | |

Table 5.6: Analysis of Variance Test Results

| | | | |
|---|---|---|---|
| **Root MSE** | 0.55825 | **R-Square** | 0.4814 |
| **Dependent Mean** | 3.67273 | **Adj R-Sq** | 0.4277 |
| **Coeff Var** | 15.19988 | | |

Table 5.7: Adjusted $R^2$

### 4.3.2. T-tests for individual variables

The t-test for the individual variables in the analysis tests the following hypotheses:

$H_0$: Individual slope coefficient is equal to zero.

$H_1$: Individual slope coefficient is not equal to zero.

If the probability value is less than 0.05 the null hypothesis will be rejected.

The probability value for 'alignment' (<0.0001), is less than 0.05 therefore the null hypothesis can be rejected. It can be concluded that there is enough statistical evidence to suggest that 'alignment' is significant in explaining the dependent variable (Overall). As mentioned before the dummy variables were not significant in the models which indicates that there is no statistically significant difference between the different Business Strategies when it comes to explaining overall business performance.

The presence of multicollinearity (correlation between the explanatory variables) was also tested by calculating the variance inflating factor (VIF). In all the cases the VIF was less than 10. Multicollinearity becomes a problem when the VIF is greater than 10.

| Parameter Estimates | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Variable** | **Label** | **DF** | **Parameter Estimate** | **Standard Error** | **t Value** | **Pr > \|t\|** | **Variance Inflation** |
| **Intercept** | Intercept | **1** | 5.10716 | 0.37007 | 13.80 | <.0001 | 0 |
| **Alignment** | Alignment | **1** | 0.37502 | 0.07255 | 5.17 | <.0001 | 1.11664 |
| **dum1** | | **1** | -0.22392 | 0.27505 | -0.81 | 0.4222 | 2.00091 |
| **dum2** | | **1** | 0.06503 | 0.28333 | 0.23 | 0.8201 | 1.88899 |

Table 5.9: T-tests results

### 4.3.3 Normality of dependant variables

The normality of all the dependent variables was tested, none of the dependent variables were strictly normally distributed but the skewness in the data was slight, therefore it was treated as negligible.

### 4.3.4 Multiple Regression Results for business performance measures

The detailed results are given in **Appendix 1**. All the results show that both the model and the individual variable "Alignment" are statistically significant in explaining the dependant variables and the coefficients are not equal to zero. The adjusted $R^2$ values for the different variables, showing the percentage of the variation in the respective dependent variables which is explained by the independent variables in the model (Alignment, Dum 1 and Dum 2) are given in Table 5.10 below.

| Variable | $R^2$ | Adjusted $R^2$ | % |
|---|---|---|---|
| **Production Volumes** | 0.2724 | **0.1971** | 19.71% |
| **Production Cost** | 0.2544 | **0.1773** | 17.73% |
| **Product Quality** | 0.6564 | **0.6208** | 62.08% |
| **Profitability** | 0.221 | **0.1416** | 14.16% |
| **New Product Development** | 0.2858 | **0.2119** | 21.19% |
| **Overall** | 0.4814 | **0.4277** | 42.77% |

Table 5.10: Summary of multiple regression results

## *4.4. Performance measurement metrics*

### 4.4.1 Ranking of maintenance performance metrics

This section assessed the extent to which different business strategy types prefer to use a selected basket of popular maintenance performance metrics derived from theory. The metrics were ranked based on the sum of scores. Table 5.11 shows the ranking for the whole sample.

| RANK | PROSPECTORS | Sum of Scores |
|---|---|---|
| **1** | **Plant availability** | 158 |
| **2** | **Maintenance costs per unit** | 140 |
| **3** | **Ratio of planned and unplanned work** | 118 |
| **4** | **Equipment reliability** | 114 |
| **5** | Overall Equipment Effectiveness | 103 |
| **6** | Balanced scorecard | 103 |
| **7** | Maintenance schedule compliance | 75 |
| **8** | Repairs turnaround times. | 74 |

Table 5.11: Rank of maintenance performance metrics

Tables 5.12, 5.13 and 5.14 show the ranking by business strategy type. Plant Availability and Maintenance cost per unit scored highest for each of the three business strategy type groups, and consequently the combined sample. The other maintenance performance metrics in the top four ranks for the three clusters are Ratio of planned to unplanned work, Equipment reliability and the Balanced Score Card. The top four performance metrics for Analysers and Prospectors are similar, and comprise Plant Availability, Maintenance cost per unit, Ratio of planned and unplanned work and Equipment reliability in slightly different orders. The Defenders group is slightly different, with Equipment reliability being displaced by the Balanced Score Card. It still however follows closely at the fifth position, giving credibility to the assumption that the results for this group are distorted due to the very small sample size.

| Rank | ANALYSERS | Sum of scores | Mean | Median | Mode |
|---|---|---|---|---|---|
| 1 | Plant availability | 76 | 4.75 | 5 | 5 |
| 2 | Maintenance costs per unit | 69 | 4.31 | 4.5 | 5 |
| 3 | Equipment reliability | 60 | 3.75 | 4 | 5 |
| 4 | Ratio of planned and unplanned work | 59 | 3.69 | 4 | 5 |
| 5 | Overall Equipment Effectiveness | 57 | 3.56 | 4 | 4 |
| 6 | Balanced scorecard | 41 | 2.56 | 2 | 1 |
| 7 | Repairs turnaround times. | 38 | 2.38 | 2 | 2 |
| 8 | Maintenance schedule compliance | 32 | 2 | 2 | 1 |

Table 5.12: Ranked metrics for Analysers

| RANK | DEFENDERS | Sum of Scores | Mean | Median | Mode |
|---|---|---|---|---|---|
| 1 | Plant availability | 30 | 5 | 5 | 5 |
| 2 | Maintenance costs per unit | 30 | 5 | 5 | 5 |
| 3 | Balanced scorecard | 27 | 4.5 | 5 | 5 |
| 4 | Ratio of planned and unplanned work | 22 | 3.67 | 4 | 5 |
| 5 | Equipment reliability | 14 | 2.33 | 2 | 4 |
| 6 | Maintenance schedule compliance | 13 | 2.17 | 2 | 1 |
| 7 | Repairs turnaround times. | 11 | 1.83 | 1.5 | 1 |
| 8 | Overall Equipment Effectiveness | 10 | 1.67 | 1 | 1 |

Table 5.13: Ranked metrics for Defenders

| RANK | PROSPECTORS | Sum of Scores | Mean | Median | Mode |
|---|---|---|---|---|---|
| 1 | Plant availability | 52 | 4.73 | 5 | 5 |
| 2 | Maintenance costs per unit | 41 | 3.73 | 4 | 5 |
| 3 | Equipment reliability | 40 | 3.64 | 4 | 5 |
| 4 | Ratio of planned and unplanned work | 37 | 3.36 | 4 | 2 |
| 5 | Overall Equipment Effectiveness | 36 | 3.27 | 4 | 5 |
| 6 | Balanced scorecard | 35 | 3.18 | 3 | 3 |
| 7 | Maintenance schedule compliance | 30 | 2.73 | 3 | 4 |
| 8 | Repairs turnaround times. | 25 | 2.27 | 2 | 2 |

Table 5.14: Ranked metrics for Prospectors

**4.4.2 Kruskal-Wallis test**

The Kruskal-Wallis test was used to test whether for each variable there was a difference in the ranked sum of scores for the different business strategy types. The results showed that there was no significant differences between the three groups on the ranked sum of scores (probability values greater than 0.05), except for maintenance cost per unit and Balanced Score Card which had a probability values of 0.0328 and 0.0267 on the ranked sum of scores using the non parametric process.

# CHAPTER 6

# DISCUSSION OF RESULTS

## Introduction

This chapter discusses the results of the study within the context of the research questions outlined in Chapter Three. The Chapter is organized into sections, each discussing a single research question by examining the results as given in Chapter Five in the light of concepts developed in literature review, Chapter Two.

## *6.1 Determine the level of perception of business strategy at the maintenance practitioner level in business units.*

This research question was aimed at determining the level of business strategy awareness at the maintenance strategy formulation functional levels in the business. In order for maintenance practitioners to be able to formulate and effectively execute maintenance strategies aligned to business strategy, they need to be aware of, and commit to, the business strategy. Awareness of any strategy is best described by awareness of strategy elements making up that strategy. Figure 6.1 below shows the distribution of the level of awareness of business strategy elements of the respondents.

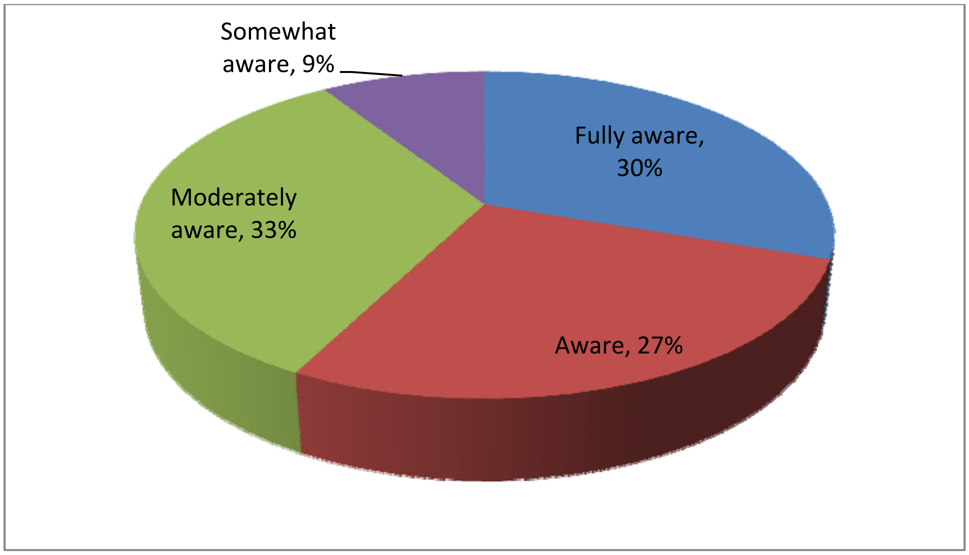


Figure 6.1 Distribution of the level of awareness of business strategy elements

30% of the respondents in the survey were fully aware of business strategy elements. The modal class was the Moderately Aware category, with 33%. Three respondents were "somewhat aware" of business strategy. Furthermore, all respondents except one concurred that their businesses had a written and signed off business strategy. Perception of strategy may also be influenced by the level of the respondents in the organisation, where lower level employees are less likely to be aware of business strategy compared to higher level employees. 82% of the respondents were Section Engineers, Operations Managers, Engineering Managers or Business unit managers, levels which can generally be described as managerial to senior managerial. Such managers are responsible for formulating maintenance strategy, or have a significant influence in determining the maintenance strategy elements adopted. They are also ultimately accountable for maintenance strategy execution. 18% of the respondents were maintenance foremen or planning superintendents, which can be classified as supervisory levels. They are primarily responsible for strategy execution.

The above situation bears testimony to low levels of awareness of business strategy amongst maintenance practitioners as a contributing factor towards lack of alignment between maintenance strategy and business strategy in organisations. According to Norden (2003), this arises mainly from failure to understand what maintenance entails and lack of appreciation of the integrated, yet subordinate role maintenance has to play in an organisation. The narrow definitions of maintenance given in Section Two further reinforce this perception, resulting in maintenance being viewed and judged as an isolated function. The need for its integration into the higher order business strategy is not understood. Results for research question 6.4 confirm this by showing that the performance metrics used to judge maintenance productivity are primary efficiency functions (plant and equipment availability, maintenance costs, equipment reliability) with little hint on execution of an integrated strategy. The Balanced Score Card was ranked low by all business strategy types.

***6.2. Investigate the nature of alignment/fit between business strategy and maintenance strategy and the impact of this on performance.***

This research question aimed to draw insights into the nature of alignment/fit between business and maintenance strategy by determining its impact on business performance. The alignment between business strategy and maintenance strategy, based on ideal business and maintenance strategy models for the sample was operationalised into a numerical variable by following the method described in Chapter Four. The impact of the calculated variable, Alignment, on business performance was then tested as the correlation between the variable (independent) and a chosen basket of business performance metrics (dependant variables). The results were verified using multiple regressions.

### 6.2.1. Whole sample

Table 5.2 summarises the correlation coefficients between alignment and perceived business performance. Alignment was significantly associated with perceived business performance in the combined sample, based on each of the five perceived business performance measures, thereby supporting Hypothesis 1. This correlation is confirmed by the multiple regression process whose results are given in section 4.3.4.

### 6.2.2. Analysers

Hypothesis 2 – proposing that, for Analysers, alignment between business strategy for analysers and maintenance strategy is positively associated with business performance is supported. The results for the Analysers business strategy cluster show significant positive correlation between four of the five business performance measures and strategic alignment. Production Volumes, Unit Production Cost, Product Quality and New Product Development are all significantly correlated with strategic alignment, while Profitability is not significantly correlated with strategic alignment with a probability value of 0.08 which is above 0.05. Overall business performance was also found to be strongly, positively and significantly correlated to Alignment.

### 6.2.3. Prospectors

Hypothesis 3 – proposing that, for Prospectors, alignment between business strategy for Prospectors and maintenance strategy is positively associated with business performance is partially supported. The results for the Prospectors business strategy cluster show significant positive correlation between one of the five business performance measures and strategic alignment. Product Quality is significantly correlated with strategic alignment, while Production Volumes, Unit Product Cost, Profitability, and New Product Support are not significantly correlated with strategic alignment with probability values above 0.05. Overall business performance is highly correlated to strategic alignment with a correlation coefficient of 0.65. The results were once again verified by the multiple regression analysis.

### 6.2.4. Defenders

Alignment was not significantly associated with business performance for Defenders. All correlation coefficients were not significant with probability values above 0.05, thereby indicating a lack of support for Hypothesis 4.

### 6.2.5. Discussion of results

*6.2.5.1. Impact of strategic alignment on business performance*

The empirical support for Hypothesis 1, 2 and 3 reinforces the argument developed in Chapter Two that alignment between business and maintenance strategy improves business performance. This implies that maintenance strategy formulation and execution should be viewed more closely and integratively in order to influence business performance. Maintenance practitioners must be informed by business strategy in their choice of maintenance strategy elements. The chosen maintenance strategy elements must be aimed to drive fit or alignment by reinforcing, adding on or complementing business strategy (Porter, 1996). Table 2.2 identifies maintenance strategy elements that would be appropriate for Defenders, Analysers and prospectors. The results supported these elements for Analysers and Prospectors.

*6.2.5.2 Universality of the impact of alignment on business strategy*

The support for Hypothesis 2 (Analysers) and 3 (Prospectors) and the lack of support for Hypothesis 2 (Defenders) is surprisingly similar to Sabherwal and Chan (2001)'s findings. They allude this to the fact that such alignment may not be entirely universal. Therefore, the significance of the association between alignment and business success depends on the business strategy. For this sample, there was significant correlation between alignment and performance for Analysers and Prospectors. However, this association was not observed for Defenders. Defenders emphasize stability, operational efficiency and economies of scale. They infrequently search outside their domains for new business opportunities, and they prefer to make few radical adjustments to the technologies they use (Sabherwal & Chan, 2001). For these businesses, any deliberate efforts by management to focus on alignment of business and maintenance strategy may not result in a proportional improvement in business performance.

*6.2.5.3 Business performance for Analysers, Prospectors and Defenders*

In all the multiple regression analysis carried out, the business strategy type variables, represented by the two dummy variables (Analysers and Prospectors), with Defenders as the reference group, were included to test whether there were differences between the three business strategy types involved. In all the analyses, the dummy variables were not significant, with probability values greater than 0.05. This indicates that there are no significant differences in the performance measures compared across the different business strategies. In simple terms, each of the three business strategy types can be successful, and there is no strategy type which is superior to each other.

## *6.3. Draw insights into the type of maintenance practice mixes (functional maintenance strategies) adopted by companies following different business strategy profiles.*

Further to 6.2.5 above, support for Hypothesis 1, 2, and 3 validates the ideal maintenance models developed from theory. Table 2.2 identifies a set of maintenance strategy elements for each business strategy type of Analysers, Prospectors and Defenders. Maintenance practitioners should therefore, especially for Analyser and Prospector business strategy types, desist from wantonly picking maintenance practices based on “best practice” but should be guided by achieving alignment with business strategy by picking the relevant elements. There is need to further research the proposed ideal maintenance strategy model by analyzing the extent to which each element reinforces particular elements of business strategy.

## *6.4. Understand the nature of relationship between maintenance effectiveness measurement metrics and business strategy types.*

### 6.4.1 Ranking of performance metrics

The last research question was aimed at understanding the nature of the relationship between maintenance effectiveness measurement metrics and business strategy by exploring how different business strategy types prefer certain metrics to others in measuring and reporting their performance. A key observation from the results given in Chapter Five is that there is consistency in the top four ranked maintenance performance metrics on all three business strategy types. Figure 6.2 below shows a radar plot of the sum of scores for maintenance performance metrics for the whole sample. Figure 6.3 shows a similar plot for maintenance performance metrics by business strategy type.

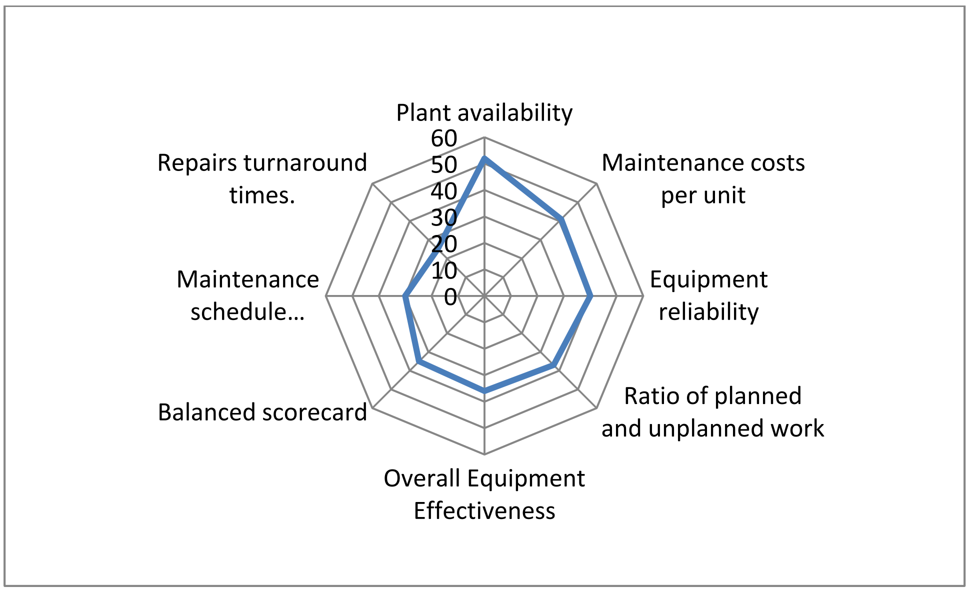


Figure 6.2: Top four metrics as classified by Tsang (1998)

The top four metrics, given here as classified by Tsang (1998) were plant availability, equipment reliability (measures of equipment performance), maintenance cost per unit produced (measures of cost performance) and ratio of planned to unplanned maintenance (measures of process performance). Tsang (2002) labels these as generic performance measures. While they are useful for judging operational support and benchmarking, they are largely retrospective and introspective in nature and do not provide information for predicting maintenance's ability to create future value needed to support business goals of the organisation. He recommends the use of the Balanced Score Card method, where performance is measured in an integrated way, from financial, customer, internal processes, learning and growth perspectives. Strategy is broken down into specific long term targets and objectives, performance measures and action plans, providing a checklist for directly evaluating the extent to which the maintenance strategy is executed in support of the business strategy. This approach was ranked lowly in the results.

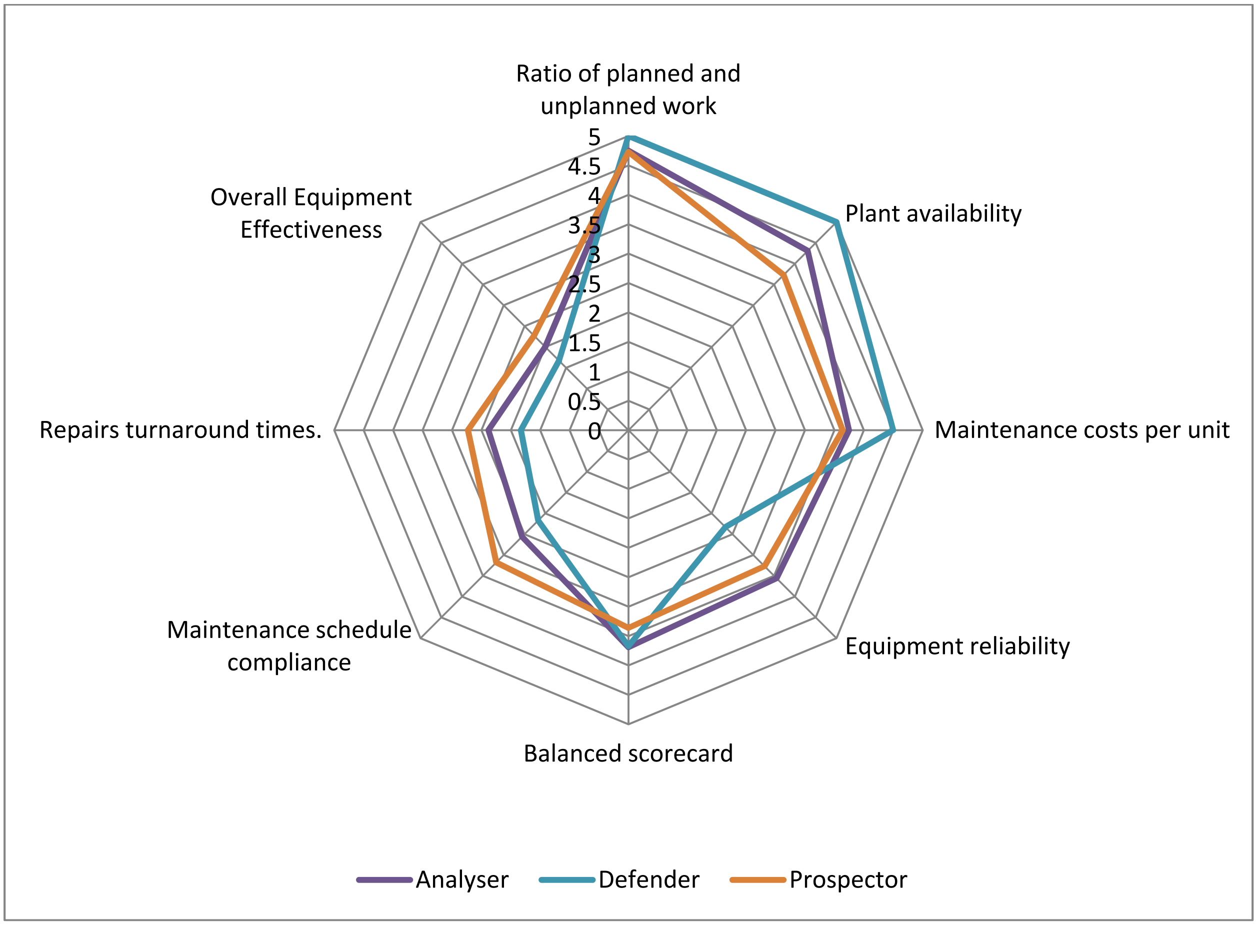


Figure 6.3: Radar plot of performance metrics mean score per business strategy group.

Maintenance practitioners must, in addition to formulating and executing maintenance strategies aligned to respective business strategies, develop and monitor performance measures which reflect that alignment. Performance measures should be linked to an organization's strategy in order to provide useful information for making effective decisions and shaping desirable employee behavior (Tsang, Jardine, Kolodny, 1999). The pitfalls relating to the indiscriminate use of common maintenance performance indicators include poor alignment and consequently poor business performance.

**6.4.2 Differences in maintenance performance**

The results of the Kruskal-Wallis test showed that there was no significant differences between the three groups on the ranked sum of scores (probability values greater than 0.05), except for maintenance cost per unit which had a probability value of 0.0328. This test also showed that maintenance performance metrics are chosen based on popularity or best practice without regard for business strategy. The feedback received by senior management may therefore fail to adequately measure the level of contribution of maintenance to creating competitive advantage and sustainability, leading to inappropriate decisions being made to maintain or changing the strategies. The obsession with measures of operational effectiveness was evident in the sample. It also appears all businesses were measuring the same aspects, meaning they were more likely to execute similar strategies than different strategies. According to Porter (1996), emphasis on improving operational effectiveness pushes the production frontier out but to no individual company's benefit. Companies should seek competitive advantage by differentiating themselves and developing a highly aligned and integrated system which is impossible to duplicate.

# CHAPTER 7

# CONCLUSION

## *7.1 Conclusions*

From the preceding discussion, the following conclusions can be drawn:

- Generally there is a low level of perception of business strategy at the maintenance practitioner level, which translates into poor alignment of maintenance strategy to business strategy at the design and execution levels.
- Low level of business strategy awareness is consequently, the main reason for poor alignment of maintenance strategy and business strategy.
- Alignment of business strategy and maintenance strategy is positively and significantly correlated to business performance. This relationship is however not universal. It holds for Analysers and Prospectors, but not for Defenders.
- There are no differences in business performance between the three business classes. Any of the three business strategy types can therefore be highly successful.
- The results validated the ideal business strategy model suggested by Sabherwal and Chan (2001) and the ideal maintenance strategy model derived from literature review for Analysers and Prospectors.
- Organisations rely on generic maintenance metrics, with plant availability, equipment reliability (measures of equipment performance), maintenance cost per unit produced

(measure of cost performance) and ratio of planned to unplanned maintenance (measures of process performance) dominating maintenance departments' score cards.

- There are no differences in choice of maintenance performance metrics between the three business strategy types.

## *7.2 Recommendations for maintenance practitioners and business unit managers*

From these discussions and subsequent conclusions, the following recommendations can be made:

- Maintenance managers must familiarize themselves with, and commit to business strategy to enable them to formulate and execute maintenance strategies that are aligned to business strategy. Maintenance strategy elements should be guided by business goals, and influenced by relevant business environmental factors. Emphasis should be placed on alignment with business strategy, other functional strategies, team and individual competencies, environmental trends and opportunities.
- Managers must ensure that resource allocation and competency development are guided by the need to achieve alignment between maintenance and business strategies. Allocation of resources or acquisition of equipment that do not reinforce maintenance's contribution to competitive advantage or sustainability will not result in proportional improvement in business performance.
- Maintenance managers and business managers must agree on a basket of relevant performance metrics which measure maintenance productivity in an integrated way, instead of adoption of generic metrics which measure short term financial, process and

cost performance. The Balanced Score Card is one such process. Such metrics will provide relevant feedback information on maintenance's contribution to business strategy execution. The signals to review maintenance strategy will therefore be picked easily as first signs of misalignment show. Resource allocation and decision support systems will consequently be guided by the need to achieve alignment, ensuring that maximum results are obtained from such investments.

- Computerised Maintenance Management Systems, often packaged within Enterprise Resource Programs are a key tool to achieve integration and relevant feedback information of maintenance productivity in an integrated way. The systems should therefore be configured to measure maintenance in relation to the extent to which it supports the business strategy. Most systems are poorly utilized because they are configured to give standard reports and functionalities which have nothing to do with business strategy. The use of consultants who have no knowledge of business strategies to set up CMMS functionalities and reports have resulted in maintenance managers chasing unimportant metrics, or aligning their maintenance strategies to poorly configured systems without addressing business goals.

### *7.3 Recommendations for future research*

This research has explored the relationship between strategic alignment and business performance based on the Miles and Snow business strategy typology. Several directions for future research emerge from this.

### 7.3.1 Ideal maintenance strategy profile

There is need to further research the maintenance strategy elements that make up an ideal maintenance strategy profile for each business strategy type. Such a research could focus on the impact of each maintenance strategy element on specific business strategy elements commonly adopted by each business strategy type by deciding whether it has no effect or it reinforces, adds on or complements the business strategy element. This research was limited to a set of maintenance strategy elements chosen based on the Hayes & Wheelwright's maintenance strategy decision framework. Further research should start by exploring the existence of more maintenance strategy elements and determining their impact on business strategy elements, and ultimately business performance.

### 7.3.2 Dynamics of alignment

There is need to further explore and understand the processes by which alignment is accomplished practically in organizations. This study may include the dynamics of alignment and the long term performance implications of alignment, answering questions on how organizations can maintain alignment in the long term.

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