

Decision Support Dashboards: Their impact on the ICT sector and how they can improve decision making

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Abstract

The objective of this dissertation is to document the research study which set out to determine what is required of decision support dashboards to enhance decision making in the information, communication and technology (ICT) sector. Another objective of this study involved the investigation of what constitutes an effective dashboard regarding its decision-making ability in ICT organisations. By combining the objectives mentioned above, the study attempted to identify whether the ICT sector incorporated any dashboard development methodologies that facilitated decision making abilities, and if not, whether such a methodology could be created. The researcher had chosen to complete a qualitative study that took an interpretive approach to analysing dashboards and the decision-making process. The researcher chose to use phenomenological theory in the process of conducting this research as the theory attempted to describe what drives an individual to act in a certain way. The researcher found this to be an effective method of investigating how participants use dashboards and what factors lead them to make good or bad decisions from a dashboard.

The researcher found that there were three areas that mainly contribute to the effectiveness of a dashboard and its ability to facilitate decision making in the ICT industry. These include end user requirements, dashboard design and the dashboard development process. Each of these areas included various elements such as collaboration, simplicity of design and an iterative development cycle. These categories were identified to be crucial for the creation of a dashboard that effectively facilitated and improved decision making abilities. The researcher then proposed a development methodology that combined these three areas. Lastly, the researcher tested this proposed development methodology in a real world scenario and found that it enhanced collaboration, dashboard design and allowed for an iterative development cycle. Overall the testing was a success as the participants stated they were satisfied with the results and the improved quality of the developed dashboard. The researcher did, however, find that the proposed methodology had some drawbacks, such as over-reliance on project management skills and an extended overall development cycle.

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1. Introduction

1.1 Background Information

Dashboards are visual tools that provide key business metrics at a summarized level to give an organisation a view of their Key Performance Indicators; some dashboards allow a user to drill down into more detail (Eckerson, 2011). However, management dashboards are mainly used to aggregate information and view a company's performance on a high level. Visualization of data in the form of dashboards is a popular decision support tool in many organisations worldwide and has been shown to deliver key benefits to companies (Velcu-Laitinen & Yigitbasioglu, 2012). These dashboards allow users to view a company's performance and KPI's at a snapshot and apply a top-down approach to problem-solving within the organisation (Velcu-Laitinen & Yigitbasioglu, 2012). According to Pauwels, Ambler, Clark, LaPointe, Reibstein, Skiera, Wierenga and Wiesel (2009) dashboards are decision support tools that aid in aligning and integrating strategy and goals in an organisation, thus leading to the alignment and integration of the entire organisation. Dashboards can be used as a communication tool as well as a decision support tool as they communicate metrics to users.

In a large number of cases, dashboards are seen as individual decision support tools that allow users to view whether a company or department is reaching their targeted goals or not. According to Velcu-Laitinen and Yigitbasioglu (2012), this should not be the case as dashboards have the potential to become powerful collaborative tools aiding in communicating key strategies, objectives and goals of an organisation as well as enhancing user's abilities to decide on how to improve or adapt their behaviour to reach those objectives and goals.

The adoption of dashboards is higher in companies with a better understanding of the different components involved in the decision-making process (Turpin & Marais, 2004). Velcu-Laitinen and Yigitbasioglu (2012) found that organisations with a higher financial turnover tend to have a higher tendency for adopting dashboards as dashboards can be

costly to implement if the data environment has not been set up correctly. Non-dashboard users tend to rely on other reporting tools for their reporting needs, that is expected as dashboards are not the solution to all of an organisation's reporting needs; it does, however, fill a gap in reporting on KPI's and other forms of metrics. Dashboards also allow companies to leverage their Information Technology(IT) and Business Intelligence(BI) architecture (Velcu-Laitinen & Yigitbasioglu, 2012).

An effective dashboard needs to include various components, however, it has been identified that the same components are required for an effective Information System(IS). One of these components is ensuring that the necessary buy-in from Top Management exists, the same component that is required for any successful IS implementation (Hedgebeth, 2007). Another important requirement states that the data used in a dashboard to compile reports, measure targets and drive all aspects of the dashboard, need to be accurate. The reason for this being that if the figures given by a dashboard are incorrect, it is very easy to lose buy-in from the relevant parties supporting the use of the dashboard (Hedgebeth, 2007). One also requires the direct input from management and end users in the development process of the dashboard. The reason for this being that most dashboards are designed to give users a view of the strategy and goals of the organisation. It is the organisation leaders and employees that created and understand those strategies and goals, not solely the IT department (Allio, 2012).

Dashboards come in various shapes and forms, one of these forms is called a Balanced Scorecard. This form of the dashboard is more focused on performance management of operational goals than it is on strategic management. However, it has very similar requirements to a more traditional dashboard (Chavan, 2009). Again one needs much understanding concerning an organisation's operational KPI's and goals. Hence, it becomes crucial to involve end users in the development process (Chavan, 2009).

One of the reasons that make dashboards so attractive to business is their mobile nature, many of the dashboard solutions created today are browser based (Iandoli & Quinto, 2012). The mobile nature of dashboards allows users to keep up to date on KPI's and overall organisation's performance while not being confined to an office desk. More timely

information has shown to lead to improved decision-making abilities which in turn leads to improved organisational performance (Barret, Mondick, Narayan, Vijayakumar, & Vijayakumar, 2008).

Velcu-Laitinen and Yigitbasioglu (2012) found that functionality plays a key role in the effectiveness of a dashboard as there is a positive relationship between drill down functionality, scenario analysis and the overall effectiveness of the dashboard in question. It was also found that such features are highly sought after by end users which show that dashboards are not just a tool to view summarized KPI's. Dashboards also need to be able to show the reason behind the summarized values they present. Research has also shown that to improve the effectiveness of dashboards one needs to take into account various human aspects. Some of these human aspects include the decision-making context, presentation of results and personal decision-making styles (Turpin & Marais, 2004).

Effectively designed dashboards gives organisations the ability to identify important information and filter out noise in the data. This information can provide key strategic insights and allow the organisation to take advantage of various opportunities. It also allows organisations to communicate their key findings to the rest of the organisation (Allio, 2012). According to Allio (2012), there is no silver bullet to dashboard design, but if one pays attention to various factors such as content, process and organisational politics one can create an effective dashboard for strategic and performance management. Pauwels et al. (2009) found that from a design and functionality perspective, it is extremely important that users view the correct measures in the exact way that they need to view the measures to minimize unnecessary communication.

As many dashboards are created with complex decision support systems in mind, an effective design methodology becomes imperative. However one of Turpin and Marais (2004) key findings were that these decision support systems cannot be applied to all levels of decision-making at once, hence a dashboard needs to be carefully designed with the end user in mind. If a dashboard is generalized to meet the needs of a wide audience, it can lead to a loss of effectiveness in the dashboards ability to assist in the decision-making process (Velcu-Laitinen & Yigitbasioglu, 2012).

Many organisations still tend to rely on “gut feel” to make decisions, this “gut feeling” points to the human factor involved in decision making. This human factor points to one of the biggest gaps in dashboards as a tool, it is the inability to take “gut feeling” into account as “gut feeling can take preference over more rational decision making with some users” (Turpin & Marais, 2004). However it can be argued that as dashboards are just a tool to supplement decision making, it cannot be expected to replace the entire decision-making process. Dashboard’s decision-making ability can also be severely hampered by the way a user decides to use the tool. If a user sees the dashboard only as a historical report and it leads to no action being taken, the dashboard loses most of its benefit from a decision support system point of view.

Yusof and Othman (2012) found that in the manufacturing industry, there was an upward trend in the performance of organisations that implemented Business Intelligence solutions. Part of these business intelligence solutions included dashboards, among other tools. The implemented BI solutions allowed organisations to convert data into valuable information. These organisations then proceeded to use this information to enhance their decision-making ability. Some of the key characteristics identified as contributing to effective decision making include; real-time data, data describing the past and forecasts describing the future, as well as the effective display of information.

Graphs were also found to be interactive, thus, users required drill down functionality and other data discovery tools to ensure that a graph’s effectiveness increased (Yusof & Othman, 2012). These findings verified those of Velcu and Yigitbasiouglu (2010) in that the rules mentioned above could be generalized to multiple industries as Velcu and Yigitbasiouglu (2010) focused on a more corporate environment. The generalizability of these findings show that some aspects of dashboards in one industry can be migrated to another industry as one fact remains constant, and that is that human beings are involved in the decision-making process at one stage or another.

Another finding of Velcu and Yigitbasioglu (2012) points to the approach taken to dashboard development; they found that many dashboards were implemented in a siloed fashion with very little integration into the rest of the organisation and, for this reason, many of the implementations were met with much disappointment. They found that as with many BI tools, the dashboard implementation suffered due to it not being able to meet its end user's expectation, a classic case of overpromising. However, as dashboard performance is entirely dependent on the design methodology and the people behind the tool it can be argued that the shortcomings mentioned above not be a result of the tool itself but rather that of the development and implementation team.

One of the big drawbacks regarding current generation dashboards is their inflexibility. As the business environment is ever changing, it was crucial that dashboards are also ever changing to ensure that the correct KPI's are being measured to drive the correct strategy. As most decision support tools are fairly static in their design, it is difficult to update dashboards to display the most recent set of metrics needed by the business. This constraint can lead to business quickly sitting with an obsolete tool if they are not willing to make a continuous investment into the tool, whether it be resources or capital (Marren, 2011). The more turbulent an organisation's environment is, the more difficult it becomes to design an effective and useful dashboard (Borgman, Heier, & Bahli, 2012).

1.2 Research Objective

The objective of this study involved the investigation of what constitutes an effective dashboard regarding its decision-making ability in Information and communication technology (ICT) organisations. This study aimed to investigate various elements of the modern dashboard and identify which of these elements create an effective decision support tool. After these elements were identified this study investigated various methodologies that are currently being implemented in dashboard development. This investigation was done to determine how these methodologies can be supplemented to enable ICT organisations to create flexible dashboards that will allow them to optimise their decision-making abilities.

As no appropriate methodology could be identified for the ICT environment, this study investigated which aspects of current methodologies in use can be used to build a methodology specifically for the ICT environment. The end goal of this study is to create a tool/methodology that will assist dashboard professionals in the ICT industry to create more effective decision support tools.

The reason that the researcher decided to focus on this specific topic is because he could find very little research completed on decision support dashboards in the ICT environment and their impact on the ICT environment. The researcher felt that as dashboards have proliferated throughout various industries, as shown in the literature review, it is crucial to determine their impact on those industries. The literature review also showed that the ICT sector tended to be a leader in the use of dashboards (Ferreira, Putnik, Cunha, Castro, Alvas, Shah, & Verela, 2013). For this reason, the researcher found the ICT industry to be an attractive research subject as the possibility of new types of dashboards existed. Another reason for the initiation of this research study was to investigate the degree of impact that decision support dashboards have on the ICT environment.

1.3 Research Questions

1.3.1 Primary Research Question

Which elements create an effective decision support dashboard for organisations in the ICT industry?

1.3.2 Sub Research Questions

What makes an effective dashboard regarding flexibility, adaptability and usefulness?

What are the characteristics of a good decision support dashboard?

What does business require from a dashboard to enable effective decision making?

Which characteristics of an effective dashboard are industry specific?

1.4 Definitions

ICT Industry: As the ICT industry is a fairly large business sector the researcher saw the need to refine the meaning of ICT industry to ensure clarity whenever the abbreviation is used. In the context of this study, ICT refers to the telecommunication industry as the majority of research respondents originate from the telecommunication industry. For this reason, all assumptions and findings have a much larger bearing on the telecommunication sector of the ICT industry than any other.

Dashboards: The researcher also saw the need to elaborate on the meaning of a decision support dashboard in the ICT industry. In the context of this study, a decision support dashboard is a visual tool that shows users the performance of key metrics within their business unit or business as a whole (Eckerson, 2011). The definition of an executive dashboard in this research project is a dashboard that is used by high-level employees in an organisation for strategic decision making. On the other hand, a definition of an operational dashboard is a dashboard that is used by mid and low-level employees in an organisation for operational decision making.

1.5 Assumptions

Firstly this study assumed that dashboards will continue to play an important role regarding decision making within the ICT industry. It also assumed that there is room for improvement in the current methodologies used to design and implement dashboards. This assumption was deduced from the findings of the literature review. Please refer to Chapter 2: Literature Review of this study for more detail as to why this assumption had been inferred.

Secondly, the researcher assumed that interviewees answered questions truthfully and to the best of their knowledge as anonymity and confidentiality were preserved at all times. The participants had the freedom to withdraw at any stage of the research, also having the freedom to request that all data collected from them be destroyed and not used in any further studies.

Thirdly, this study assumed that the sample size was representative of the population. As this study centered around a qualitative study, the sample size was determined by the quality of information received from participants rather than a sheer quantity of participants. For this reason, participants were specifically chosen for their knowledge base and experience to be able to give the researcher a very detailed understanding of the way in which dashboards are used in the ICT industry. The exact number of participants was chosen to ensure that any individual participant did not have a significant impact on the overall results of the study. These measures were all taken in an attempt to minimise human bias. More information regarding the population sample is available in Chapter 4.2.1: Analysis.

Lastly, the researcher assumed that all of the individuals who participated in the testing of the proposed methodology acted as they would under normal business conditions and thus the test was a fair representation of an individuals reaction in that scenario.

1.6 Limitations

This study focused solely on the ICT industry and was not be generalizable outside of the ICT industry. As stated in the Definitions paragraph, this research study focused more heavily on the telecommunication industry within the ICT sector which limited the generalizability of the findings outside of this industry. As the other industries were outside of the scope of this study, the researcher did not action the limitation mentioned above.

Another limitation of this study came from the type of technology being studied; this study focused on dashboards in their current state of maturity. The researcher could not guarantee that results were generalizable to future iterations of dashboards as the technology might radically change. The results of this study were dependent on the effectiveness of the tools used to collect the data. Hence, the research tool used limited the usefulness of the findings. The period over which this study was completed was one year by a part-time researcher, thus, the researcher did not have the time resource available for investigation of a larger sample size.

The purpose of this research study was to propose a methodology for the development and implementation of an effective dashboard in the ICT industry. As this study only focused on the proposal of a methodology, extensive testing of this methodology was outside of the scope of this study. Testing of this methodology did occur, however, it was only done on a select case, and thus, this study cannot generalize the effectiveness of this methodology to all scenarios in the ICT industry. As limited testing had been done on the development methodology, the researcher strongly recommended further research and testing occur before this development methodology could be viewed as successful in real world applications.

1.7 Brief Chapter Overview

Chapter 2 of this study centred on the literature review. In this chapter the researcher investigated various sources of information regarding dashboards, their implementation and effectiveness in the ICT industry. The researcher also investigated various methodologies used when designing and implementing dashboards. Many of the findings in the literature review were then used in the following chapters as the literature review provided a guideline as to what needed to be investigated in this study. The sources of information covered in the literature review ranged from journal articles to textbooks used in various courses. A full list of all the literature reviewed can be found in the reference list.

Chapter 3 focused on the methodology used in the research process. In this chapter, the following aspects of the research process were covered: research paradigm, research theory, research technique, research instruments and data analysis. The researcher discussed the various methods used and the reason for choosing these various methods while conducting this research project. The researcher also explained the process that was followed while conducting the research and the reason for using this process.

Chapter 4 focused on the analysis and findings of the research conducted. In this chapter, the researcher took the reader through how the data analysis was completed and the findings of his research, and how he came to those findings. The researcher also delved into the process of how these findings were incorporated into a dashboard development methodology as well as the design of the actual methodology. The methodology was then discussed in detail and analysed to give the reader a view of its strengths, weaknesses and risks. This chapter also focused on how the ICT industry is affected by dashboards and how the dashboards used in this industry differ from those found in other industries. After the analysis of the methodology, this proposed methodology was tested in an actual real world case. The researcher presented the benefits and drawbacks discovered while testing this methodology, along with the overall performance of this methodology in Chapter 4.

Chapter 5 concludes this research study in a manner that provides the reader with a clear and concise view of what constitutes an effective dashboard optimised for decision making and how the methodology described in the analysis chapter would supplement the dashboard development processes currently used in ICT industry. This chapter aimed to give definite answers to the research questions listed above.

2. Literature review

2.1 Introduction

The researcher investigated research that had already been done in the field of dashboards and decision making, in the following sub-chapters. An ample amount of research was found that had already been done on the topic of dashboards and how they interrelate with the decision-making process. The researcher started with providing a broad overview of the findings that came from the literature review. This section did not focus on the exact details of the literature but was rather included to give the reader a general idea surrounding the themes, ideas and beliefs relating to dashboards that had been identified through the literature review.

After a broad overview had been provided to the reader, the researcher delved into the details of the literature review findings. Here the researcher explored many concepts and themes found in the literature. These concepts and themes included but were not limited to benefits of dashboards, stumbling blocks identified while designing and implementing dashboards, the effect of dashboards on the decision-making process and various methodologies currently used to design and implement dashboards. After a detailed analysis had been provided, the researcher closed this chapter by summarizing key findings and identifying their impact on the overall research project.

2.2 Broad Overview

Some interest was shown in the research of dashboards as a decision support system. This interest was due to dashboards being used as tools to show key metric's performance and other valuable information to end users (Few, 2006). Most of the literature found in this field of study revolved around how dashboards can be used as a service in aiding various functions of a business. Research ranged from Pauwels et al. (2009) who investigated how

dashboards could be used in a marketing environment to Silveria, Rodriguez, Casati, Daniel, D'Andrea, Worledge and Taheri (2010) who explored the implementation of dashboard's and its ability to assist in governance. Both of the authors mentioned above found dashboards to have great potential in an organisation and that they require further research in an attempt to make them a more viable solution for business.

Much of the literature reviewed identified key problems with developing and implementing dashboards; these problems ranged from a silo effect when designing and implementing dashboards right through to a neglect of the human factor (Turpin & Marais, 2004). Even though there are many problems concerning the way dashboards are currently implemented, the benefits far outweighed the resources necessary to resolve these problems (Pauwels, et al., 2009). March and Hevner (2005) found that to support managerial decision making it was critical that one had timely, integrated and accurate information displayed in an easy to understand format. Many of the literature reviewed suggested that further research into the topic of timely and accurate information will aid in the adoption of more effective dashboards.

Some of the literature reviewed did include some form of methodology for creating and implementing an effective decision support dashboard. However, no solution was specifically aimed at the ICT industry. Many methodologies were developed as generic methodologies that can be applied to any industry due to the nature of decision making (Palpanas, Chowdhary, & Mihaila, 2007).

Overall the literature on dashboard development and implementation had shown much growth. However, there is still much that could be added to this specific part of decisions support systems (Borgman, Heier, & Bahli, 2012). Dashboards have the ability, and in some cases have become, critical decision-making tools that can greatly assist the business in making accurate and timely decisions. However, as the business environment keeps on

adapting and changing, so to must the dashboard development and implementation methodologies keep on adapting and changing (Allio, 2012).

2.3 Details

This subchapter was broken into themes rather than authors, as stated in the above introduction chapter of the literature review. The subchapter will begin with the benefits of dashboards and progress from there. As much of the literature revolved around the implementation of dashboards and their benefits, there is no shortage of advantages of dashboards found in the literature. Allio (2012) found that dashboards provide a tool that allows business to bring together key metrics and decision making, thus allowing the business to standardize their objective and goals through the entire organisation. He also found that properly developed dashboards allow organisations to filter out unnecessary information and only focus on what is crucial. It was also found that dashboards give users the ability to visually mine data without the need for complex algorithms and large investments into advanced data analytics software (Jain, Ari, & Li, 2008). Another study found that dashboards also acted as a validity check for data being used in other systems, this was done through users checking the dashboard and making sure that everything seemed more or less as it should. If outliers or data inaccuracies were identified in a dashboard they would be investigated and be corrected if need be (Barret, Mondick, Narayan, Vijayakumar, & Vijayakumar, 2008).

Dolan, Veazie and Russ (2013) performed a quantitative study to determine the impact that a properly developed decision support dashboard can have on business. This dashboard was then tested on various professionals in the medical industry. The study found that dashboards, whether used alone or in conjunction with more traditional decision support tools, had the potential to be an effective format for clinical decision making. In another study done in the medical industry, a group of researchers created a dashboard based on defined process indicators as set out by the World Health Organization. This dashboard was then posted monthly to be viewed by research subjects and the researchers found an

increase in compliance over time, hence showing that the use of a dashboard can influence the behavior of humans (Meinke, Reutheebuch, Fassl, Gisler, Heiberger, Seeberger, Erckstein & Widmer 2013). Both the Dolan, Veazie, and Russ (2013) and the Meinke et al. (2013) studies supported the claim that dashboards can improve decision making in the clinical environment. Donaldson, Brown, Aydin, Boltan and Rutledge (2005) then further supported these findings by reporting the same findings concerning a research project focused on nurses and their performance benchmarks. It was also found that dashboards have great potential for assisting the decision-making process in mental health institutions as they aid in organising and reporting of critical information in easily interpreted formats (Chorpita, Bernstein, & Deleiden, 2008). From these four studies focused on the clinical environment, it became clear that dashboards could have a positive impact on decision making. However, because all four studies were based in the clinical environment, the results cannot be used to generalize the findings to other industries but rather forced the researcher to investigate whether the same benefits were possible in other industries, such as the ICT industry.

Pauwels et al. (2009) found that dashboards serve to simplify the complex business environment, thus ensuring that managerial staff focus on the key metrics and do not get distracted by less important problems. The researchers also found that dashboards served as a tool to organize important information, not just to simplify information. Through this, the business increased accountability within the organisation and improved cross-departmental integration. Comparing the studies found in the above paragraph with those done by Pauwels et al. (2009), the researcher found that a lot of similarities existed between the clinical environment and the business environment, and thus a lot of benefits experienced by dashboard users in the clinical environment were also experienced by users in the business environment. The researcher found results in the literature review regarding the use of dashboards in the clinical environment to be relevant in the business environment and that the benefits of dashboards found in the clinical studies mentioned above would also be experienced in research related to the business environment.

Dashboards also allowed users to have constant access to timely information, assuming that the dashboards were implemented on the correct hardware and software platforms (Velcu & Yigitbasiouglu, 2010). One of the key benefits of dashboards is that they allow managers of various levels to monitor and control key metrics within a company, this especially became important to business after the Enron scandal in 2001 (Velcu & Yigitbasiouglu, 2010). Treude and Storey (2010) found that dashboards kept project teams aware of key metrics and the changes in key metrics. They found that dashboards became pivotal to task prioritization and increasing competition between various project teams. Treude and Storey (2010) also found that there is an unclear distinction between high-level and low-level awareness and dashboards could assist in clearing up this distinction.

According to Silveira et al. (2010) designing an effective decision support dashboard comes down to understanding what the user expects to find in the dashboard and understanding what data can effectively be visualized in the dashboard. The researchers found that it is critical to structure the data in such a way that it is active and intuitive, especially when dealing with a wealth of information. The reason for adopting this structure was the requirement that users must be able to immediately identify key information and be able to drill down into the detail. Palpanas, Chowdhary and Mihaila (2007) found that it is important to create a dashboard that is intuitive and easy to read to maximize usability, they found that functionality is important but if the user cannot use the interface then that functionality was lost. Silveira et al. (2010) also found that the simplicity of a dashboard's design was one of the major challenges when developing an effective decision support dashboard focused on governance. The studies mentioned above approached dashboard design from two different angles however both found the simplicity of a dashboard to be very important to a dashboard's success. Based on the findings listed above the researcher concluded that a simple dashboard design is key to a successful dashboard that facilitates the decision making process.

Marx, Mayor and Winter (2011) completed a study where they investigated the effectiveness of Executive Information Systems (EIS) of which dashboards formed a part.

Among their findings was a need for complete and accurate information with the emphasis on strategic information. This finding substantiates the belief that every level of management requires a different level of information and what might be suited to senior management is not always suited for middle management. This belief is supported by Anthony (1965) in his work surrounding hierarchical models of organisations, and their different information system needs. Anthony (1965) broke the organization's information system needs into three distinct categories; strategic planning, management control and operational control. Each of these categories had distinct characteristics and informational needs. Although Anthony (1965) found Decision Support Systems to be the largest need for strategic planning regarding information system needs, much of the literature reviewed showed the need for decision support systems on a more operational level, an example of this would be Silveira et al. (2010). The research done by Anthony (1965) and the use of the Anthony triangle remains relevant due to its continued popularity (Ho, 2015).

Marx et al. (2011) found that users would not just like to view the information but would also want the ability to analyze the information, thus, drill-down functionality is required. Pauwels et al. (2009) verified the notion that drill down functionality is required in a dashboard and went as far as to state that it can be critical to a dashboard's success. Pauwels et al. (2009) argued that this functionality is especially important if users were expected to complete variance analysis or developers provided the same dashboard to multiple managerial levels. This finding also confirmed that of Marx et al. (2011) and Anthony (1965) regarding the need for different types of information required at different levels of management. Another finding of Marx et al. (2011) was that overly complex information system interfaces were found to deter the users from using the decision support tool. This finding is limited to executive level management as Marx et al. (2011) mainly investigated executive information systems. However, Pauwels et al. (2009) and other literature such as Few (2006) and Allio (2012), that focused on dashboard design in general found simplicity to be one of the key drivers behind a dashboard's success. For this reason, the researcher believes that the findings reported by Marx et al. (2011) regarding the simplicity of dashboard design can be generalized to dashboards other than those developed solely for executive use. Chorpita and Bernstein (2007) also found simplicity to be

key to an effective dashboard however they did not state that a complicated dashboard would automatically decrease in effectiveness. Rather, Chorpita and Bernstein (2007) stated that the more complex a dashboard became, the better the end users understanding needed to be regarding the metrics shown on the dashboard. This view somewhat diverged from the other views expressed in the literature as it did not regard a complex dashboard to be ineffective, but rather just requiring a better understanding.

Marx et al. (2011) also found that the users expressed a need for flexibility as their environments were constantly changing, and they required a tool that changed with their environment. Lastly, the subjects of this study stated that the cost of developing such dashboard tools was too high, however, the time factor played a bigger role than the actual cost factor. This study suggested that business is more concerned that a decision support system is delivered on time than within budget. According to Marx et al. (2011), these findings create a design paradox as executives require a tool that is comprehensive and includes all the information required to run a business but, on the other hand, they require a tool that delivers simple information presented in a comprehensive way. This finding was limited to the work done by Marx et al. (2011) and the researcher could not find similar claims in other research. However, as the researcher is aware that not every literature resource could be reviewed in this research study, it is possible that this finding is present in literature not reviewed by this researcher.

Silveria et al. (2010) found that it is crucial to have a well thought out navigation structure to make a dashboard as efficient and user-friendly as possible. Developers should not only focus on the information that is displayed and the functionality provided by that data but also focus on how users will navigate the information (Silveira et al., 2010). Again the literature (Silveira et al., 2010) found that drill down functionality is key to an effective dashboard; however it found that roll up functionality should not be ignored as it can be just as important to the right audience, something that was not present in other literature reviewed.

Chorpita and Bernstein (2007) found that a number of factors contribute to creating an effective dashboard regarding its decision support functionality. They found that compatibility of the information to the organisation's cultures and values were key. To simplify, showing the cost of inventory to the sales team might not help them in achieving their goal, if maximizing sales were their goal, and thus the dashboard would not assist them in achieving that goal. Another example would be to implement metrics that the organisation believes in, as the organisation will not use metrics it tends to find of little decision-making value. These findings overlapped with those of Allio (2012) who discusses the importance of culture within an organization and its impact on decision making. Allio (2012) found that if a dashboard conflicted with a company's culture, then the dashboard would have little chance of success. Chorpita and Bernstein (2007) also found that feedback plays an important role in decision making. However, this was difficult to address due to automated nature of the tool.

The following paragraphs focus on decision-making and what impacts decision-making. Turpin and Marais (2004) identified a number of models that describe the decision-making process. These models included the rational model, the model of bounded rationality and the organisational procedure view among many others. Each of these views had a different approach to making decisions. Hence, from the literature the researcher found it important to identify the audience's most common view of decision making and to try and facilitate this in a dashboard. Turpin and Marais (2004) also identified various decision makers in the process. Even though not all of these decision makers might always be involved, based on this finding the researcher felt it necessary that a dashboard needs to be flexible enough to facilitate different types of methods of decision making in much the same way that it needs to be flexible in order to adapt to a changing business environment. Only once the different forms of decision making is truly understood can one start to look at ways in which to support it (Turpin & Marais, 2004).

Dolan, Veazie and Russ (2013) created a decision support dashboard to evaluate its effectiveness in making decisions. They found that user's decision-making ability benefited

from a simple design as well the ability to only select the information they deemed necessary. However, users requested the ability to view more detailed information in order to make a more accurate decision, again coming back to the findings of Marx et al. (2011) regarding the need for drill down functionality. Dolan, Veazie and Russ (2013) also found that the implemented dashboard allowed users to work more effectively through complex decisions as it allowed them to quickly identify alternatives and tradeoffs between options through a less cluttered user interface, thus improving time to decision. 80% of participants of this research study also found that the dashboard was a useful tool to train others and help them make more effective decisions (Dolan, Veazie, & Russ, 2013).

Velcu and Yigitbasiouglu (2012) stated that dashboard's assistance in decision making comes from a concept called Cognitive fit theory. This theory revolved around the belief that there is a fit between the individual's decision-making ability, the presentation of information and the task. It proposes that decisions made under fit conditions outperform those under non-fit conditions and that the degree to how well a condition fits is dependent on how the information is presented, the user's knowledge and the current task that needs to be done. Thus to enable improved decision making the dashboard needs to leverage the users knowledge by providing information in an understandable way to the user and ensure that the information supplied is relevant to the user for the current situation.

Elias and Bezerianos (2012) found that interactive dashboards help users gain key insights that in turn are used in decision making. Dashboards can assist in gathering information from various sources where information is taken in at a glance and processed by the user. According to Elias and Bezerianos (2012) dashboards also greatly assisted in decision making as they have the ability to incorporate annotations. Annotations assist users in tracking past decisions as well as give them the ability to analyze past decision processes and analyze the effectiveness of those decision processes.

Both Velcu and Yigitbasiouglu (2012), and Elias and Bezerianos (2012) found that dashboards can have a positive impact on decision making. This finding is another example how two studies focused on different aspects of the same subject, in this case decision-making in the context of dashboards, and came to similar conclusions regarding the impact that dashboards have on decision making. The work by Turpin and Marais (2004) did not go into detail as to whether dashboards had a positive or negative impact on decision making, but rather focused on the different elements that can have an impact on decision making as a whole, thus highlighting the need for dashboards to take into account the various ways decisions are made if they wish to be successful.

Bharati and Chaudhury (2004) investigated decision-making satisfaction of users of web-based decision support systems. In summary, the findings reflected that information quality and system quality has an impact on decision-making satisfaction. However, information presentation, or design, did not have an impact on decision-making satisfaction. Bharati and Chaudhury (2004) did come to this conclusion through the use of regression and structural equations modelling techniques that provided a positive or negative correlation for each of the three aspects mentioned above. The study did state however that correlation is not always an indicator of causality, but the researchers believed that because those causal relationships were acquired from both the literature and theoretical, they could infer causality where it had already been validated. This finding is in contrast with that of Marx et al. (2011) and other researchers as mentioned earlier who found that a simple dashboard design leads to a more effective dashboard. It has to be noted though that decision-making satisfaction and decision-making ability are two different concepts, and that the research done by Bharati and Chaudhury (2004) was focused on web-based decision support tools in general and not specifically on dashboards.

Various methodologies had been created for designing effective dashboards, amongst them the model-driven design methodology proposed by Palpanas et al. (2007). This methodology proposed techniques that incorporated various models to decrease the time taken to develop a dashboard as well as make it less cumbersome. The methodology was broken up

into different phases namely: Pre-Modeling activity, Modeling activity and Post-Modeling activity. The Pre-Modeling activity focused on creating predefined report templates that are used to define metrics, dimensions, data structures and so forth. The Modeling phase was used to identify key metrics, create page templates, assign users to key metrics, and so forth. Lastly, the post-modeling phase focused on the deployment of the model and implementation into production. This methodology had been used to create an effective way of deploying dashboards but provided very little insight as to what needs to be taken into account to create an effective decision support dashboard.

Allio (2012) describes several ways in which to create an efficient dashboard, some of which have already been discussed in this chapter. There were, however, some components that had not yet been discussed, and these are listed below. Firstly it was suggested that the dashboard should have a clear strategy that it measures, thus clearly communicating the goal of the dashboard to the end user and minimizing the risk of creating confusion. Secondly, Allio (2012) found that management teams need to be included in the design of the metrics as this will boost accountability and senior management buy-in, which is crucial to the project. Once a dashboard has senior management buy-in the dashboard is also more likely to be used than if it had no senior management buy-in. Thirdly, Allio (2012) stated that dashboards should maximize the context of metrics, thus not showing metrics in isolation but rather as part of a whole. Lastly, he found that a culture of performance management and measurement is crucial to the success of any dashboard, this statement ties in with one of his previous findings regarding senior management buy-in. It was also found that culture plays a very important role in dashboards effectiveness in terms of decision making, if the company culture is of such that they find no value in performance management and measurements then they will find no value in dashboards. On a final note, Allio (2012) found, as reflected in many of the other literature references, an inflexible dashboard quickly becomes an obsolete dashboard, thus, a dashboard should be designed to be flexible.

Silveira et al. (2010) proposed a methodology that first looked at how different users make decisions in an organisation. The researchers analyzed processes in which decisions were being made and ensured that the dashboard would supplement this decision-making process instead of hindering the process. Once the needs and decision processes were identified, the researchers then looked at how navigation needs to be designed to ensure the best decision is being made. This methodology is much more attractive to the researcher as ensuring that the dashboard methodology assists in supplementing the decision-making process is key to the researcher.

Marx et al. (2011) developed a dashboard based on the six principals found in their research that had been discussed in the above text. Their methodology combined these six principles by using a combination of methods and techniques that promoted each of these principles. This methodology showed promise but due to their small sample size, the data could not be generalized to a larger sample. Pauwels et al. (2009) defined a simple methodology in which the development of dashboard can be broken up into five stages namely: selecting key metrics, populating the dashboard with data, establishing the relationship between dashboard items, forecasting scenarios and connecting to financial consequences. This methodology aimed to incorporate the requirements of effective decision making with the practicality of implementing a software tool.

Many of the methodologies found in the literature can add some benefit to an ICT specific dashboard in one way or another, and it is evident that a combination of these methodologies might deliver the best results. Very little could be found concerning a methodology for creating dashboards specifically in the ICT industry. However, Ferreira, Putnik, Cunha, Putnik, Castro, Alves, Shah and Verela (2013) did find that ICT dashboards tend to be a leader regarding innovative and new dashboard designs.

Eckerson (2011) discussed some steps and techniques regarding the design and deployment of dashboards. However, before he delved into dashboards he first emphasized the

importance of a proper Business Intelligence (BI) environment to support these dashboards. The author broke the BI environment into five different phases and believed that even though an organisation has some form of a dashboard at each stage, an organisation needs to achieve the final phase to extract the maximum value out of dashboards.

The first phase was entitled “Prenatal/Infant”, in this phase an organisation is said to be at the start of their BI journey, where data is difficult to access, dashboards are developed by programmers and customized reports are a very labour intensive process. The second phase was called “Child”, in this phase organisations are focused on empowering the employees reporting needs. Department managers focused on analytic structures that support a single business process or business function. They also focused on acquiring BI tools. However, these tools tended to serve only a small number of individuals known as power users.

The third stage was called “Teenager”, which focuses on consolidating separate BI projects into one project entity. In this stage, the organisation truly started to use performance dashboards as they were intended to be used. The reason for this was that data is more freely available, processes more automated and users more interested in the benefits of on-demand decision support systems. The fourth stage was called “Adult”. At this point, the organisation could deliver enterprise wide BI solutions that include dashboards. There was also much more cooperation between the business and the BI teams through the use of platforms such as committees, and BI best practices were solidified within the organisation. The final phase was referred to as “Sage”, in this phase the organisation tended to start to make BI services available to customers and suppliers to help them better manage interactions within the organisation. An example of this would be an organisation’s supply chain sharing their demand forecast with the supplier to ensure that the supplier can meet their raw material needs. This sort of integration could be done through the use of simple dashboards or reports.

Sallam, Richardson, Hagerty and Hostmann (2011) found thirteen capabilities that a Business Intelligence platform would require to function effectively, among these thirteen capabilities were reporting, dashboards, interactive visualization and scorecards. This research study focuses mainly on dashboards however as per previous findings from the literature review it is clear that reporting, interactive visualization and scorecards all form a part of dashboards. By this logic, it is then clear that from the 13 capabilities identified by Sallam et al. (2011) dashboards can in some instances fulfill not just 8% of the capabilities but in fact 31% of the required capabilities.

Sallam et al. (2011) identified three stages of research focus in Business Intelligence and Analytics and broke them into currently adopted, in the process of adopting and future adoption. Dashboards and Scorecards were assigned to phase one research which Sallam et al. (2011) described as technologies and applications that are currently in use in organisations and the business environment in general. Sallam et al. (2011) again referenced dashboards in phase 3 of their Business Intelligence and Analytics research in which dashboards are described as prominent emerging research areas that show promise for future adoption. In phase three Sallam et al. (2011) referred to mobile dashboards as a tool for mobile business intelligence and analytics.

Eckerson (2011) created a rough guide for developing dashboards, and as found through the entire literature review, there were no truly effective methodologies specifically developed for dashboards that were easily accessible to the public. Eckerson (2011) did, however, create a short guide that gives a broad overview of what is required to design and deploy a performance dashboard. He firstly focused on the need for a business sponsor that can help motivate the necessity of the dashboard in question, similar to what was found in the research of Allio (2012). It is important to ensure that the business sponsor is of a fairly high level within the organisation as he/she can help steer the organisation in the direction required to make the dashboard a success. An executive business sponsor can also more easily influence other top management decision makers and enable full business support (Eckerson, 2011).

Eckerson (2011) also found that after gaining executive support, one needs to sell the dashboard to mid-level management as these are usually the individuals that control the departmental budgets and influence how other staff members buy into the project. The author found that a risk that also needed to be mitigated at this point was that of certain individuals being threatened by dashboards, especially performance dashboards. Once proper support has been gained in the organisation, it was crucial to determine the type of dashboard being implemented. For example, operational dashboards are usually designed and managed at a departmental or organisational level, and much input will need to come from those levels. On the other hand, strategic or executive dashboards are usually developed for consumption by an executive audience and will require much input from that level to ensure a single department does not dominate the results.

After identifying the part of the business involved it is crucial to choose a champion or business driver for the implementation team (Eckerson, 2011). This individual is usually a senior executive with strong communication skills and strong knowledge of both business and the technical side of the business data. After a champion had been chosen a committee is then created that includes both members from the business departments involved as well as individuals from the technical team. This committee would then define the measures to be used in the dashboard. After the measures are defined, they are sent to a technical team in charge of creating the dashboard. Lastly, the finished dashboard would then be monitored regarding usage and possible improvements to ensure that it is adding value to the organisation.

The above-discussed methodology describes the high-level end to end process of dashboard development as seen by Eckerson (2011). It first looks at selling the idea to the organisation, secondly on building the dashboard and thirdly on ensuring the dashboard adds value. Unfortunately, the researcher did not find much detail regarding the actual design process of a dashboard in terms of user involvement and decision-making techniques. Eckerson (2011) did, however, state some ways to effectively design displays, create effective

performance measures and deploy dashboards that are integral parts of a dashboard development methodology.

As Few (2006) stated, dashboards display information that is needed to achieve specific business goals. Thus, it becomes critical in the design phase of a dashboard to identify these goals and ensure that the end users are all aligned as to which goals they would like a dashboard's assistance in achieving or else the development team runs the risk of scope creep. Another design recommendation from Few (2006) is that the dashboard should fit on a singular screen which refers to his rule that only critical data should be displayed on a dashboard to ensure that the most important information is communicated. This rule also makes it imperative for a dashboard designer to limit scope creep as much as possible as it will result in a complete redesign of the dashboard in most cases (Few, 2006).

Few (2006) then addressed the question of whether a dashboard should always display real-time data or whether the data presented can be static. He argued that the nature of the data reflected should purely be a derivative of the goals the dashboard attempts to accomplish. If the objective of the dashboard does not require real time data, then it is up to the dashboard design team along with the end users to determine when the data needs to be refreshed. It again becomes critical to involve the end users to ensure that there is full buy in and that the dashboard fulfills the needs of the end users.

Few (2006) then identified key supporting attributes that a dashboard requires to meet its objectives. He broke these supporting attribute into two large groups, namely display mechanisms and customizability. Under display mechanisms, he argued that display mechanisms should deliver the information in the best possible way while at the same time taking up the least amount of space and time. He also stated that by using display mechanisms just because they are fashionable, the design could become counterproductive as the most efficient way to display the data is not being utilized. These display mechanisms can also lead to less space being available for other information displays. The other

supporting attribute focused on how customizable the dashboard should be. He stated that if the dashboard is not tailored exactly to the needs of the end user, it will fail to serve its purpose, again showing the need to have end users involved in every step of the dashboard design process.

The researcher found that all of the methodologies mentioned above contained a similar pattern to dashboard development however some methodologies placed more emphasis on certain steps than others. The researcher could not find one truly unique development methodology but could find unique concepts within each methodology reviewed. Some of the paragraphs above did not refer to a full methodology as such but rather steps that need to be taken during the development phase to ensure a dashboard is successful. The reason the researcher felt the need to analyze this particular part of the research together with full methodologies was that these steps form part of a chosen development methodology.

A key framework for dashboard development discussed by Eckerson (2011) is known as the Double MAD framework and can be broken into three main components namely model, analytics and deliberation. This framework was proposed as a framework that defines the next-generation of dashboards capabilities at that time. The first layer of this framework, namely model, focused on what-if modelling capabilities in a dashboard. Eckerson (2011) stated that the what-if modeling served the purpose of trying to indicate what would happen in the future, thus bringing in a component of predictive analytics. The second layer of this framework, namely analytics, focused on integrating statistical algorithms such as regression modelling into a dashboard. The purpose of this would be to categorize and predict information, again pointing to the integration of not only predictive analytics but also descriptive analytics. The last layer of this framework, namely “deliberate and act”, brought in the collaborative aspects of a dashboard. Within this layer the dashboard should be capable of supporting discussion threads and initiating workflow processes as well as allow users to set alerts. The researcher found that the concepts discussed by Eckerson (2011) in his Double MAD framework to be more advanced than what was found in other literature.

Decision Support Systems technology and applications have been able to evolve significantly from their initial limited scope and utilization with the improvements in technology and processing power (Shim, Warkentin, Courtney, Power, Sharda & Carlsson 2002). Decision support systems started out as individually based decision-making tools, however, they have shifted focus to organisational decision making. This has resulted in decision support systems starting to focus on organisation-wide application. It is this organisation-wide application where dashboards shine as one of the tools in a Decision Support System's toolbox. However the fact that dashboards can still be a very effective decision support tool for an individual should not be neglected, and a dashboard does not need to be focused on organisational decision making to add value (Pauwels, et al., 2009). It is also important to note that dashboards are just one key component of an effective decision support system and is usually utilized as the information delivery mechanism (Shim et al., 2002).

Shim et al. (2002) investigated the past present and future of decision support systems and found that multi-source data will become key in the implementation of optimized decision support systems in the future. With the arrival of Big Data, this prediction seems to have realized as multiple sources of data are now being analyzed and provided to end users through various applications and tools, with dashboards remaining one of the more popular tools to display the output of these Big Data systems (Chen, Chiang, & Storey, 2012). At present data is generated at an unprecedented rate due to advancements in Information Technology (Chen, Chiang, & Storey, 2012). Big data relies more heavily on visualization techniques based on text and web mining techniques (Chen, Chiang, & Storey, 2012). These techniques start to move away from the core functions of a dashboard which is to view and track Key Performance Indicators (Few, 2006). This said it is not impossible to incorporate this type of visualization into a dashboard, but one should always be clear as to the reason for incorporating this data into a dashboard and whether this is the best way to display the required information to the end user (LaValle, Lesser, Shockley, Hopkins, & Kruschwitz, 2013).

It was also found that predictive analytics can play a role in exploratory data analysis (Shmueli & Koppius, 2011). Exploratory data analysis can be described as identifying certain relationships between variables that were previously unknown (Shmueli & Koppius, 2011). One way to implement this type of analysis was by visually identifying trend and patterns in the information provided. These types of analysis can yield not only a better understanding of the information being viewed but also help the user to learn about the measurements used. More advanced analytical models would also have an impact on the output from a dashboard as dashboards are visual tools that also assist in identifying relationships between information provided.

Sallam et al. (2011) also identified the need for data visualization on mobile devices. The reason that it has become such a prominent research area is that within Sallam et al. (2011) Business Intelligence and Analytics study they found that according to industry experts the number of mobile devices in use will reach ten billion by the year 2020. This possibility will have a large impact on current dashboard designs as many more users will start utilizing browser-based dashboards that can be viewed on tablets and smartphones. The problem with dashboards in relation to mobile devices is the fact that the display area is significantly reduced on a mobile device. Another factor that will need to be considered when designing a dashboard for mobile devices is the orientation of the screen that can significantly impact the layout of a dashboard. Yuen, Schulte, Bitterer and Tapadinhas (2012) stated that the number of dashboard users will increase as the adoption of smartphones and tablets increases. This trend again poses a risk for traditional dashboard design methodologies as traditional methodologies worked well with large screens that could provide a high resolution (Airinei & Homocianu, 2010). Another limitation found for mobile dashboards was the limited memory and processing power.

All of the above limitations play a role in designing dashboards as developers now have to design separate dashboards, one for traditional viewing and one for mobile viewing. However, the development life cycle needs to remain the same length as the business still views it as one dashboard just viewed on multiple devices. For this reason, it again becomes

important to have a flexible design methodology that will allow for a design that is mobile friendly (Airinei & Homocianu, 2010).

Airinei and Homocianu (2010) stated that mobile dashboards could lead to a competitive advantage for organisations due to the ease of access to information as well as the quality and increased the speed at which an organisation can make decisions and react to numerous events. The integration of multiple data sources available anywhere there is cell network coverage also adds weight to the mobile dashboard argument. However, Arinei and Homocianu (2010) stated that due to the barriers currently experienced in the mobile dashboard environment it will be a while before the identified benefits can be realized. Since this study was published, there have been various technological improvements made with some mobile devices such as the Apple iPad three tablets performing the same resource-intensive tasks as a personal computer. This development has resulted in a number of applications such as Google Analytics and SAP Business ByDesign Dashboard emerging with the sole purpose of providing mobile dashboards. Another technology trend is also helping to eradicate the limitations of small screens on mobile devices, the trend of ever-increasing display sizes on mobile devices. This trend has helped alleviate the resolution and screen size limitation (Boulos, Wheeler, Taveres & Jones 2011). As technology marches forward so does the processing power and graphical abilities of mobile devices, eroding many of the limitations that Arinei and Homocianu (2010) referred to. Due to consumer preference and cost, small screens will persist to some extent and thus a design methodology needs to be developed to solve this problem for mobile dashboards to realize their full potential.

2.4 Conclusion

The researcher elaborated on the many benefits incorporated in the use of dashboards as the literature showed that dashboards can and have been used as an effective reporting tool as well as an effective decision support system. Benefits of dashboards range from allowing users to quickly filter through information to integrating business strategies and

goals. However, as dashboards are decision support tools at their core, it is also important to take into account what defines a successful decision as well as how a user comes to a decision. For this reason, the researcher also delved into the different principles behind an effective decision as well as how a dashboard can lead the end user to make the correct decision.

The researcher also explored and discussed various methodologies currently proposed by the literature and evaluated the effectiveness of each for the purpose of this study. The researcher then came to the conclusion that a hybrid methodology would work best as it will need to take into account the specific needs of the ICT industry.

3. Research Method

3.1 Introduction

In the past few decades, research approaches have proliferated to such an extent to allow researchers to select from a large variety of research methods. Choosing a general framework at the start of the research was crucial as it impacted many aspects of the research project, from general philosophical ideas down to analysis procedures (Creswell, 2003). For these reasons, it was seen as a vital part of the research project as it became the foundation on which knowledge was built. The research method had been broken into five different components namely research paradigm, research theory, research technique, research instruments and data analysis. As the first three components are interrelated, they will be discussed under the heading of research design.

Research instruments will be dealt with separately as they are the tools used by the researcher, and the quality of the findings are very dependent on the tools used to collect the data (Simon, 2011). After the research instruments have been discussed the researcher will explain the ethical impact of the study as well as the precautions that have been taken to ensure that the study has been conducted in the most ethical manner possible.

3.2 Research Design

Research Design consists of three components namely research paradigm, research theory and research technique. As this study took a qualitative approach to research, the researcher investigated some of the paradigms used concerning qualitative research in the Information Systems paradigm. After much investigation, the researcher found that the Interpretivist approach will benefit this research study the most. The reason for this choice was based on the principle that decision making is a very personal process, and every person has a unique way of making decisions and weighs variables based on what is

important to them (Turpin & Marais, 2004). The researcher investigated other paradigms such as the positivist paradigm but found that due to the quantitative nature of the positivist approach it would not be possible to delve deep enough into what makes a person act the way they do when confronted by information.

The researcher then investigated various theories in the interpretivist paradigm, focusing mainly on Hermeneutics, Interactionism and Phenomenology. It was found that Hermeneutics is a very effective research theory for understanding text collected in a study of a body of text (Meyers, 1994). As it mainly focused on the text, the researcher decided that it not be particular suited for identifying why a person would act the way they do and, in turn, allow the researcher to identify which components need to be manipulated to allow users to make effective decisions.

Interactionism investigates how a collective's view of the surrounding world is impacted by interactions within the collective (Reeves, Albert, Kuper & Hodges 2008). Ultimately it attempts to identify how collectives attempt to create and modify the meaning of their surroundings through interactions within the group. This theory was very attractive to the researcher as this study focused a great deal on how people make decisions. However, this theory views individual as a part of a collective. One of the limitations of this study was the time resource, hence the researcher will not be able to study large groups due to their complexity. Another deterrent factor of this theory was that it placed more emphasis on the group than on the individual.

For the reasons mentioned above, the researcher decided to use the phenomenology theory when conducting this research project. Phenomenology explores how the human consciousness and self-awareness impacts various aspects of the individual's world and society as a whole (Reeves et al., 2008). Studies based on Phenomenology concern themselves with an individual's understanding of their surrounding and how this impacts their actions. Dashboards are seen as tools to aid in the visualisation of data through which

business tracks performance and, in turn, makes decisions based on the perceived performance (Few, 2006). The current view on dashboards placed the tool in the realm of decision support tools, which in turn meant that the use of dashboards were very dependent on how a person viewed the information provided to them. Phenomenology looks at why humans use the tool in the way they do and what factors impact how decisions are made from the information provided.

Because phenomenology aims to identify how people interpret the world around them through past experiences, it enables a researcher to evaluate the way in which meaning is associated with various aspects of reality (Starks & Trinidad, 2007). As the researcher performing this study is interested in how people attach meaning to information and data provided to them through visualisation techniques, it was found that phenomenology would assist in this regard. Starks and Trinidad (2007) argued that once the reasoning behind people's decisions can be understood, it should allow for better understanding of the appropriate method to be used to visualize data. This argument had been deduced based on journal articles from Reeves et al. (2008) and Moustakas(1994). Phenomenology had been used to some extent in information systems research, especially concerning Decision Support Systems (Hassall, 1998) (Baskerville, 1999).

The research technique chosen by the researcher completing this study consisted of a combination of literature reviews, semi-structured interviews and observations with parties involved in the creation of dashboards as well as the end users of dashboards. The initial research started with a literature review to determine what research has been done on this subject as well as the findings on what creates an effective dashboard regarding decision making. The second part of the literature review focused on current methodologies used to develop and implement dashboards and whether any of these methodologies is suitable for the ICT industry. The literature review was also used to create the format and questionnaires used in the semi-structured interviews.

After the literature review was completed the researcher started the process of identifying possible candidates within a multinational organisation currently operating in the ICT industry. Once a list of candidates had been identified the researcher started the process of collecting data through the use of the above-mentioned semi-structured interviews. Data was then analysed, and the findings were communicated to the participants to ensure that the researcher had interpreted the results correctly. The researcher then started the process of investigating how to amend/develop a methodology that takes into account the findings of the above results once the results had been confirmed by all participants.

Because no suitable methodologies could be identified the research project expanded into the creation of a methodology for the development and implementation of effective decision support systems through data visualisation. After the researcher had finalised the methodology, he reverted to the participants to test the newly created methodology and document the results through semi-structured interviews and observations. These tests were not done extensively as the goal of these tests were to determine initial benefits and not the prolonged impact of the use of this methodology, as this was outside the scope of this study.

3.3 Research Instruments

For the purpose of data collection, the researcher used a questionnaire with a set of open-ended questions. The reasoning behind this choice was the fact that this was a qualitative study and it was found that close-ended questions are more suited for quantitative studies. Open ended question gave the interviewee the freedom to express his opinions and beliefs concerning certain questions. Hence open-ended questions were better suited for qualitative studies (Oates, 2010). Because this study followed a phenomenological approach to research it was found to be vital to observe interviewees in the same context as where the phenomenon occurred, and allow interviewees to describe their experiences while in the same place as the phenomenon (Starks & Trinidad, 2007). As mentioned above, open-ended questions were found to be best suited for these needs as it allows interviewees to

describe their experiences but still allow the interviewer to delve into more detail where needed (Starks & Trinidad, 2007), thus the questionnaire took a semi-structured approach.

As stated in the above chapter, the questionnaire was based on the literature review findings and designed to take full advantage of research that had already been done on the topic. For this reason, the questionnaire design was very dependant on previous research and in a sense an extension of research that had already been done. Lastly, observations were used to gather information regarding the testing of the proposed methodology. The researcher approached and interviewed research participants where the researcher felt he could not gauge the reaction of the end user or developers to a certain event. These interviews were conducted in a semi-structured fashion; however each set of questions were unique to each participant.

3.4 Data analysis

Qualitative techniques were implemented to analyze the data. As data was captured in both textual and audio format multiple methods of analysis were used to determine the true meaning of data. Firstly the textual data was analyzed using theme analysis as defined by Oates (2010) to determine a central theme for each answer. To determine the central theme, the researcher analysed both the interviewee's answer as well as body language. Based on the literature and using a phenomenological methodology the researcher decided to use central theme analysis. Another technique used in analyzing data can be described as the categorization of common themes or phenomenon in the data. From a phenomenological aspect these common themes would describe the common experiences found in the organization which acts as the population sample for this research study. The rationale behind the use of these two data analysis techniques came from the literature reviewed regarding data analysis. Starks and Trinidad (2007) investigated various research methodologies, one of which is Phenomenology. They found the above-mentioned techniques to be the core data analytics tools used in the Phenomenological approach.

The researcher then documented both the user's answer and the way in which the answer was given. The data collected was then captured and stored in a spreadsheet for easy categorization and analysis. After central theories had been identified, they were categorized for further analysis. More information regarding the analysis process can be found in chapter 4.2.1 which provides details on the analysis chapter.

This process was repeated until the answers could be clearly identified as to add value to the overall findings. The process was completed for all questions and after the analysis was completed the individual results were returned to the respective participant to ask whether they agree with the findings. The audio data was used to supplement the textual data collected and not replace it. The reason for this was the researcher's believed that one could more clearly understand the context behind an interviewees answer from observing the interviewee.

3.5 Ethics

Participants remained completely anonymous. The researcher had asked the participants to provide their contact details as he had to confirm whether the findings of the data analysis were correct, but this information was not made publically available. Participants had also been given the right not to participate, to withdraw as well as the right to informed consent. Due to the nature of the research the participants could not be given the right to anonymity during the research process; however their personal details are only known to the researcher and will not be made available to anyone other than the researcher, thus enforcing the right to confidentiality. The researcher only used the data collected for the purpose of this research project and the data collected was not used for any personal gain.

The researcher acted professionally through the entire research process, ensuring that his actions comply with the highest ethical standards and not to jeopardize the research in any

way due to unethical behavior. The research method, technique and paradigm were carefully scrutinized to ensure that no ethical misconduct occurred. It was also established that the research project did not breach any ethical standards.

3.6 Conclusion

In conclusion, the researcher chose to complete a qualitative study that takes an interpretive approach to analyzing the decision-making process. He also chose to use a phenomenological theory in the process of conducting this research. The reason for this being that the theory attempts to describe the reason participants would make the decisions they do and thus allow the user to identify which elements can be altered to improve the decision-making process.

In this chapter, the researcher also explained the techniques and method that were used to complete this study. The researcher began the study with an in-depth literature review of the field to identify the findings of previous research projects. The other objective of the literature review was to identify methodologies currently being used in the development and implementation of dashboards. Once the literature review was completed the researcher developed a semi-structured questionnaire aimed at identifying which elements assist in creating an effective decision support dashboard. The findings from this questionnaire as well as the literature review were then used to create a methodology for the effective development and implementation of a dashboard aimed at aiding the user in making effective business decisions.

Lastly, the researcher explained the ethical impact of this study and that it does not breach any known ethical standards. The researcher also explained in detail the measures put in place to ensure that all participants were treated in an ethical manner.

4. Results

4.1 Introduction

In the following chapters, the researcher presented the results of his research in six separate sections. At the end of each section, the researcher evaluated a dashboard's impact on the ICT industry, and what makes ICT dashboards unique from other dashboards. The first section looked at what end users expect from a dashboard and what they require from a dashboard. It is the end user that determines whether a dashboard is successful or not, as it was found that one key metric that determines the success of a dashboard is how often a dashboard is used. As the principle driver of usage is the end user, the researcher found it important to delve into what they expect and require of a dashboard and whether these expectations and needs are realistic or not.

Secondly, the researcher investigated what drives a successful dashboard design and how current dashboard designs can be improved to facilitate better decision making. Thirdly the researcher investigated how dashboards are currently being developed and whether there are any deficiencies in the current development process implemented by various dashboard developers. The researcher investigated current development methodologies and their impact on dashboard development as a whole. Fourthly, the researcher combined the findings of the above three categories to propose a development methodology best suited to dashboard development in the ICT industry. Lastly, the researcher tested this methodology in a real world scenario to investigate whether the proposed methodology had a positive effect on the development of dashboards.

4.2 Research Findings and Analysis

4.2.1 Analysis

The researcher interviewed fifteen participants in total with each interview lasting between an hour and an hour and a half. The researcher had to carefully select participants as the participants for this research project came from a single organization. However, this organization acquires people from across the international telecommunications industry and thus selected participants had a large amount of experience in different telecommunication organisations. The organisation also specializes in consulting and other services and thus many of the participants are currently exposed to both local and international telecommunication organisations other than the organisation they are employed with. The researcher initially decided to split the population between developer and end user. However after some interviews, it was found that the researcher also needed to split the end user population. The reason for this was that end users on different levels in the organisation had distinctly different requirements and opinions regarding dashboards and their uses. For this reason, the researcher divided the end user population into executives, middle management and analysts before starting with the research. From the sample population of fifteen interviewees, five were identified as developers while ten were identified as end users.

The researcher found that executives tended to have more experience with different types of dashboards than middle management and analysts. The researcher then also decided to analyse end users based not just on how much they have worked with dashboards, but also which type of dashboards they have worked with. This decision led the researcher to identify two distinct types of dashboards, one being an executive dashboard while the other being an operational dashboard. The researcher found that end user requirements and design philosophy differed between these two types of dashboards as each dashboard was clearly used for a different type of decision making and thus needed to be treated differently during the analysis.

As described in the data analysis chapter of this research study, the researcher used a variant of theme analysis as defined by Oates (2010). This form of analysis involved the researcher having to identify the underlying theme of each answer and then compare that theme to the rest of the population. To do this, the researcher made use of audio and written data. Written data was imported into a spreadsheet software package and analysed through the use of categorization. Within the interviewee's answers, the researcher found that most answers did not just carry a single theme but rather showed a combination of themes that were impacted by the interviewee's sentiment on the matter. Thus, the researcher started to analyse the data not only based on the theme contained in each answer but also the sentiment and the impact of social factors. A condensed version of the questionnaire's findings can be viewed in Appendix 6.3. Please note however Appendix 6.3 only shows a condensed version of the findings which are elaborated on further in the chapters to follow. The main themes found through the research analysis process can be viewed in Appendix 6.4 along with their relevance to the research and how they were weighted in this research project. The weights were calculated based on overall interviewee responses.

The researcher first analyzed both the written comments and audio captured during the interviewee. He then made sure that the comments and answers written down during the interview corresponded with that of the audio file. If he found that the written comments and answers were lacking some of the audio file's detail he would then add that detail to the written comments. Once the researcher felt that the written comments and answers were an accurate representation of the interview he then started to complete the data analysis spreadsheet. To complete the spreadsheet the researcher used central theme identification as discussed in Chapter 3: Method. This technique was used to identify the underlying theme in each interviewee's answer and to gauge their experience with the subject in question. The spreadsheet used in the data analysis process was structured in such a way to capture participant ID, question ID, condensed answer, sentiment and extra applicable information. This spreadsheet design was chosen to facilitate the grouping of themes and phenomenon as described in Chapter 3: Method.

Once the data analysis spreadsheet was completed the researcher started to group various questions and ideas together to gauge responses and sentiments. Sentiment was calculated using binary numbers, 1 equaled a positive response while 0 equaled a negative response. Where traditional sentiment could not be used the sentiment was based in relation to what was found in the literature review. For example, if the literature review found a less cluttered dashboard to be more beneficial to decision-making and the interviewees agreed, then the sentiment is positive. The reason this type of scale was used was to hedge against overly negative responses biasing the results and ensure that all participant's answers were treated the same.

The researcher then summed the sentiments and divided the sum by the total number of respondents. If the average equated to 0.4 or less the population's sentiment would be viewed as negative, anything higher than 0.6 would be viewed as positive and an average between 0.4 and 0.6 would be viewed as neutral. Themes in relation to questions were also analysed in a similar fashion. If a certain theme appeared in 3 respondents answer out of 15 respondents, the researcher would identify a low occurrence of this theme in the population. The researcher again used the scale mentioned above where a value of 0.4 or lower is seen as low, a value of 0.6 or higher is seen as high, and anything in-between is seen as neutral.

The rationale behind the use of this scale can be found in the type of population under investigation. The researcher found the responses to be a normally distributed data set as the researcher had already divided the population into various sub-categories to ensure one type of respondent does not bias the overall response of the population. As the data was not positively or negatively skewed because of the action taken by the researcher, the researcher decided to use a measurement scale in line with a normally distributed data set. The researcher also found data to be normally distributed in cases where the researcher found that there is no need to divide the population into subcategories. One of the other main drivers behind the distribution profile was the qualitative nature of this study and the

way in which the researcher interpreted the answers with either a one or a zero based on each participant's response.

Interesting subjects and opinions not directly related to the questions arose from many interviews. The reason for this was that the researcher allowed the interviewee to diverge from the core questions in an attempt to fully gauge the interviewee's opinion and experience. These subjects and opinions were then captured separately, and future interviewees were observed to see if they also brought up those subjects or opinions. Subject and opinions that seemed to show up frequently in the interviews were then introduced into the research if they fitted the scope of the research. One interesting finding was that thirteen of the research subjects had, at least, one unique subject matter or opinion that they wished to discuss. Those subjects and opinions that the researcher felt could add a lot of insight but fell outside of the scope of this research will be introduced in the Future Research chapter.

Lastly, outliers were identified in the data, such as themes or concepts that were unique to individual groups or interviewees. These ideas and concepts were not discarded if the researcher felt that it could add value to the researcher study. The researcher decided to include these ideas and concepts in the research study and make special mention of the group or individuals that introduced the idea or concept. A number of these outliers were identified as this was a qualitative study and interviewees answered open-ended questions.

Developers and end user's definition of a successful dashboard also differed from one another. The collected data showed that developers tend to measure a dashboard's success based on its total usage. Developers believed that if an end user frequently used a dashboard, then it is seen as adding value to that user and thus can be labeled a success. End users believed a dashboard to be successful if the information displayed on the dashboard led to decisions taken that added value to the business. This research study investigated effective dashboards, thus dashboards that not only led to decisions made by

the business that could add value but rather dashboards that led to the best possible decisions made by the business to add the most value. For this reason, successful dashboards were analyzed in the context of which interviewee believed them to be successful and the factors they believed contributed to a dashboard's success. Lastly, as interviewees were divided into two categories, namely developer and end user, developers were asked some end user questions in order to gauge their experiences with certain phenomenon and topics. However, end users were never asked development questions as they did not possess the necessary experience required.

4.2.2 End User Expectations and Needs

Through the use of an open-ended questionnaire, the researcher found that collaboration between the end user and developer to be key to a successful decision support dashboard that truly aids in enhanced decision-making ability. However this collaboration goes further than just working together on a project, it extends to the sharing of knowledge as well. It was found that one key to a successful dashboard is educating end users on what the purpose of a dashboard is and should be. This interaction then in turn also assists developers in managing end users expectations. Both end users and developers found that a dashboard created through collaboration added a lot more value than one developed in isolation by the developer.

Although collaboration was found to be critical to end users, it was also found that end users tend to view a dashboard development project as an IT project and thus expect IT to drive the project. This finding was not true when interviewing developers as the developers saw the projects as a collaboration between business and IT, with the final customers being business. For these reasons, dashboard projects tended to receive less priority from business than required and this negatively impacted the quality and overall chances of success for a dashboard.

It was also found that end user's trust regarding developers played a large part in the overall development process. If an end user did not trust the developer they would get so involved in the project that they would end up micromanaging the project and ignore much of the advice given by the dashboard developer. The above-stated scenario is why one of the findings showed that trust in the developer is seen as important and the developer should ensure that trust is built throughout the development process. However, it was found that it is also important for end users to be open and honest with developers regarding their expectations and needs. Once the communication channels are open between the end user and developer, it was found that the probability of success for these type of projects increased, as stated by developers.

End user interviewees also expressed interest in using the knowledge of a data visualization expert in the design process of the dashboard. This visualization expert should be the dashboard developer, however it was found that four of the developers did not possess a formal training certificate or degree that included data visualization as a separate subject. Developers tended to rely more on experience and knowledge gained through a trial and error basis. The researcher rather focused on the impact that a lack of formal qualification had on the end users view of the developer's abilities to assist, as it was outside of the scope of this research project to identify whether on the job experience is as good as or better than a formal qualification. In a number of cases, it was found that a formal qualification in data-visualization assisted in building trust between the end user and developer. This qualification, in turn, assisted in collaboration between end users and developers. This finding however is limited to the population being researched as it is very dependent on the company culture, where the majority of the population researched were very qualified in their respective fields and had a vast amount of experience in those fields. From observations and interviews, the researcher could deduce that qualifications were highly respected in the organisation and carried much weight.

Developers stated that end users should also not get overly involved in the dashboard development process as this can hinder development due to scope creep, increase the risk

of conflict and introduce unnecessary complications. Again it became critical that end users be fully aware of the involvement required by them, and even though the project is a collaborative effort between business and IT there are some areas where business's involvement can detract instead of enhancing the quality of a dashboard. These aspects include elements such as data architecture and platform selection. Overall it was found that end users need to be very involved in the development process of a dashboard. However, there is a limit to how much they should be involved.

One aspect where end user involvement is critical is the visual design of the dashboard. Many end users stated that they found collaboration critical when it comes to the visual design of both executive and operational dashboards. End users stated that because they would be using the dashboard and making decisions from the dashboard they generally knew what type of design they require from the dashboard. End users were, however, open to collaboration with developers as long as the developer was skilled at data visualization and could prove it to the end user, again showing the need for trust between the end user and developer.

Another key finding regarding the design of a dashboard and its impact on the end user was that end users expected a very straight forward mechanic from a dashboard, the ability to identify problems and the dashboard providing enough information as to give the end user an idea of what needed to be fixed. This requirement was one of the basic requirements from end users, and the researcher will discuss how it was suggested to enhance this feature in the design subsection. This basic requirement was in many cases the only requirement from end users, which led to the finding that in many cases the end users are not aware of the full decision support capabilities dashboards possess. For the most part, it was only the executive end users that asked for more advanced decision support tools such as trend analysis and outlier detection. It was found that the reason for this finding was that in the population sample analysed, executives worked mostly with executive dashboard while analysts and middle management focused on operational dashboards. Executive dashboards were mostly used for strategic decision making that carried much weight while

operational dashboards were used for day to day operations and primarily to identify operational problems within the business.

Even though most end user interviewees expressed interest in more advanced analytical techniques for root cause analysis and scenario planning, this type of analysis was seen to be a nice-to-have feature on a dashboard rather than a necessity. It can be argued based on findings that because only a very small number of interviewees have worked with more advanced dashboards, the majority of the population cannot miss what they have not experienced. Those interviewees that have been exposed to more advanced dashboards did show a strong interest in incorporating some of the more advanced features into current dashboards. As mentioned elsewhere in this study, developers did warn against creating a dashboard that becomes everything to everyone. The majority of developers felt that advanced predictive and descriptive analytics had some place in dashboards but should not be viewed as one of a dashboard's core competencies.

As mentioned above the advanced analytical methods proposed to interviewees fell into two categories, predictive analytics and descriptive analytics. Seeing as predictive analytics focuses on forecasting future behavior and events, the interviewees were asked how valuable they would find a dashboard that predicted the future performance of a metric. Most interviewees showed some interest in this functionality, but the response remained fairly neutral. One reason for this was that some interviewees felt that gut feel was just as important as numbers and that algorithms cannot predict everything. The majority of interviewees stated that even though they might look at the prediction, they would still consult with others and use their "gut feeling" to override the prediction. Interviewees felt more comfortable with the idea of introducing descriptive analytics into a dashboard. These type of analytics focused on finding trends in past data, identifying outliers and analysing historical information to find hidden relationships and meaning. Interviewees were more open towards utilizing the descriptive functions in dashboards for decision-making purposes but have very little experience with actual real world application of this technology in dashboards.

Middle Management and analysts did not differentiate between operational and executive dashboards in the same way that the executives did. The reason for this situation was that most of the middle management and analyst interviewees had very little experience with executive dashboards. It was clear that the expectation from a dashboard vastly differed between that of the executive end users and that of the rest of the population. For the reasons mentioned above, it became crucial for developers to inform the end user as to which type of dashboard they requested, as executive and operational dashboards do not have the same purpose and output within this population.

There was also a difference between executive and middle management/analyst end users willingness to get involved in the development of a dashboard. Executives tended to shy away from getting involved as they did not have the time to collaborate with developers on the detailed level that they wished. They would rather assign the task to a Business Analyst or similar role, however this opened up risk to misinterpretation. This action would also lengthen the development process as the feedback loop tended to be much longer than that of middle management or analysts. On the other hand middle management and analysts were much more willing to get involved in the development process as these dashboards tended to be used on a daily basis and became an integral part of their work day. There was no indication that middle management and analysts had more time available than executives, however middle management/analysts were found to work on a more technical level. Currently, it is still unclear as to what drives middle management/analysts willingness to participate, and further research will need to be completed to establish the cause.

Some end users admitted having used dashboards for something other than its intended purposes, such as using dashboards to create static reports instead of making any decisions from the data. It was then found that even though these dashboards were used they did not add the full value that was intended when development started. These dashboards were also not designed for those purposes and would end up being discarded once a better tool was introduced. This behaviour led to the dashboard ultimately failing and never being

used as a true decision support tool. It thus became important to make sure the dashboard achieves what is required from it by the end user. It also became important that the developer assesses whether a dashboard is the correct tool to meet users' requirements and not waste the resources on a dashboard that can never satisfy the end user's needs.

Ensuring the end user will use the dashboard for the right purposes came back to the collaboration factor discussed earlier. A developer needed to fully understand the end user's requirement to be able to ascertain whether a dashboard is a correct tool to satisfy an end user's needs. From research findings, it became clear that an end user believed the final result of a dashboard should lead to a decision that has a positive impact on business. Even though some middle management and analyst interviewees did not always state it so clearly, the underlying theme was unanimous that a dashboard should lead an end user to a decision. If the end user is planning to use the dashboard to generate static reports and so forth then the developer needs to be able to step in and advise the end user. This behaviour, in turn, leads to fewer dashboards being seen as failures and a higher success rate for dashboard development projects as stated by developers who were interviewed.

Not a single end user interviewee had a specific methodology on how they used dashboards to come to a decision. However after analysing all individual answers, a clear pattern emerged where the end user would first search for the negative KPI's/trends. After finding these negative KPI's/trends, they would then analyse them in the context of the business and attempt to complete a root cause analysis to find the source of the problem. After they have found the source of the problem they then started to investigate possible solutions to the problem, this investigation would usually take place without the help of the dashboard. From the analysis of the interviews, it was clear that the majority of end users used dashboards as an alert mechanism to show them where they need to focus resources. Another major use of the dashboard was as a comparison tool to see whether the business had improved or not. Only one interviewee mentioned using a dashboard to focus on positive KPI's/trends and finding out what went right in the business. Within the researched

sample dashboards were more used as a reactive tool to be able to fix problem areas than a preventative tool to prevent problems from occurring.

In most cases, end users would take dashboards results with to a meeting where they felt important decisions needed to be made. They required the dashboard to aid in the decision-making process by supporting findings presented at the meeting. However, the dashboard results were only seen as part of the decision-making process, and the meeting attendees could come to a decision that would not be supported by the dashboard. The end users tended to use dashboards as a decision support tool without being over-reliant on the tool. Most interviewees felt that dashboard only comprised of a part of their decision support requirements and that other tools also needed to be used in the decision-making process, while at the same time never ignoring the human factor.

Lastly, it is very important to make sure that the company is mature enough for the implementation of dashboards and that it has a culture that will support this type of decision support tool. All of the developers that discussed company culture and maturity stated that without the correct culture or maturity level a dashboard is doomed to fail, as one of the key components of making a dashboard a success and, in turn, aiding in decision making is user buy-in. Developers felt that if the company was not ready for dashboards, then there is little need for dashboards as they will not be used. The developers suggested that end users should always first be assessed in terms of business maturity and the culture that they are working in to ensure that a dashboard is a success.

The end users interviewed are all currently employed in the ICT sector and when asked what makes dashboard in the ICT sector different to those in other sectors the response was fairly neutral. Many of them believed there is no real difference between end user requirements and needs in the ICT sector versus other industries. A few, however, did mention that due to the volatility in the ICT sector they required tools that would react faster to change and adapt quickly to business's needs. From the research, it can be deduced that time available

to come to a decision is less than in more established sectors and thus, a dashboard would need to be developed that is reactive enough while at the time not over reactive.

4.2.3 Design

All interviewees stated that a streamlined, uncluttered dashboard design worked best in aiding in the decision-making process. The reason for this was that cluttered and unnecessary information was seen to detract user's focus from priority items. Interviewees' responses did differ to some extent due to one group referring to operational dashboards and the other referring to executive's dashboards. Interviewees that were used to working with operational dashboards were more open to a bit of clutter in their dashboards, where those working with executive dashboard stated that under no circumstance should a dashboard be cluttered. A small subset of the population that used both operational and executive dashboard stated that the reason for this was due to the fact that employees using operational dashboards usually required more detailed information to do their work. On the other hand executive management usually could not spend time on detailed information and relied on their teams to summarize the detail.

This behaviour led to a finding that operational dashboard design focused more on Key Performance Indicators (KPI) then high-level business objectives. Operational dashboards would be used to analyse performance against those KPI's and analyse where improvements needed to be made. In turn, executive dashboards focused more on strategic business goals then purely a set of KPIs. The researcher did find that operational dashboards in the ICT sector tended to support executive dashboards. The reason for this was that middle management and analyst' KPIs were set up in such a way that they supported business strategy. This was done intentionally by the organisation to ensure that the whole business drives the correct goals. The structure was summarized by a large number of interviewees as follows; KPIs drive business goals and, in turn, business goals drive business strategy.

From the above finding, it can be argued that a dashboards design, as well as the information shown on a dashboard, should be structured in such a way that it always drives the businesses strategy. This requirement makes it vital for both developer and end user to fully understand the end goal of the information displayed on the dashboard and ensure that it drives the business strategy. End users and developers also stated that it is important for them that a dashboard should not create an isolated picture of the department and should allow the user to view other areas of the business that are impacted or, at least, aid in the understanding of what the impact would be on the entire organisation. In some cases, the dashboard should also provide a view of the market. However, based on interviewee feedback, this should not be done at the cost of simplicity. It was also stated that information sharing within the organisation can be a sensitive matter and that not all information should always be shared throughout the entire organisation, thus, it becomes the end user and his/her superior's responsibility to provide the developer with what organisational, and market information should be shown on a dashboard.

Nine out of the ten end users interviewed expressed the need for drill down and aggregation functionality within a dashboard to investigate the data presented. Both end users and developers did, however, warn against the granularity of the data available in the drill down function. They believed that the drill down functionality should be limited to what is useful to the end user and under no circumstances overwhelm the end user. For this reason, the value added from the drill down functionality would need to be weighed against the complexity added by such functionality. As stated by developers, complexity was not just limited to the visual aspect of the dashboard but also incorporated the risk of an end user getting confused by the data presented or losing track of the purpose of the dashboard.

Three developers stated that dashboards should not be used as a tool for all of the end users data needs but should rather be a tool focused on assisting end users in making the best possible decision by showing only the most critical information necessary for making the decision. The developers argued that adding too much detail lengthens the time to

decisions and that dashboards are not necessarily the best tools for detailed analysis due to their supporting infrastructure and speed of extracting large sets of data. For the developers, a dashboard needed to be developed in such a way that some drill down functionality was provided to assist with decision making, but if the drill down functionality was not sufficient the end user would need to use a different tool. Developers also stated that drill down functionality should be more limited on executive dashboards than on operational dashboards due to executives working with high-level information while middle management and analysts focus more on the detail.

End users stated that they required more drill down functionality than is usually provided in dashboards. This requirement showed a distinct disconnect between the needs of the end users and what developers were providing. Again this design element ties back to the discussion of communication between developers and end users. Developers need to be clear on what current technology can provide and what tool should be used to satisfy the end user's needs. In stating this many interviewees found that the developer should not limit the design of a dashboard to his experience with dashboards but rather communicate with the end user on how the end users have used dashboards in the past, what has worked for them, and why.

From a visual perspective, it became clear through data analysis that simplicity was key to designing a dashboard. Eight end users stated that they found themselves to more easily relate to graphs with minimal text than tables compared to graphs with a lot of text. This behaviour can however again be driven by company culture as upper management tended to request presentations that have too much detail to be simplified and presented in graph format. These presentations would then be discussed, and decisions would be made from those discussions. This behaviour again shows the need for understanding who the dashboard is being designed for and what drives their decision making.

As simplicity is key to designing a successful dashboard it was also found to be important for end users to be able to see everything that they needed to see in order to make a decision without viewing any unnecessary information, all on one page. This requirement became a difficult design task as multiple decisions were made from one dashboard. All end users had negative responses when asked whether they would prefer a dashboard that reorganizes itself in terms of priority items. The reason for this was that they felt they would become confused and spend too much time trying to find the piece of information they were looking for. End users did state however that they would prefer a review session where they can review the current dashboard and make changes where necessary. These changes would then be implemented, and no ad hoc changes would be allowed until the next review session. These review sessions would also not be very frequent and should occur once a quarter or semester based on interviewee feedback. When the developers were approached with this idea, they also felt that it was in the best interest of the dashboard's decision support ability to not make changes too frequently but still allow for some flexibility. This belief again came back to the volatility and rapid changes experienced in the ICT sector and the fact that dashboards can have a negative impact on the ICT sector if they adapt too quickly to new trends.

Both end users and developers felt that the aesthetics of a dashboard was somewhat neglected in the development process. They felt that not enough resources were spent on making a dashboard visually appealing. End users stated that a lot of value can be contributed to the look and feel of a dashboard. They stated that in the past they were much more willing to use a visually appealing dashboard, and thus the visual appeal increased the chance of a dashboard being successful. Developers did admit that unfortunately they do not always have the resources available to spend on the aesthetic aspects of a dashboard. For them, priority is given to creating a working dashboard that displays accurate information, thus more time is spent on the data architecture, infrastructure needs and general operations behind a production dashboard.

Design and aesthetics play a big role in decision support dashboards in the ICT environment. It was found that the researched organisation is very integrated with their clients and both share and design dashboards for clients. This aspect makes the design of a decision support dashboard even more critical as it now not only acts as a decision support tool but also as a marketing tool of sorts. From observing the organisation the researcher found that these relationships can also be found among other companies within the ICT sector and is especially prevalent in supply chain departments. Creating visually appealing dashboards that both assists in decision making and assist in building a company's brand has become key to the researched organisation. Based on the above findings dashboards can have a negative impact on the business of ICT organisations if implemented purely. This finding is however restricted to the researched organisation as well as similar organisations.

4.2.4 Development

It was found that the development process for dashboards currently includes a number of different issues. These issues include a lack of collaboration, excessive development cycles, excessive scope creep, no structured development methodology and a lack of understanding from end users. In this section, the researcher explored how the current development process functions, what developers feel works in the current process and what developers feel needs to change in the process.

Firstly every developer interviewed felt that they did not receive the necessary collaboration from the business. Developers believed that business was of the opinion that as long as the business provides the specifications document their part was done, and the rest was IT's responsibility. For the most part, this was the opinion of end users, the majority of end users felt that once they provided the specification document to IT, they would need to wait for a developer to approach them, and responsibility remained the developers to try and facilitate collaboration. In most cases even though the end user would have liked to be more involved they simply did not have the time available which led to developers having to chase down end users. Once the end user was able to provide feedback it was usually very high

level and brief, excluding feedback given during user acceptance testing. The reason for this behaviour could be contributed to the lack of accountability on businesses side of the development coin.

In most instances, there was no formal project plan put together for the development of a dashboard, and thus, no proper resource planning occurred. This behaviour also led to a lack of a structured approach regarding how the dashboard would be developed. Another side effect of the lack of a proper project planning was seen in the lack of full end user buy-in for the project, this in turn had a detrimental impact on the dashboard development. From what the researcher observed it seemed as if dashboards were not given the highest priority but rather seen as a nice to have tool that could be developed if there were no other pressing projects. This behaviour could be contributed to not only the way in which project planning occurred but also the data maturity of the organisation. It is unclear as to the precise factor that was driving this behaviour and without further research it would not be possible to say for certain. All of the characteristics mentioned above led to some dashboard projects not meeting user expectation, thus, in many cases, the dashboards ended up not being used by the end user or used for incorrect purposes.

It was also found that the majority of developers would determine whether a dashboard was successful or not only when it rolled out into production. In most cases, developers measured the success of a dashboard by how frequently it was used. This measure of success is a logical one however as soon as the dashboard is unsuccessful the majority of developers would go back to the collection of user requirements and more or less start the development process from scratch again. This behaviour equated to a very unreactive development process with a very high risk associated to failure. This sort of development process also led to the workload almost doubling if a dashboard were to fail and needed to be redeveloped. Another concern regarding this development process was the fact that end users usually waited until the end of the development process to see any real results. Along the way, they would then lose interest in the project and thus be less open to collaboration. It can then be argued that a long development cycle that cannot periodically show end users

any results tend to have a negative impact on the quality of a dashboard and, in turn, the decision support function that it performs.

Developers also found themselves spending excessive amounts of time ensuring the data was of the correct quality and that data sources were reliable. As discussed previously this led to developers neglecting other aspects of the dashboard such as design and aesthetics. Developers did, however, list data quality as one of the most important factors in the overall success of a dashboard. Developers felt that it was key to maintain trust and buy-in from the end user and that without high data accuracy the dashboard would be doomed to fail. Some developers expressed concern regarding the fact that they spent too much time extracting, transforming and loading (ETL) the necessary data and that end users did not always understand the complexity behind these processes. Tools used in the dashboard development cycle were among some of the elements contributing to the time taken to complete ETL tasks.

Two of the developers interviewed mostly used Microsoft Excel to develop dashboards while one of those developers used Microsoft Excel exclusively for dashboard development and ended up having to send out dashboards via email to end users. Of the three developers who used other tools to develop dashboards, not one stated that they had a preferred tool for dashboard development. Rather they found that they would use any tool currently available to them that best suited the task. These developers rather focused on the methodology of dashboard development than the tools used to build them. They felt that there was no perfect tool after having used tools such as QlikView, Cognos and SQL Server Reporting Services, but rather that the approach to dashboard development was key. When asked whether they had a structured methodology behind dashboard development none of them could provide a truly structured approach. Instead, it was found that two of the developers that did not use Excel as their main dashboard development used some variant of the Waterfall methodology while the other one used some variant the Agile methodology. Half of the developers that predominantly used Excel as their dashboard development tool also used some variant of the Waterfall methodology while the other one

used the Agile methodology. It was then clear that three out of the five developers used some variant of the Waterfall methodology.

From the above-stated findings, the leading dashboard methodology was found to be a derivative of the Waterfall software development methodology, this opened up dashboard development to the risks associated with the waterfall methodology. Shukla and Saxena (2013) found that Waterfall models had a number of problems, the first of which was cost estimation. According to Shukla and Saxena (2013), the Waterfall model is associated with high costs, effort and administrative requirements. Iterations take a long time to implement, and changes are perceived to be very costly, thus pushing out problems to later phases. The researchers also found that these models were prone to high risks and had shown low complexity and a lack of user involvement. As stated earlier collaboration from the end user was found to be one of the key drivers for a successful dashboard, thus any part of the development process that hindered collaboration would increase the risk of the dashboard failing to meet the end users requirements. With the aspects mentioned above combined with research findings, it became clear that a Waterfall development methodology was not suited for dashboard development and increased the risk of dashboards not performing as decision support tools. The Waterfall methodology could thus lead to the ultimate failure of a dashboard.

Those developers that were incorporating the Agile methodology advocated their chosen methodology by stating from experience that they have found the Waterfall methodology to be insufficient for their dashboard development needs. The Agile methodology which incorporated an iterative model at its core allowed developers to provide and receive constant feedback from end users thus enabling them be more reactive to changes and understand the end users' needs better. This methodology also enabled developers to more easily identify and managed risks while providing frequent deliverables to end users. From a complexity point of view, developers found the development cycle to be less complex when compared to other methodologies while providing much-needed flexibility. Overall the developers that have implemented an Agile methodology found that more of their dashboards were successful compared to when using methodologies such as the Waterfall model.

Interviewed developers found little difference between the development processes in the ICT environment when compared to those of other environments. The only real difference was the fact that the ICT environment tended to have a faster pace than other environments, again leading to end users expecting changes to occur in a shorter timeframe to ensure that they can react to business events as soon as possible. This characteristic led to a somewhat more unstructured environment with users demanding more be done in less time and the cost of error being higher when compared to more stable industries. The reason for this higher than average cost of error is that the majority of developers implemented a waterfall model and would go back to requirement collection if the dashboard failed, thus doubling the development time and as shown by the research findings, development time is a critical factor in the ICT environment.

4.2.5 Methodology

After taking into account aspects from the end user's needs, design factors and development processes, it was found that in most cases the methodology used for dashboard development was insufficient to create dashboards that would achieve the full potential of a decision support tool. From the above findings, it was clear that the Waterfall development methodology was not well suited for dashboard development in the ICT industry. An Agile methodology was much more suited to the ICT industry, but needed to be supported by various project management tools to succeed. For this reason, the researcher proposed a methodology that incorporates both the principles of an Agile development methodology and the principles of sound project management.

It was clear that proper interaction between the end user and developer needed to take place before a dashboard project is started. In this interaction, developers need to be clear with end users as to what is possible or not possible in the context of dashboard design, thus ensuring that end user's expectations are managed from the start. For operational dashboards, it would simply involve sitting down with the end user and discussing what

current technology allows developers to do and what cannot be done. For executive dashboards, it becomes a bit more complex as developers will not always be able to have an information sharing session with the executive, as shown by research findings. In these scenarios, it is crucial that executives assign this business responsibility to a qualified professional within their team, usually a business analyst or similar.

After the initial information sharing session, it then becomes both the end user and developer's responsibility to create a project plan where both business and IT shares accountability. This project plan should include deliverables for both business and IT with clearly defined completion dates. It should also include senior sponsorship that can provide the resources needed for both parties, as well as understand the need for collaboration. If no such senior sponsor is available, then it is up to both business and IT to explain the need for collaboration and ensure the senior sponsor buys into the concept. All other aspects of the project plan need to be completed such as resource planning, RASCI tables and dependencies. It is critical for IT to complete a detailed resource requirements plan to assess what is needed for both IT and business in terms of time, human resources and capital. This resource plan needs to be strictly adhered to and requires buy-in from both IT and business. It is also imperative that the dashboard project gets treated with the correct priority level and that parties involved ensure that the priority level does not degrade over time, this should be the responsibility of the project sponsor who has the seniority to drive this part of the development process.

Once the project planning phase has been completed, both IT and business can then continue to identify the various deliverables involved in the dashboard. This task should involve breaking the dashboard into sections and completing one section at a time. As shown by the findings of this research it is more beneficial to deliver smaller components at a time to ensure that any changes are limited to a small part of the dashboard and that business can be engaged on a regular basis to ensure buy-in and collaboration continues. These deliverables need to be approved by both the developers and their business counterparts to ensure that developers can adhere to their resource plan and end users

expectations are managed, all while driving collaboration between the two parties. Any changes that need to be made to these deliverables are made in the iterative design and development methodology; it is advised against redesigning the project plan unless it is necessary. As this approach is built on sound project management principles, it is assumed that a buffer would be built into the project plan for any unexpected changes.

It, unfortunately, remains the responsibility of the developer to manage scope creep, and they would need to assess whether changes recommended by the end user are actionable in the current project and resource plan. Even though this approach to dashboard development is designed to ensure flexibility and collaboration, there is a point at which flexibility and adaptability in the development process can end up hurting the overall project. This statement was expressed by the majority of interviewees and hence the introduction of a quarterly review process once the dashboard has been completed. This quarterly review process was introduced to make sure the dashboard remains flexible and relevant, especially in an ICT organisation. As there is no limit to the iterations that the development process can go through it is crucial that developers manage this aspect as per the requirement of the project.

Both the visual design and calculations used in a dashboard should again be a collaborative effort between business and developer. Development of a dashboard should, however, be left to developers as they are the experts in the field and most end users do not possess the skills needed to add value to this process. Research findings also point to end users disinterested in being involved in the technical development process. Research also pointed to developers not feeling that users should be involved in the technical development process due to the risk of scope creep and unnecessary disruptions. For these reasons developers should only interact with end users once technical development is finished and the completed deliverable is presented to the end user. Once the deliverable is presented, the end user needs to decide whether it has achieved its intended purpose or whether something needs to be changed. It is up to both end user and developer to ensure that if an end user requests a change be made to the deliverable that it is for a realistic reason. If both

parties cannot come to an agreement, it should then become the project manager/project sponsor's responsibility to make the final decision based on weighing both cost and possible value that can be added by implementing the change.

The design phase will be up to both developer and end user however some key principles need to be followed. These principles include creating a simple design, limiting the use of text and tables, deciding on the appropriate drill down functionality and highlighting key metrics by identifying them through the use of various visual tools. The developer needs to understand fully the requirements of the user and be able to make suggestions where they feel it is necessary. Again a balance needs to be struck between what the user wants and what would maximize the decision support capabilities of a dashboard. The aesthetics of a dashboard should also not be neglected and thus, enough time should be allocated to the design phase of each deliverable without detracting from the development and data quality aspects of a dashboard.

Once the end user has signed off on all deliverables, it is then up to the developer to publish the dashboard. The platform that will be used to support the dashboard should have been finalized during the initial high-level requirements gathering phase. The reason for this is to ensure that the platform has the capabilities to support the requirements of the finished dashboard as well as the requirements of the end user, for example, remote and mobile accessibility.

Proposed development process for effective dashboard development in the ICT industry

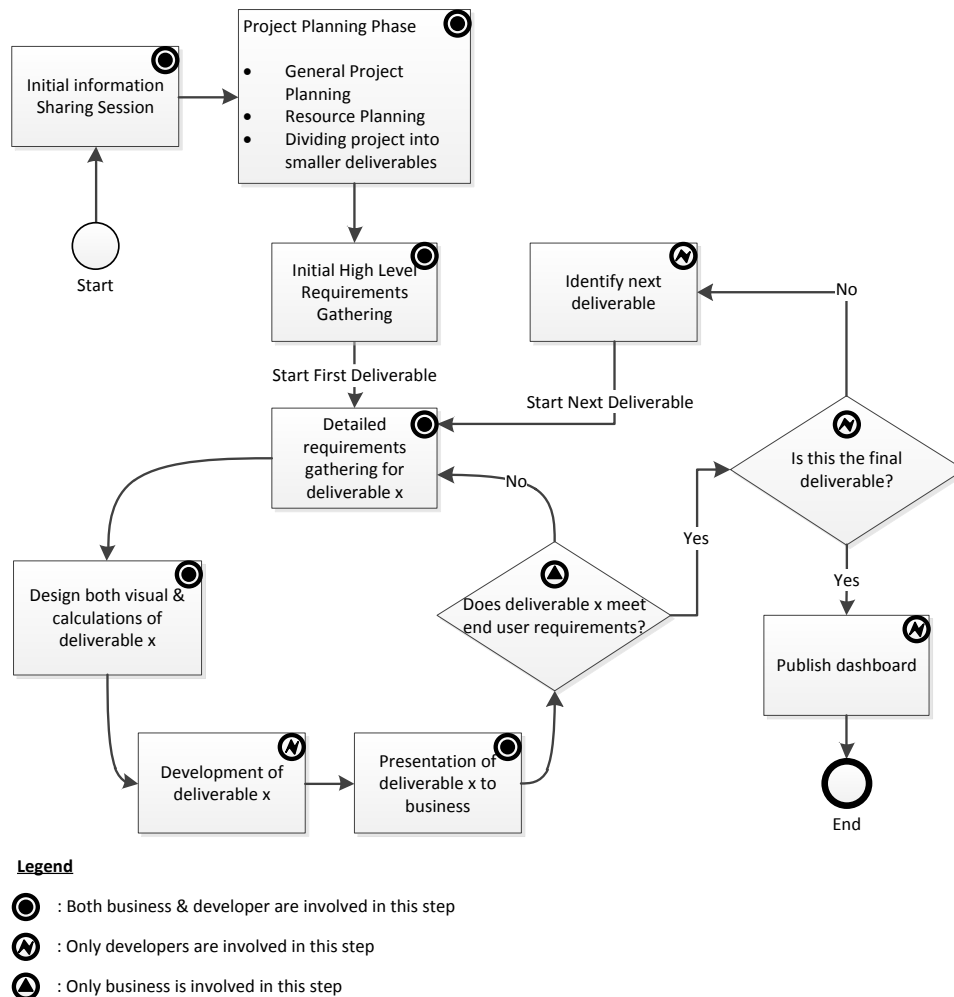


Figure 1: Proposed development process for effective dashboard development in the ICT industry

4.2.6 Testing the proposed methodology

The researcher received approval from the organisation involved in the study to implement the proposed methodology on one of the new dashboards they were developing for sale to a client. The organisation required a dashboard that enhanced the current decision support tool that the client had available to them. The researcher felt this to be a good case study to see whether the proposed dashboard development methodology would be effective as both business and IT were willing to prioritise this project, as it had a senior director's sponsorship due to the sales aspect of the project. It should be noted that the researcher

was directly involved in all aspects of the dashboard's development, from requirements gathering to data architecture design. The level of senior sponsorship experienced in this project aided in resolving many of the hindrances associated with dashboard development that were identified in this research study. Some of these hindrances include lack of collaboration, lack of priority given to the project and a general lack of availability from the required parties.

The dashboard that was developed needed to fill the role of an executive dashboard but enable the executives to drill down to a more detailed level if need be as well as show different aspects of the client's business. For this reason the dashboard posed an interesting challenge to developers as it needed to be a mix of both operational and executive dashboards. As stated earlier in this study, executive and operational dashboards have distinct needs and thus it is very difficult to combine the two. For this reason it was decided fairly early in the development cycle that the dashboard would be broken into three sub-sections. The first dashboard would fulfil the role of executive dashboard with drill down functionality while the second and third dashboard would fulfil the role of operational dashboards focused on two distinct areas of the client's business. This gave the researcher a chance to test the development methodology on both operational and executive dashboards.

The following paragraphs detail the development process that was followed, the benefits gained by applying the proposed methodology as well as the risks and complications that arose from using this methodology. The project started with an initial information sharing session between the business development manager and the organisation's Business Intelligence team. In this session the business development manager explained what would be needed from the dashboard and what purpose it served. A number of discussions took place during this meeting where the business intelligence team established the high level requirements of the dashboard as proposed by the business development manager, and which tools would be best suited for the project. This process known as the initial information sharing session formed the starting point of the project. The session allowed

business and IT to establish the scope and requirements of the project through a collaborative session and it was observed to facilitate trust between the two parties as the Business Intelligence team could show examples of previous work done and business could explain why they required something a certain way without going into too much detail. Unfortunately as this process occurs before the initial project management meeting a number of requirements and technical aspects were not taken into account. This can be attributed to the informal structure of the meeting and the fact that neither party had a fixed agenda of discussion points. The session also involved more of a brainstorming session and led to a loss of focus on critical components of the dashboard. The researcher advised that in future implementations of this methodology the participants should prepare a more structured approach to the meeting to ensure that all participants are focused on the task at hand.

The second phase of the development methodology involved project planning. Within this phase the Business Intelligence team determined the resources required to build the specified dashboards. Unfortunately the Business Intelligence team could not provide clear resource requirements as they were tasked with supporting current business operations as well as the development of this dashboard. Even though the dashboard did enjoy a higher priority than usual, the Business Intelligence team had a number of support tasks that enjoyed higher priority. However, these support tasks did not interfere with the development of the dashboard as they were handled swiftly. These support tasks did however ensure that the Business Intelligence team could not provide an exact resource plan but rather an estimate. The researcher found that it was very difficult for IT to provide exact resource requirements due to the nature of their role within this organisation. If an organisation were to have a dedicated dashboard developer this would not be the case.

Another part of the project planning phase was breaking the project into smaller subsets or modules. These subsets included dashboard design, data architecture and user acceptance testing. Due to the agile nature of the proposed methodology the development team decided not to divide the time resource between the different modules but rather assign a

time resource to all three combined. These changes complicated the project planning more than expected and the researcher found that to manage this type of project one would require a person with some experience in managing Agile projects due to their complexity. Overall the project planning phase was more complex than initially anticipated however ensured that all project team members knew what their respective roles were and what was expected of them. Meeting invites were used to manage team members and communicate deadlines as well as get project updates.

As most of the high level requirements were discussed in the initial information sharing session the project members decided to use the high –level requirements gathering meeting as a tool to validate and expand on requirements gathered in the initial information sharing session. The researcher saw the enthusiasm in the initial information gathering session as a positive but due to the session occurring before the project management phase the high level requirements phase lost a lot of value and most of the work done in the high level requirements gathering phase was duplication of work. This led to some frustration as team members on both the business and IT side were constrained in terms of time and found the high level requirements gathering session unnecessary. The researcher proposed more stringent management on the various phases within the proposed development methodology to ensure as little frustration and duplication as possible, thus minimizing a risk of loss of buy-in.

Once the high-level requirements phase ended the Agile phases could start. It is in these phases or workshops that the researcher saw the benefit of this proposed methodology. Each development phase included data architecture design, dashboard design and user acceptance testing. The dashboard developer, business development manager and researcher were present for all these sessions. The business intelligence team created a flexible data architecture based on the identified requirements from the business development manager and presented it to him in an easy to understand manner. The dashboard developer would also have a pre-built dashboard present that was designed according to the business development manager’s specification. After presenting both the

data architecture and the dashboard to the business development manager the dashboard developer then opened discussion on the first part of the executive dashboard. The business development manager then requested changes or confirmed he was happy with that part of the dashboard. The researcher found the requested changes to be reasonable and within scope, the opposite behaviour that was described by developers in interviews. The researcher believes this behaviour to be a result of the business development manager having a high level understanding of both the data architecture and the tools used to create the dashboard. However, more research will need to be conducted to verify the beliefs of the researcher.

The process mentioned above was completed for all deliverables in each of the three dashboards and the business development manager completed user acceptance testing in the workshop itself. The researcher did find the Agile process to be lengthy as the business development manager would request additional changes once a dashboard was fully completed. Another factor that could contribute to a longer development cycle is the choice of the dashboard developer to use a new experimental tool for the development of the dashboards. It was agreed to use this tool as it was both user friendly and more visually appealing than other tools available at the time, but required the dashboard developer to learn the tool as development progressed. The business development manager stated that he wanted the most visually appealing tool as from his past experience users preferred visually appealing tools.

The dashboard was then presented to the client and the client agreed to buy the tool as they felt it could improve their decision making ability as well as reactivity to unforeseen events. The client stated that the dashboard reflected what they would like to see not only on an operational level but also at an executive level, but required some changes to be made to the dashboards. The fact that the client required further changes to the dashboard could be contributed to the fact that the client was not directly involved in the dashboard's development and it was up to the business development manager to gauge the client's needs to the best of his knowledge. Overall the test showed that even though the

methodology requires more attention to the project management aspect, the Agile portion of the methodology served its purpose in ensuring the dashboard meets the end users requirements, which in this test was the business development manager.

The business development manager stated that he believed all necessary decisions the client needs to make in context of the dashboards could be made with the completed dashboards. Thus, from the business development manager's point of view these dashboards also contributed to the decision making ability of the client.

There are some limitations to this test of the proposed development methodology. Firstly the end user in this test was not the true end user of the dashboard but rather represented the end user, and as shown above, the representative was not entirely accurate in terms of the needs of the true end user. However, if one views the representative as the actual end user and discount the client from this scenario, then the test can be seen as achieving the needs of the end user. Another limitation of this test is the fact that it does not gauge the quality of the decisions made from the developed dashboards. Yes the dashboards met the end users expectations if the business development manager is viewed as the end user, but without testing the quality of the decisions made from those dashboards, it cannot be ascertained whether the dashboards truly enhanced the end users decision making ability.

Results of proposed development methodology

Result of test	Impact on dashboards	Researcher's Comments
Improved collaboration and communication	Positive	Based on feedback, both end user and developer experienced more collaboration than in other projects.
Realistic change requests due to iterative nature of methodology	Positive	Even though end users had numerous changes, the changes were in scope and realistic. It is difficult to gauge the difference between the number of requested changes using the tested methodology and other methodologies as the researcher had to rely on interviewee's feedback regarding the number of previous changes, which could be biased.
Improved end user buy in	Positive	Based on end users feedback, they were pleased with the end result and how the development process progressed. End users actively engaged with developers in a positive manner and very little negative behaviour could be observed by the researcher.
Met decision making ability requirements	Positive	Based on end user feedback, it was found that the dashboard would facilitate all necessary decisions needed to be taken by the client.
Improved overall project management	Positive	Based on observations, a more stringent project plan was followed by all involved parties which allowed for clearer communication, division of responsibilities and time management.
Met end user expectations	Positive	Based on end user feedback it was found that the dashboard met all end user requirements. This finding is based on the business development manager being viewed as the end user and not the organisation's client.
Increased understanding from developer	Positive	Based on feedback, end users experienced better understanding regarding their requirements from the developers, due to better communication and collaboration.
Increased understanding from end user	Positive	Based on feedback, developers experienced better understanding regarding system limitations and other technical aspects from the end users, due to better communication and collaboration.
Lengthy development process	Negative	The researcher found the development process to be lengthy due to the iterative nature of the proposed methodology. It is not possible to quantify whether the length of the development cycle is longer than that of previous development methodologies without observing those methodologies.
Heavy reliance on project management resource	Negative	Due to the complex nature of Agile projects when compared to Waterfall projects, the researcher observed the need for an experienced project manager when implementing an Agile methodology.

Table 1: Results of proposed development methodology

4.3 Conclusion

In conclusion, the researcher broke the Research Findings and Analysis chapter into a number of sub chapters and discussed the various findings or significant phenomenon in each phase of the research. Firstly the researcher discussed the analysis process through delving into the population sample used, statistical methods applied and how the sample was divided due to the nature of the population. The next three sub-chapters focused on the three different aspects that were found to be important for an effective decision support dashboard namely; end-user requirements, design and development. In these three sub-chapters the researcher highlighted key findings such as managing end-user expectation, simplicity of design and collaboration to be critical to ensure a dashboard can effectively facilitate the decision-making process. These findings will be discussed in more detail in chapter 5.2: Conclusions which delves into the overall conclusion of this research study.

This chapter revealed that no current dashboard development methodology found in the literature review was perfectly suited for the ICT sector. For this reason the last two sub-chapters investigated the design of a new methodology for dashboard development as well as its testing. The designed methodology was tested in a real world scenario and the results were found to be mostly positive with some shortcomings.

5. Conclusion

5.1 Summary of findings

From the above research findings, it is clear that an effective dashboard consists of realistic and clearly communicated end user requirements, a design that is simple, easy to understand and straight to the point, and lastly, a robust, flexible development methodology. Firstly dashboards should be developed in an environment that facilitates collaboration and trust to ensure that communication easily and regularly flows between the end user and developer. The end user should also be able to differentiate between an operational dashboard and an executive dashboard. If the end user is not able to make this distinction, then it becomes the developer's task to educate the end user. It was also critical that developers ensure a dashboard is a correct tool for the end user's needs, thus ensuring that the dashboard will not be used for tasks it was not designed for. Dashboard projects did, however, suffer from low priority assigned by business and IT combined. This behaviour led to a lack of proper project planning and an increased risk of failure for the project.

Most of the participants believed there to be little difference between the end-user requirements in the ICT sector and other sectors. However, it was found that due to higher volatility end user requirement for changes should be more frequent. This was not the case and the relationship between volatility and number of requested changes was inversed. Participants did however state a shorter time to decision is required in the ICT sector.

The design component of a dashboard can be broken up into three broad areas, the simplicity of design, end user needs, and finally the type of dashboard being designed. A dashboard design should always be simple and intuitive, minimizing the risk of users becoming overwhelmed and confused by the information presented. Users should feel at home with a dashboard design, and feel that it is not just something that was given to them

but something that they helped to create. However simplicity should not mean unattractive as it was found that end users would much rather use a dashboard they find aesthetically pleasing than one they do not. The design should always meet the requirement of an end user, and the design should never be placed above end user requirements.

A dashboard design should facilitate the meeting of end user requirements, and a developer should always be open to end user suggestions but keep best practice in mind as well.

Another key finding was that dashboards required some form of drill down functionality, however that this drill down functionality should be limited based on the needs of the end user. The dashboard should not be a tool for detailed data analysis and thus, developers need to ensure the drill down functionality will not be misused.

Lastly, the design of a dashboard is very dependent on the type of dashboard the end user requires. If the end user requires an executive dashboard, then the developer should take into account that detail should be limited on the initial presentation of the dashboard with some added drill down functionality if needed. Some detail can be added, but the design should facilitate a clean and uncluttered appearance at all times. Operational dashboards, on the other hand, require a bit more detail and users are open to a bit more information presented on a dashboard at any given time. The aesthetics of a dashboard played a big role in the ICT sector and was found to very important to the research participants. The more integrated a dashboard is with external parties, the more value is placed on the aesthetics of a dashboard in the ICT sector. Another reason why aesthetics played a large role in the researched organisation was due to the positive correlation found between appealing aesthetics and the overall dashboard use.

The dashboard development process was also found to play an important role in how effective a dashboard becomes in supporting decision making. It was found that collaboration is key in most aspects of the development process, except for the technical development that involved actual coding, data structures and so forth. Collaboration also

needed to be supported by shared accountability between business and IT. Another key finding was that most dashboard developers do not make use of proper project planning techniques while developing a dashboard and thus, resource planning is usually found to be lacking. Developers also admitted to allocating more of their time to the technical side of dashboard development and thus not focusing enough time on the design aspects that they knew required more attention. Lastly, the researcher found that most developers tend to utilize the Waterfall development methodology for dashboard development and that this methodology is not well suited for dashboard development, especially in the ICT industry. The reason that this methodology is not well suited for the ICT industry is that the risk of failure associated with the methodology is high. The Waterfall methodology also tends not to facilitate collaboration as much as other methodologies and development cycles become very rigid and inflexible.

The final two sections the research findings chapter dealt with identifying and testing a suitable development methodology for dashboards. In this section, it was found that an Agile and iterative methodology is a better fit for successful dashboard development in the ICT industry. This type of methodology facilitates both collaboration and general communication, it allows flexibility in the development process and lessens the risk of total failure of the dashboard. Even though the proposed methodology is heavily focused on collaboration between business and developers it still assigned some steps in the process to either business or developers. The proposed methodology introduced project management principles which were found to assist in the dashboard development process.

The testing of this proposed methodology showed that increased collaboration helped achieve end user needs and aided in the believe that end users could make better decisions using a dashboard they were more involved in creating. End users felt they would be able to make better decisions using the dashboard developed with the proposed methodology. The testing also showed that constant feedback from developers aided end users in refining their requirements and build trust between the developer and end user. It was also found that the development methodology assisted in ensuring that end user requirements were

met. The test however did reveal that the proposed methodology relied heavily on proper project management and an experienced project manager which can become a problem in environments where an experienced project manager is not always available. A detailed list of test findings is available in Table A.2.

5.2 Research Conclusions

This research study found that an effective decision support dashboard consists of 3 things, meeting end user's needs and expectations, a well thought out design that is both usable and aesthetically pleasing and lastly a development process that supports dashboard's unique requirements. From the literature review, it was clear that a number of design and development themes arose. The literature pointed towards the need for an effective development methodology as well as an understanding of what drives a decision, to create an effective dashboard that truly aid the end user in the decision-making process. This finding was aligned with what was reported by the research findings, even though the research findings were focused on the ICT industry. The findings did, however, delve into more detail than the literature review and revealed that one of the most important factors that contributed to an effective dashboard was the developer truly understanding the end users' needs. It was found that the more closely developers and end users worked during the development process, the higher the probability of success became for a dashboard.

The literature also pointed towards collaboration being key to a successful dashboard development process, however it was observed that developers in the ICT industry do not experience the required level of collaboration from end users. For this reason, the researcher proposed a development methodology that is designed around principles to enhance collaboration. Another key component of an effective dashboard was found to be the drill down or analysis functionality provided by a dashboard. Various sources in the literature review stated the requirement of such an analysis function to enable an effective

dashboard, however the findings from this research study cause reason to pause. In the ICT environment it was seen a necessity to have some form of drill down functionality, however, both end user and developer warned against too much drill down functionality. Research participants felt that a dashboard should not be an all in one analysis tool, and detailed data analysis is not well suited for a dashboard environment. Interviewees warned against the risk of end users becoming overwhelmed by the detail and thus resulting in the drill down functionality detracting value from the dashboard instead of adding value.

There were various elements that contributed to an effective dashboards, many of which were already identified in the literature and a few that the researcher could not locate in the literature. Those elements that were revealed by the research and found in the literature review included simplicity of design, single page display, dashboard adaptability to business and full understanding of end user requirements to name a few. More interesting were those elements not found in the literature review such as those listed below.

End users felt that trust between the end user and developer played a large role in the development process and eventually the success of a dashboard. The reason for this was that end users would be more open to advice from a developer if they had a trusting relationship with that developer. Another finding was that end users do not always desire complete flexibility in a dashboard. End users felt that by changing a dashboard too often, it detracted from a dashboard's overall effectiveness as a decision support tool. End users rather preferred a quarterly or semester review process where a dashboard can only be changed once a quarter or semester. This process would limit the dashboard from over-reacting to short-term business trends that should not always be used for decision making. As stated by interviewees, end users in the ICT environment are used to rapid changes due to the volatility in the industry and thus are used to short-lived trends that in some cases have a large impact on the industry, thus these end users become wary of adapting to every trend.

Another element that had a big contribution to the effectiveness of a dashboard was how timeously decisions could be made. Both literature and the research findings showed that timely decision-making is key to an effective dashboard. For this reason, both the design and usability of the dashboard should be set up for easy and effective decision making enabling a reduction in the time to decision component of decision making.

Business required a simple and easy to understand dashboard that can be used to assist in the decision-making process. This dashboard should incorporate all of the elements mentioned above as well as those not mentioned but identified in the research findings sections. Business also required dashboards that are easily developed and use a development process that is flexible enough to change when need be. As shown in the literature review, business is not just concerned with the development cost of a dashboard, they are also concerned with the time cost associated to dashboard development and ensuring that the project is completed on time. It was found that the majority of developers in the ICT industry apply a variant of the waterfall development methodology that run the risk of doubling the development time if the first iteration of a dashboard fails, as well as being very rigid. Thus, the research points to a Waterfall development methodology being counterproductive to business requirements and concludes that a different methodology is required.

Another requirement of business is to be able to delve into the data provided by a dashboard. The reason for this was that end users not only wanted to view information on a dashboard, they also wanted understand data and felt that this functionality adds much value to a dashboard. As mentioned earlier developers need to be careful regarding how much data they provide to the user, but it is critical that at least some data be provided to the end user. It was found that middle management and analyst end users were unsatisfied with the amount of data provided by drill down functionality even though they were aware that dashboards should not provide too much data. This finding pointed to a misalignment between end user requirements and what developers provided.

As mentioned earlier the Waterfall development methodology was not particularly well suited for dashboard development. It was found that this sort of project required a much more iterative methodology with frequent feedback given to end users. For this reason, the researcher proposed a methodology based on the Agile approach. This methodology used an iterative model to ensure that the project is broken into smaller deliverables thus enabling developers to continuously deliver outputs to the end user. Delivering constant outputs to the end user forces collaboration between the end user and developer and ensures the end user remains invested in the project. This methodology was built around ensuring that accountability is shared between business and the development team.

Developers showed a lack of proper project planning when starting a dashboard development project. For this reason, the development methodology was combined with project management principles to ensure that a structured process is followed end to end. This methodology also forced all involved parties to treat the project with the same priority as other development projects, something that seemed to be missing from dashboard development projects, based on research findings. The proposed methodology was an altered version of those found in literature and instead of altering a selected methodology the researcher decided rather to combine various methodologies and then augment it to make it applicable to the ICT industry.

The researcher then tested this methodology in the organization being researched. The researcher found that the proposed methodology assisted in improving collaboration, communication and understanding as shown by the results and thus came to the conclusion that an Agile methodology is more effective at developing dashboards than a Waterfall methodology. The researcher did find some drawbacks to this methodology. Firstly the methodology was very dependent on an experienced project manager, which may not always be available. Another drawback was the time taken to complete the Agile phase of development. As the Agile methodology is iterative in practice, it can lead to long development cycles if the end user makes continuous changes during development.

However, due to the overall positive impact of the new methodology, the above stated conclusion remains

It was found that even though the ICT differed from other industries in some respect, it was very similar as a whole regarding decision making and the impact of decision support tools such as dashboards. One of the notable differences found in the research was the volatility in the industry and the speed at which decisions are made. As the ICT industry is heavily technology focused, the introduction of a new technology could lead to having a very large impact on business and thus the decisions that needed to be made. This phenomenon is the reason why the time to decision is seen as an important metric when making decisions inside the ICT industry. The increased volatility also played a big part in how adaptable the business and its dashboards should be, as mentioned earlier.

The researcher concluded that the impact that dashboards have on the ICT environment seems to be similar to those in other industries with a few variations as mentioned in the above paragraph and the summary of findings. Dashboards are still a widely used tool in this industry and seem only to be growing in scope based on some of the interesting ideas brought up by both end user and developer alike. Dashboards can currently be viewed as one of the main tools for decision support systems and shows no signs of slowing down, based on the results of this research.

5.3 Summary of contributions

The researcher believes that this study added knowledge to the current use and development of dashboards applicable to and to be used by the ICT industry, and to some extent other industries as well. It identified factors that were necessary for the successful implementation of a dashboard as well as what is needed to make dashboard an effective decision support tool. The research study identified three key components of dashboard development that all need to be taken into account when a dashboard is under

development. Within each of these components, the research study then identified individual factors that need to be in place to create an effective dashboard for the use of decision making. It also investigated the specific requirements of the ICT industry and how this industry differs from other industry in its use of decision support tools. Another aspect it investigated was the development of dashboards and which type of methodology is best suited for dashboard development in the ICT industry.

The most significant contribution that this research study made was the introduction of a proposed research methodology for the ICT industry. This methodology looked at all aspects of the overall development process and attempted to create a more structured approach to dashboard development by combining all factors that contributed to a successful dashboard.

5.4 Future Research

First and foremost the researcher believes it is important to test the proposed dashboard development methodology more thoroughly. The completed research currently points to the proposed methodology being better suited to dashboard development than other methodologies currently used in the researched industry. This finding is, however, difficult to verify without a number of real world application of this methodology. There is a number of factors that can lead to the success and failure of a development methodology, however investigating these factors fell outside of the scope of this research project, hence the research would need to be completed as a separate research project.

Interviewees raised some interesting concepts during their interviews. One of these concepts was the gamification of dashboards and how this would change the use of dashboard and the impact on end users. Gamification introduces the concept of assigning points to a dashboard based on its usefulness, decision support functions and a wide range of other variables. It also assigns points to users for various actions and allows for a

comment section in dashboards. This concept was excluded from the research project as no interviewees had physically worked with such a dashboard, but some did believe that this kind of feature could add value to a dashboard and its ability to facilitate decision making as a whole.

Another concept that was introduced was the proliferation of social dashboards in modern day society. One developer stated that even a mobile phone's home screen can be viewed as a dashboard seeing as it displays not just a number of key metrics regarding a device but also information about the users social and work life. It can even be augmented to display KPIs regarding a user's health. This tool, however, is a different type of dashboard then the ones investigated in this research project. Dashboards that encompass aspects of a user's social life, physical well-being and general day to day life should rather be categorised as social dashboards. The impact of these types of dashboards have not yet been fully explored as the researcher could not find much prior research done on this topic. It is thus proposed to diverge from a dashboard's impact on the business environment and investigate the impact they can have on the social environment and how they impact user's behaviour and decision-making on a day to day basis.

Lastly, dashboards are a great tool to display quantitative information, however there is no simple way to display qualitative information; this is usually up to the end user to incorporate into the dashboard. As most users view dashboards as a quantitative tool showing averages, sums and so forth, they could not provide much insight on the qualitative information overlaid on dashboards. It is thus proposed to investigate whether it is possible for developers to include and display more qualitative data easily and understandably.

Extending on this would be a dashboards ability to provide its own insights through advanced machine learning. The impact that this would have on end users need to be gauged as within the population researched there was significant pushback from some

interviewees regarding the idea of a dashboard that provides business recommendations to the end user.

6. Appendices

6.1 Questionnaire (Part 1)

Question #	Dashboard Design in ICT environment questionnaire (All questions below will be used to stimulate a discussion rather than just providing an answer)	Research Question: What makes an effective dashboard in terms of flexibility, adaptability and usefulness?	Research Question: What are the characteristics of a good decision support dashboard?	Research Question: What does business require from a dashboard to enable effective decision making?	Research Question: Which characteristics of an effective dashboard are industry specific?
	Design/Functionality (Scale = lower number equals lower score)				
1	From 1 to 10, how much detail should a dashboard have in your opinion? Please state your reasoning behind your answer?	x		x	x
2	Should the dashboard look exactly as the user specified or do you believe the designer should be allowed to change if they see the need?	x		x	x
3a	Would you like to design the dashboard yourself or have an experienced dashboard designer assist? if you would like an experienced designer's involvement please rate from 1 to 10 how involved that designer should be?	x	x		
3b	If you would like an experienced designer's involvement please rate from 1 to 10 how involved that designer should be?	x	x		
4	How important is colour, theme and general aesthetics to you?	x	x		x
5	Should a dashboard be cluttered or streamlined?		x	x	x
6a	Should a dashboard have drill down functionality?	x	x	x	x
6b	If you answered yes to the previous question, how granular(detailed) should the data be?	x	x	x	x
7	How involved do you wish to be on the overall design & build of your dashboard? (scale = very technical to only aesthetical)	x		x	
	Decision Making (Scale = lower number equals lower score)				
8	How do you use a dashboard to come to a decision, are there any specific technique you use to analyze a dashboard?				x
9	Do you look more at the graphs or numbers when reading internal dashboards? (graphs used to identify trends/ numbers used to view impact)	x			
10	How should a dashboard assist you in decision making? E.g. automatically identify outliers, pick up trends you might miss etc.			x	
11	How should information on a dashboard be communicated to you?(Not the apparent visual but rather priority info first and then the less important information etc.)	x	x		x
12a	How important is the view of the entire organisation and market when making decisions?				x
12a	Should decisions be taken in isolation of one another?				x
13	Is a dashboard there to just look at your KPI's and find solution for improving KPI's or do you use it for long term strategic decision making?		x	x	x
14	Would you describe yourself as a visual or auditory person with regard to decision making? e.g. Do you prefer meetings when making a conclusion or physical reports?		x	x	
	Results (Scale = lower number equals lower score)				
15	Do you believe you need to be involved in how the results on a dashboard KPI's are calculated?			x	

6.2 Questionnaire (Part 2)

Question #	Dashboard Design in ICT environment questionnaire (All questions below will be used to stimulate a discussion rather than just providing an answer)	Research Question: What makes an effective dashboard in terms of flexibility, adaptability and usefulness?	Research Question: What are the characteristics of a good decision support dashboard?	Research Question: What does business require from a dashboard to enable effective decision making?	Research Question: Which characteristics of an effective dashboard are industry specific?
16	What do you believe the results of a dashboard should be?	x		x	x
17	Can results be over complicated as long as they add insight to the end user?	x		x	x
18a	How would you determine whether a dashboard is successful or not?	x	x	x	x
18b	Please elaborate on your answer.	x	x	x	x
19	Which steps will you take to change a dashboard from unsuccessful to successful?	x	x	x	
20	From 1 to 10(1 = low, 10 = high), how flexible should a dashboard be in terms of exploring data and adding new measure, and why? Build (Scale = lower number equals lower score)	x			
21a	Do you use a certain methodology when designing a dashboard?	x	x		
21b	If you answered yes to the previous question can you please elaborate on your answer?	x	x		
22a	How involved should the end user be in the build of the dashboard?	x	x		
22b	Based on your previous answer are you experiencing this level of involvement?	x	x		
23	Are there any design queues you found works especially well for design in the ICT environment	x	x		
24	How important is the data source when building a dashboard, from 1 to 10	x	x		
25	Do you use any specific software tools when designing a dashboard, if yes please elaborate?	x	x		
26	What is the average amount of resources(time, people, capital etc.) needed to develop a executive dashboard?	x	x		
27	If you were to think of dashboards development in a similar manner as a SDLC(System Development Life Cycle), how would you describe that SDLC?	x	x		
	Questions to be completed by researcher (Scale = lower number equals lower score)				
28	Which type of dashboard is this interviewee the most familiar with?				
29	Is this interviewee an end user or developer?				
30	How experienced is the interviewee with dashboard?(Scale = 1 to 10)				

6.3 Condensed Questionnaire Findings

Question	Respondent Type	Sentiment	Condensed Finding
1	Developer	Positive	Only show necessary data
1	End User	Positive	Only show necessary data
2	Developer	Positive	Developers should have some freedom and input
2	End User	Positive	Developers should have some freedom and input
3	Developer	Positive	Specialist contributes to technical aspects
3	End User	Positive	Specialist aids in user buy-in and ensuring the highest quality possible
4	Developer	Positive	Very under appreciated
4	End User	Positive	Very important as assists with overall usability
5	Developer	Positive	Design should always facilitate usability
5	End User	Positive	Too much detail detracts from overall use and decision support capabilities
6	Developer	Neutral	In some instances yes, in other no
6	End User	Positive	Yes, but limited only to what is required
7	Developer	Positive	End users should only be involved on the aesthetics
7	End User	Neutral	Population split, key differentiator found in their role
8	Developer	Positive	Developers believed users made decisions very systematically
8	End User	Negative	End Users could not identify a specific technique for decision making
9	Developer	Positive	Developers believe end users to be graphically inclined
9	End User	Positive	All interviews preferred graphs
10	Developer	Positive	Dashboards should remain simple in terms of decision support
10	End User	Neutral	Some users expressed need for simplicity while others welcomed more complex solutions
11	Developer	Neutral	Dashboards should tell a story with the most important information prioritized
11	End User	Positive	Dashboards should prioritize important information but the design should not constantly change
12	Developer	Positive	Developers believed an holistic view is very important as long as it serves a purpose
12	End User	Positive	End users believed an holistic view is very important as long as it serves a purpose
13	Developer	Neutral	Differs between executive dashboards and operational dashboards
13	End User	Neutral	Differs between executive dashboards and operational dashboards
14	Developer	Positive	Visual
14	End User	Positive	Visual
15	Developer	Neutral	Depends on the type of end user
15	End User	Neutral	Executives should not get involved however other users should
16	Developer	Positive	Business performance
16	End User	Positive	Business performance and areas of risk
17	Developer	Positive	Simplicity is key
17	End User	Positive	Simplicity is key
18	Developer	Positive	Usage and business performance improves
18	End User	Positive	Usage and the ability to make decisions that add value
19	Developer	Positive	Restart requirements gathering
20	End User	Positive	Very flexible
20	Developer	Positive	Very flexible
21	Developer	Negative	No real methodology stated in most cases
22	Developer	Positive	Very involved but not experiencing involvement
23	Developer	Neutral	A number of developers could not identify any difference between ICT and other environments
24	Developer	Positive	Good data quality is crucial
25	Developer	Neutral	Wide range of tools mentioned with Excel being the most prominent
26	Developer	Neutral	Vastly different answers received
27	Developer	Neutral	Split between Waterfall and Agile

6.4 Main themes found during research

Main Theme	Relevance to research	Weight in research study
Collaboration is vital but not present	High	High
Knowledge Sharing	Medium	Low
Dashboard usage key to success	High	Medium
Data and business maturity key to the success of a dashboard	Low	Low
Simplicity in design increases decision making ability	High	High
Limited detail in terms of data granularity	High	Medium
Dashboards are user specific	High	High
Feedback critical to development	High	High
Dashboards should remain a visual tool	High	Medium
Better decisions made from visual tools	High	Medium
Trust between developer and end user is key	High	High
End users do not want to design dashboards alone	Low	Low
Good aesthetics is vital to dashboards success	High	High
No structured approach found to decision making	Medium	Low
No singular view on the goal of a dashboard	Medium	Low
No singular methodology for dashboard development	High	High
Lack of structured approach to dashboard development	Medium	High

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