BEYOND FUNCTIONALITY AND A USER INTERFACE: A DESIGN THINKING PERSPECTIVE ON THE DESIGN OF DASHBOARDS

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ABSTRACT

With an increasing interest in Business Intelligence, dashboards have played an important part in giving a summary of data presented in a single page for users in an organisation to get a glimpse of what is going on in their systems. Research studies and publications in the area of dashboards to date have been focused either on the graphical user interface, functionality, or technological aspects. Certainly, there is a wider range of issues and elements related to the dashboard design process that need to be taken into consideration, ranging from the preparation, the actual design process, and the impact of the design process at a later stage. Through interpretivist case study research, this study aims to explore and understand the dashboard design process and how this impacts organisational performance, processes, and the IS/IT environment. Also, this study explores how the design process corroborates with the fundamental characteristics of design thinking. Lastly, this study explores key principles and elements in dashboard design.

The findings confirmed that the process of dashboard design is initiated by internal or external organisational triggers. Purposes and goals of the dashboard should be defined and aligned with organisational strategic goals. There are important elements to check which gauge the preparedness of an organisation to start the design process. Essentially, the design team should work with key users and stakeholders in determining the viability and feasibility of the initiative before requirement gathering can be initiated. Multidisciplinary collaboration exists throughout the process, where users and stakeholders would be actively involved in making dashboard design decisions. Early prototyping is used as a tool in designing and collaborating with users. Throughout the process, designers should endeavour to balance analytical thinking and intuition, as these are important characteristics of design thinking. This would enable designers to be open minded in framing problems and exploring solution concepts.

Finally, when the design and development process is complete, the dashboard can be implemented and integrated with the current IS infrastructure in the organisation. The whole process potentially *finishes* when users have used and adopted the dashboard. In general, the dashboard design process continues with an evaluation and improvement plan, as the study suggests that a dashboard design process should be ongoing and aligned with organisational business strategies. Additionally, the design team has to continue to engage and collaborate with users to continually improve and gauge the progress of dashboard adoption in the

organisation. As a result, users can also evaluate if the use of the dashboard brought positive impacts on the organisation.

This study has provided a better understanding of issues surrounding dashboard design. These include but are not limited to strategic change in current processes and/or the structure of the organisation which can significantly impact dashboard design. Furthermore, this study has informed IS design practitioners on the evolution of roles in a dashboard design team. The importance of a holistic approach in analysing design problems and co-existence with solution and concept development has been highlighted as a notion that should be embraced, apart from possessing multidisciplinary communication skills. Also, this study has discussed how key elements and a set of design principles could be used to inform and support the dashboard design process in organisations. Lastly, this study has developed a seminal framework for ongoing dashboard design in which design thinking mindset is prevalent, regardless of the design and development method employed by the organisation.

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Two roads diverged in a wood, and

I took the one less travelled by,

And that has made all the difference.

I wish to dedicate this thesis to both my parents, Bambang and Monica. Thank you for always reminding me that difficulties and capabilities are two different things. I hope I have made you proud. To my sisters, Felicia and Agustina, and my brother, Theodore, thank you for your unending support. To my brothers in law, Erik (for helping with logistic issues) and Dr Marcus Santoso (for his wisdom that doing a PhD entails 30% conducting research and 70% having fun). To my partner in life, Jose, you have never asked me "*why are you doing this?*" When things get tough, you have never doubted me. Instead, you just told me to carry on and finish what I started.

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Lastly, I thank Dr Diane Brown for copyediting my thesis in accordance with the *Australian Standards for Editing Practice* (2013), in particular Standards D and E.

DECLARATION

This thesis contains no material which has been accepted for the award to the candidate of any other degree or diploma. To the best of my knowledge, the thesis contains no material previously published or written by another person except where due reference is made in the text of the examinable outcome. This thesis contains material that has been published as follows:

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Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Introduction

This study explores the process of both designing a digital dashboard beyond its functionality and the graphical user interface plus the impact of the dashboard design process on organisational performance, processes, and the Information System/ Information Technology (IS/IT) environment. The study uses the notion of design thinking as its theoretical lens to understand the intricacy of the dashboard design process. This chapter particularly discusses the context of the study, problem statement, and research motivation. Subsequently, research objectives and questions are outlined followed by a discussion on the strategy and methods of this study. Lastly, research significance and contribution are discussed, followed by an outline of the structure of this thesis.

1.2 Context of the study

This study is focused on issues related to the process of designing dashboards. In real life, dashboards generally are used in a car or in an aeroplane displaying vital information such as speed, temperatures, oil level, and so on to help their users in making decisions. In IS/IT environment, dashboards are also used to deliver at-a-glance summarised information for performance monitoring by users in an organisation (Dover 2004) and to support decision making (Eckerson 2011). The use of dashboards can be widely varied which will be discussed further in the next chapter. For this study, the context is specifically focused on the use of dashboards in an organisation to support its businesses.

In an organisational context, managers use dashboards to support their daily tasks in their organisations (Rasmussen, Bansal & Chen 2009; Resnick 2003). Created through analysis of the data, the dashboard is used to represent key metrics that matter for decision makers (Howson 2008). These key metrics may be influential in decision-making activities, hence arguably the appropriate design of the dashboard is pivotal for the organisation. The context of design transcends beyond the graphical user interface (GUI) of the dashboard. Other elements such as data/information, users/organisations, and current systems, infrastructures, and/or business processes need to be taken into consideration during the design process.

Contemporary organisations, particularly medium to large organisations, need something to help managers monitor the performance of their organisations more easily and efficiently (Few 2006). A dashboard is an outcome of Business Intelligence (BI) that could be used to facilitate management tasks of monitoring, examining, and controlling performance in key organisational activities (Eckerson 2006). According to Rasmussen, Bansal and Chen (2009), a well-designed dashboard displaying key information can help managers spot potential problems and hence, take proper action to improve the situation. It seems clear therefore that having efficient tools to access information related to key performance indicators would be valuable to decision makers in the organisation (Dyczkowski, Korczak & Dudycz 2014).

Arguably, the creation of a dashboard is a design issue and activity. Fundamentally, design occurs in most things we do (Papanek 1984), as it is a basic human activity (Lawson & Dorst 2009; Papanek 1984). Everything around us is a product of design and everyone is capable of designing (Cross 2011). A design process starts when we want to create something new (Cross 2011) or when we want a current situation to change into a more desired one (Simon 1996). Once we initiate the preparation of any actions toward a desired and possible end, the design process has begun (Papanek 1984).

However, research studies and publications on dashboards to date (to be discussed further in the next section) have been focused either on the graphical user interface, functionality, or technological aspects. Certainly, a wider range of issues and elements related to the dashboard design process need to be taken into consideration, ranging from preparation, the actual design process and its impact at a later stage. Furthermore, Dover (2004) suggested the success of dashboard design relies on the how the dashboard is being used and accepted by users. Indeed, the issue of system design seems to have a close relationship with the use or adoption of the system at a later stage (Barki & Hartwick 1994; Markus & Mao 2004; Pauwels et al. 2009).

Therefore, this study explores key elements or aspects that influence dashboard design and also investigates the impact of the dashboard design process, and its relationship to current organisational processes and the IS/IT environment. Additionally, this study analyses the design process using the concept of design thinking as its theoretical framework. Design thinking strives to create innovation by balancing what users want in a design with what is technologically feasible and viable from the organisation's perspective (Brown 2008). The next section discusses this further, along with this study's problem statement and research motivation.

1.3 Problem statement and research motivation

Research in the past has been conducted regarding the importance of dashboard design, development and implementation (Clark, Abela & Ambler 2006; Pauwels et al. 2009; Yigitbasioglu & Velcu 2012b). For example, Clark, Abela and Ambler (2006) performed two surveys which had shown a link between dashboard use and better ROI (Return of Investment). Pauwels et al. (2009) conducted a study that focused on the developmental stages and effectiveness of marketing dashboards, measured by benefits generated for the organisation. Yigitbasioglu and Velcu (2012b) reviewed the literature on dashboard visualization, appearance and user characteristics. Generally, while the graphical user interface (GUI) and visual features were essential, they found that functionality was also an important feature that needs to be taken into consideration when implementing a dashboard. They argued that as users continue to utilise information to support their decision making, designers should be mindful of the effect of information overload. It is important not to make poor design decisions by putting anything on the dashboard which distracts users' focus on key information on the dashboard (Yigitbasioglu & Velcu 2012b).

Similarly, practitioner-oriented publications discuss how information should be visualised in dashboards (Few 2006), how to monitor, manage, and measure businesses with dashboards (Eckerson 2011), and how they should be designed through a number of steps on the dashboard design process (Rasmussen, Bansal & Chen 2009). Generally, authors tend to treat the dashboard as a final product of design, without looking at the detailed design process. This might send an inaccurate indication to managers as potential users, that designing a dashboard is a straightforward task. Therefore, managers might not be expecting to encounter such potential issues faced by designers as data availability and reliability. Undoubtedly, it is not uncommon that some process change or improvement is needed as part of dashboard design initiative.

Overall, it is evident that there has been a high emphasis on the visual aspect of dashboard design (Dowding et al. 2015; Few 2006; Yigitbasioglu & Velcu 2012b), to be discussed in more detail in Chapter 2. However, there is limited academic investigation on the detailed process of designing dashboards and the impact on organisations. Therefore, this is the main motivation for pursuing this study, as it is important to have academic groundwork to support the development of this interesting research topic in theory and practice. This study also

provides a standpoint to confirm the existence of the apparent misconception, discussed in the earlier paragraph, driven by practitioner-oriented publications.

In terms of the theoretical lens of this study, design thinking was selected for its practical application in real world problems as the literature suggests. Design thinking is a way of thinking, strategizing, and approaching problems (Martin 2009). As mentioned in the previous section, it strives to create innovation by balancing what users want in a design with what is technologically feasible and the viability from the organisation's perspective (Brown 2008). It is evident that there has been an increasing interest in design thinking across a number of disciplines (Araujo 2012; Bradigan & Rodman 2008; Burdick & Willis 2011; Du, Jing & Liu 2012; Johansson-Sköldberg, Woodilla & Çetinkaya 2013; Koh et al. 2015). Koh et al. (2015), for example, attribute this growing interest with the increasing need to be more creative and innovative in satisfying the demand for new products and services. Although mostly been discussed in the design field (Cross 2011; Dorst 2011; Paton & Dorst 2011), Martin (2009) noted that design thinking could be an advantage for businesses by achieving a balance between analytical and intuitive thinking as well as between exploration and exploitation in organisational learning. Additionally, Brown (2009) discussed design thinking in an organisational context, highlighting the change in organisations through innovation.

Since design thinking seems to have a positive impact on organisations (Araujo 2012; Bradigan & Rodman 2008; Burdick & Willis 2011; Du, Jing & Liu 2012), this study could make use of the design thinking concept and see if its characteristics can be found in the process of dashboard design. Also, there seems to be a growing interest in design thinking in IS (Gaskin & Berente 2011), particularly in IS development (*Design Thinking in ISD* 2012; Lindberg et al. 2012). While this is potentially a good start, there is always room to grow in terms of research. Therefore, the exploration of a design process through a design thinking perspective will certainly produce insights for other researchers in the IS field, predominantly in the area of dashboard design.

Additionally, this study investigates the impact of the dashboard design process regarding current organisational processes and structures, systems, data, and/or infrastructure. According to Eckerson (2011), dashboards drive organisational change. In a way, designing dashboards could impact or trigger change in various activities or processes in organisations. When designing dashboards, the impact on current circumstances in organisations, such as organisational culture in terms of performance monitoring and decision making, needs to be

understood. Apart from this understanding, the data required for dashboards need to be made available and is currently captured in the organisation's current processes or systems.

1.4 Research objectives and questions

The main research objective and two related sub-objectives have been determined for this study. The main objective is:

> ***RO1: To explore and understand the dashboard design process and how it impacts organisational performance, processes, and IS/IT environment.***

A dashboard is one of the outcomes of BI (Eckerson 2011). BI is a data-driven information system (IS) which gathers and stores data to enable knowledge users such as executives, managers, and analysts to make decisions (Chaudhuri, Dayal & Narasayya 2011; Negash & Gray 2008a). The rapid uptake and use of IS/IT in organisations have demonstrated the ability to impact impacts on various aspects in the organisation, particularly the range of activities and the decision-making process (Gurbaxani & Whang 1991). Gallagher, Mason and Vandenbosch (2004) however indicate that an information system project could lead to initiatives to improve current organisational processes and systems. Based on this premise, designing dashboards can be regarded as an instance of IS adoption and use in organisations. Hence, this study notes the importance of looking at dashboard design impacts in relation to current organisational performance, processes, and structures, systems, data, and/or infrastructure.

A dashboard, when properly implemented, could be a "catalyst" for something broader to take place (Dover 2004, p. 48). Just as Eckerson (2011) suggested, dashboards can drive organisational change. In a way, designing dashboards could impact or trigger change in various organisational activities or processes. For instance, when an organisation calls for a certain metric that is unavailable or captured by an existing process or system. When data or information needed is not available, some changes may need to be made accordingly as part of the dashboard design exercise. However, these changes are not necessarily in relation to database management or at systems level. Instead, it could take the form of a process innovation or organisational change to capture the relevant data to be displayed on the dashboard. Therefore, this study aims to explore and understand the extent of this impact.

The first sub-objective is:

> *RO1.1: To explore if there are elements in the design process of the dashboard indicative of the concept of design thinking.*

This study looks into the process taking place before dashboard design becomes a reality. In understanding such a process, the notion of design thinking is used as a theoretical framework. According to Johansson-Sköldberg, Woodilla and Çetinkaya (2013), more empirical study is needed as the notion of design thinking has been generally developed merely based on practice. Thus, this study serves as an empirical review of the notion of design thinking. The key concept of design thinking describes the idea of creating design innovation through balancing desirability with feasibility and viability (Brown 2009). In the literature review (Chapter 3) the concept of design thinking will be discussed extensively. In particular, the chapter outlines definitions and characteristics of design thinking. Furthermore, this study explores dashboard design process in organisations and investigates if any elements of design activities indicate the characteristics of design thinking.

Last but not least, the second sub-objective is:

> *RO1.2: To explore key principles and elements in dashboard design.*

There are a number of elements to be considered when it comes to designing a dashboard. Those elements essentially could become contributing factors when making a design decision that leads to the production of a dashboard. This study explores key principles in relation to such design elements used by organisations that lead to successful dashboard design.

Research questions

In line with the research objectives stated, the following three research questions contribute to achieving these objectives. In relation to RO1, the following research question has been asked.

> *RQ1: How does the dashboard design process affect the organisation in terms of its existing systems and processes?*

The first research question is aimed to obtain information from the design team on the detailed design process. A design team may consist of designers, managers, users, and other stakeholders (Stolterman 1999). The questions formulated would be around the relationships between the process of designing a dashboard with the current processes, IS/IT environment, and/or other matters (i.e. performance, cultures, decision making, etc.) in the organisation.

In relation to the first sub-objective (RO1.1), the following research question was prescribed.

> *RQ2: In what ways do the design process corroborate with the fundamental characteristics of design thinking?*

The second research question aims to obtain information from the design team on the detailed design process. To operationalise it, the design team is consulted on the thinking process or any discourse that involves not only analytical thinking but intuition (Cross 2006) during dashboard design. As a result, insights and understandings can be gained through this second research question to see if the design process corroborates with the concept of design thinking.

In relation to the second sub-objective (RO1.2), the third research question is formulated.

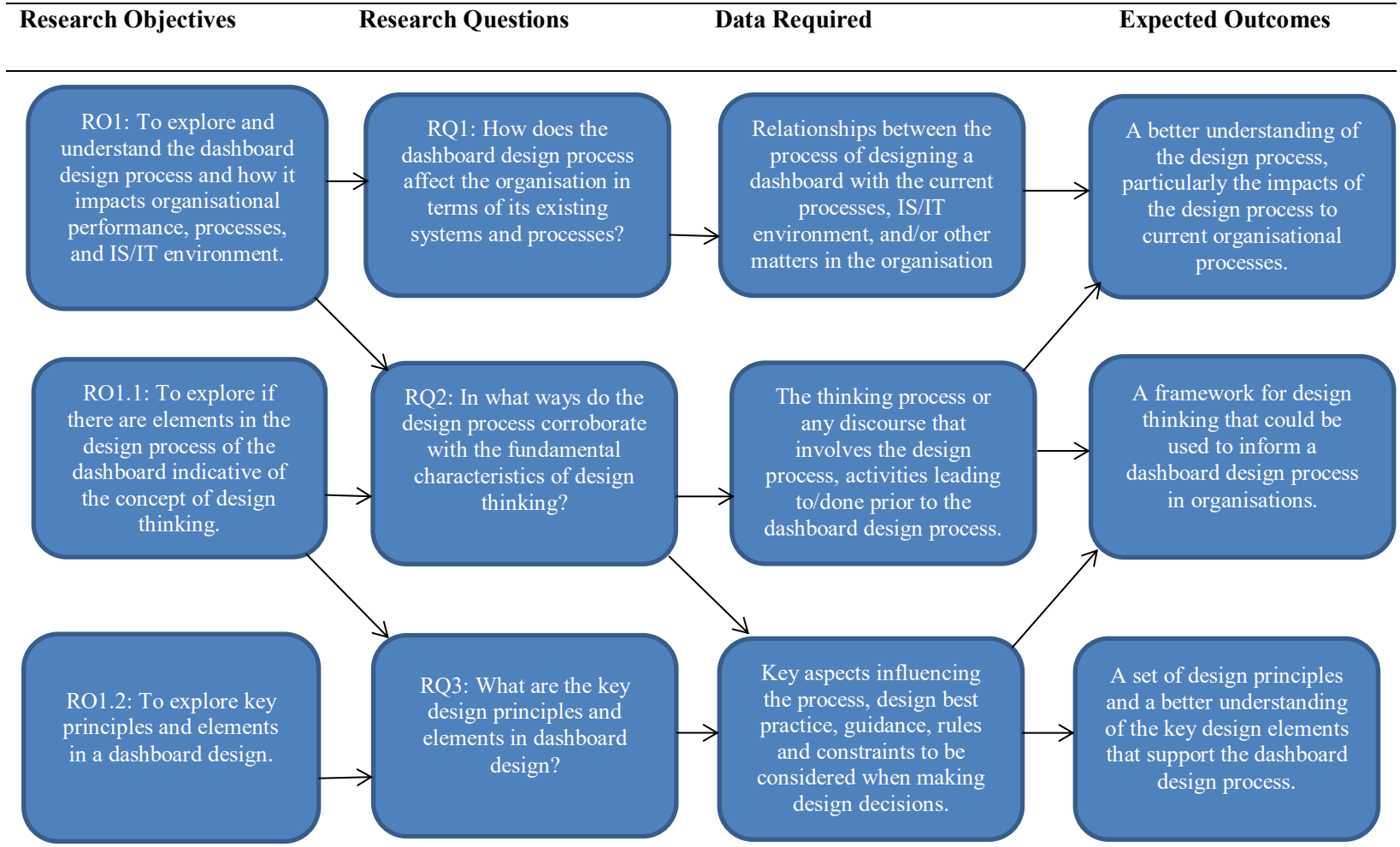
> *RQ3: What are the key design principles and elements in dashboard design?*

The third research question aims to identify key aspects that influence the process of designing a dashboard in the organisation according to the design team and users. Furthermore, this study attempts to obtain information from the process owners and design team on the list of principles used by the organisation that leads to successful dashboard design. This includes design best practice, guidance, rules and constraints as well as elements to be considered when making informed design decisions.

This study does not merely emphasise user interface and dashboard functionality, but conducts a thorough examination from different points of view. For instance, from the designers' point of view it could be determined whether system architecture, software technology, database and information systems were crucial aspects in making a design decision. Other than that from the users' and stakeholders' point of view this study would investigate whether user characteristics and organisational culture were important features of dashboard design. In addition, this study will also examine other considerations in the process of designing a dashboard (e.g. purpose of the dashboard, metric selection criteria, and analytic features).

Table 1.1 summarises the research objectives, questions, along with data required, and expected outcomes.

Table 1.1 Research objectives, questions, data required, and expected outcomes



1.5 Research strategy, methods, and data analysis

The research strategy employed for this study is case study research following Benbasat, Goldstein and Mead (2002), who argued that it is suitable for IS research as researchers could perform the study in the organisation as a natural setting. As a result, insights from practice can be investigated and synthesised. Other reasons for selecting a case study strategy is that the phenomenon being studied cannot be taken away from its context (Yin 2003); and through case study, a deeper understanding and richer descriptions are to be achieved on the subject of research in a real-world context (Yin 2012). In addition, this research aims to understand the intricacy of the processes going on in the organisation by addressing the 'how' and 'why' questions and by focusing more towards organisational rather than technological issues (Benbasat, Goldstein & Mead 1987). Two cases, UniOne and CareOne, were selected for this study (see Chapters 5 and 6 for descriptions).

Qualitative data for this study is gathered through semi-structured interviews with key personnel in the design team including managers, analysts, and a business user at the executive level. The interview questions cover design process, considerations, collaborations, conflicts or discourses relevant to the process of creating a dashboard. Also, key aspects influencing the process of designing a dashboard in the organisation will be discussed with the participants. Lastly, each interview session will be transcribed and the transcripts serve as research data.

For the data analysis, qualitative content analysis will be used as this method analyses an extensive range of textual data, including interview transcripts and notes on observations, which can be employed regardless of research methods and design (Julien 2008). Qualitative content analysis focuses on both the content and contextual meaning of a text (Hsieh & Shannon 2005); and in particular, it examines the text in depth for the purpose of categorizing parts of the text with similar meaning into a number of categories (Weber 1990). Furthermore, qualitative content analysis involves close reading of the textual data, assignment of codes to clusters of text which can be transformed into themes (Julien 2008), as well as grouping "similarly coded data" into categories (Saldaña 2013, p. 8).

The initial data analysis or 'first cycle' of coding, to use the term by Miles, Huberman and Saldaña (2014), begins with a deductive approach by preparing a list of initial codes. These codes are prepared based on the theoretical framework (to be discussed in Chapter 3), and as

a result of reading the literature on dashboards and design thinking. Subsequently, the theoretical framework and literature review will also inform the development of interview questions used for the data collection. At a later stage, following Forman and Damschroder (2008) study, the data analysis approach is combined with an inductive approach. Hence a priori or initial codes are used to start coding the data, while at the same time new codes are identified inductively to improve the initial codes.

The initial codes are greatly informed by and derived from the literature review as well as from the theoretical framework. While reading each interview transcript, the initial codes are applied and the code list is updated with additional codes when interesting ideas are encountered. Subsequently, the codes are categorised and data analysis is continued with the development of themes based on my interpretation of the data. Although themes normally are "derived from codes" (Firmin 2008, p. 868), Saldaña (2013) argued that themes were not merely a translation of codes, thus they were not coded; instead, themes were the result of coding, categorisation, analysis, and reflection.

Figure 1.1 describes and summarises key steps and research strategy in this study.

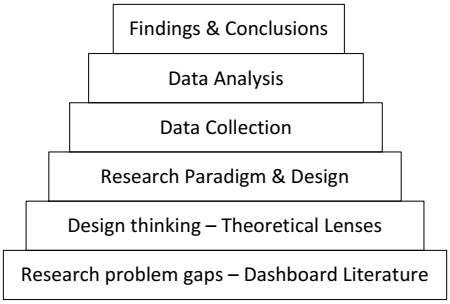


Figure 1.1 Research strategy, methods, and data analysis

1.6 Research significance

This study will make the following contributions to the body of knowledge:

- To provide a better understanding of the dashboard design process, particularly on the impacts of the design process to current organisational performance, processes, and the IS/IT environment.
- To develop a seminal framework on design thinking that could be used to inform a dashboard design process in organisations.

- To develop a set of design principles and a better understanding of key design elements that support the dashboard design process.

1.7 Structure of the thesis

This thesis consists of nine chapters in total. The first half of the thesis presents the introduction (Chapter 1), literature review on dashboards and design thinking (Chapters 2 and 3), and lastly the research paradigm, methods, and design (Chapter 4). The two subsequent chapters (5 and 6) discuss each case study (UniOne and CareOne), followed by cross-case analysis in Chapter 7. Chapter 8 highlights key findings of this study and addresses the research objectives and questions. Chapter 9 concludes the thesis with reflections on quality, followed by a discussion on limitations and future research. Table 1.2 outlines the structure of the thesis.

Table 1.2 Thesis structure

Chapter	**Contents**
Chapter 1 – Introduction	• Context of the Study • Problem Statement & Research Motivation • Research Objectives & Questions • Research Strategy, Methods & Data Analysis • Research Significance & Contribution
Chapter 2 – Literature Review on Dashboards	• Dashboards • Dashboards, Scorecards, & Business Intelligence • The Dashboard Design Process • Impacts of Dashboards to Organisations
Chapter 3 – Literature Review on Design Thinking	• Design Thinking • Design Thinking Characteristics • Design Thinking Strategy • Design Principles • The View of Design & Design Thinking in Information Systems • Conceptual Framework
Chapter 4 – Research Paradigm, Methods, and Design	• Research Paradigm & Philosophical Assumptions • Research Design • The Process of Coding • The Cross-Case Analysis
Chapter 5 – UniOne	• Background Information • Information on Research Participants • The aims of designing a dashboard for an organisation • Key aspects and principles in dashboard design • Designing a more user-centred dashboard

	• Ways to deal with challenges in realising a desired dashboard design • The notion of impact on dashboard design and use
Chapter 6 – CareOne	Similar to Chapter 5
Chapter 7 – Cross-case analysis	• The aims of designing a dashboard for an organisation • Key aspects and principles in dashboard design • Designing a more user-centred dashboard • Ways to deal with challenges in realising a desired dashboard design • The notion of impact on dashboard design and use
Chapter 8 – Addressing Research Objectives and Questions	• Highlighting key findings • Addressing research questions • Implication for practice
Chapter 9 – Conclusion	• Conclusions of the research • Reflections on quality • Limitations and future research

1.8 Summary

In this chapter, the context of the study, problem statements, and research motivations were discussed. The research objectives and questions were outlined followed by a discussion of the research strategy, methods and data analysis used in this study. Lastly, research significance and contribution to the field were discussed. The following chapter presents a literature review on dashboards.

Chapter 2: Literature Review – Dashboards

2.1 Introduction

This chapter outlines the review of literature surrounding the issue of dashboards as the context of this study. First, the definition of dashboards is explained and described. Second, dashboard types, purposes and components in general are discussed. Third, the relationship of dashboards with both Scorecards and Business Intelligence (BI) is defined. Lastly, the importance of the dashboard design process and the impact of designing a dashboard for organisations are outlined.

2.2 Dashboards

As mentioned earlier in Chapter 1, essentially dashboards in real life, in a car or in an aeroplane, contain vital information such as speed, machine temperature, oil level, and so on. It is purposefully placed in front of a driver to be visible at a glimpse while the driver is focused on driving. With that, the driver could make decisions based on the information on the dashboard. In an organisational context, dashboards help users to get a glimpse of performance information in their systems through a set of pre-defined key metrics that matter for them (Howson 2008).

Definitions of dashboards based on the literature are outlined in Table 2.1. A keyword is highlighted to represent the most prominent idea from each definition. From those highlighted keywords, six themes are subsequently identified to help understand and to break down those definitions. The themes comprise what the dashboard is, what it does, what it aims to do, what it contains, and some special features (if any). With these themes, a two by two matrix is created in table 2.2 to further analyse and synthesise the definition of dashboards for this study.

Table 2.1 Definitions of dashboards based on the literature

Definitions	References
Dashboards are an electronic **interface** (typically a portal) that provide employees with timely personalised information to enable them to monitor and analyse the performance of the organisation.	McKeen, Smith and Singh (2005, p. 1015)
Dashboards are diagnostic tools designed to provide busy managers with a **quick overview** of a company's performance.	Yigitbasioglu and Velcu (2012a, p. 39)
Dashboards serve as the **vehicle** for addressing the challenge of marketing accountability via a robust, integrated system that has brought additional validation to the importance of marketing within the corporation.	Cioffi and Miller (2004, p.237)
Dashboards deliver at-a-glance **summaries** presented in a highly visual and intuitive format so managers can monitor progress towards goals; also provide such insights that let individuals see the big picture and, more importantly, understand the impact of their actions on the rest of the company.	Dover (2004, p. 44)
A dashboard is a relatively small **collection** of interconnected key performance metrics and underlying performance drivers that reflects both short- and long-term interests to be viewed in common throughout the organisation.	Pauwels et al. (2009, p. 177)
A dashboard is **a visual display** of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance.	Few (2006, p. 34)
Dashboard is the **assembly** of key marketing metrics or indicators onto a single display, be it a computer screen, slide, or paper.	Clark, Abela and Ambler (2006, p. 19)
A performance dashboard provides timely information and **insights** that enable business users to improve decisions, optimise processes and plans, and work proactively; also communicates strategic objectives and enables business people to measure, monitor, and manage the key activities and processes needed to achieve their goals.	Eckerson (2011, p. 4)

Table 2.2 Breakdown of dashboard definitions

References	What it is	What it does	How it does	What it aims to do	What it contains	Special features
McKeen, Smith and Singh (2005, p. 1015)	An electronic interface	To provide information	N/A	To monitor and analyse the performance of the organisation.	N/A	Timely, can be personalised
Yigitbasioglu and Velcu (2012a, p. 39)	Diagnostic tools	To provide a quick overview	N/A	To monitor a company's performance.	N/A	N/A
Cioffi and Miller (2004, p.237)	A 'vehicle' of integrated systems	N/A	N/A	To increase accountability, to justify performance.	N/A	N/A
Dover (2004, p. 44)	At-a-glance summaries	To provide insights or the big picture	N/A	To monitor progress toward goals and to understand the impact of their actions on the rest of the company.	N/A	Highly visual and intuitive formats
Pauwels et al. (2009, p. 177)	A small collection of metrics	N/A	N/A	To reflect short- and long-term interests of the organisation.	Interconnected key performance metrics and underlying performance drivers	A common view throughout the organisation
Few (2006, p. 34)	A visual display	To provide at-a-glance monitoring	Consolidate information throughout the organisation	N/A	The most important information in the organisation	A single screen
Clark, Abela and Ambler (2006, p. 19)	An assembly of key metrics	N/A	N/A	N/A	Key metrics or indicators	A single screen
Eckerson (2011, p. 4)	N/A	To provide information and insights, to communicate strategic objectives	N/A	To improve decisions, to measure, monitor, and manage the key activities and processes needed to achieve their goals.	Key activities and processes	Timely

A working definition of dashboards is summarised based on dashboard definitions outlined and analysed in Tables 2.1 and 2.2. A dashboard aggregates all the information throughout an organisation and assembles it into a single display (Clark, Abela & Ambler 2006; Few 2006; Pauwels et al. 2009). It contains timely information presented in key metrics to monitor organisational performance (McKeen, Smith & Singh 2005) and key activities to support decision making (Few 2006). Furthermore, it also enables organisations to have a common view of its performance metrics and underlying drivers (Pauwels et al. 2009). Regardless of user roles in the organisation, dashboard users are in the same 'ship' moving towards the same goals (Clark, Abela & Ambler 2006; Wisan 2002).

Though metrics seem to be at the heart of the dashboard where all important information is presented, there does not seem to be any agreement between a few different authors such as Harel and Sitko (2003), Seybert (2012), and Yigitbasioglu & Velcu (2012b) when it comes to defining how many metrics should be included in a dashboard. As a result, this arguably makes it difficult to precisely define what constitutes a single display, as in dashboards, as a common view across an organisation. Few (2007) contended that the term 'dashboards' has been used inaccurately to describe any types of screen-based display which contains a multiple number of charts regardless of its purpose. In addition, he argues that the main purpose of dashboards is merely for monitoring, not for analysis (Few 2007), which is considerably limiting and contradictive to the abovementioned dashboard definition discussed by McKeen, Smith and Singh (2005).

Given this study focuses on the dashboard design process, therefore it adopts the view that metrics and associated data constitute an important component of the dashboard regardless of the number of metrics in a single display. Other components of the dashboard are discussed in subsection 2.2.3, following the discussion below on three types of dashboard and dashboard purposes based on the literature.

2.2.1 Types of dashboard

According to Eckerson (2006), in general there are three levels of users who use dashboards namely executives, analysts, and workers. Firstly, executives usually constitute the top level, monitoring organisation's key performance metrics through the dashboard. Secondly, analysts constitute the middle level, analysing information in which the metrics are shown with more details. Thirdly, on the bottom level workers would be able to drill into a very detailed

information to support decision making. However, in some situations users would be able to move between all three levels seamlessly. Eckerson (2006) depicted this dynamic in a framework called MAD (monitor, analyse, drill to detail) (Figure 2.1). The form of a pyramid intuitively tells an appropriate proportion of users and metrics on each level in an organisation.

This categorisation in Figure 2.1 resonates with the three organisational levels provided by Anthony (1965) which are strategic, management, and operational levels. The strategic level focuses on company-wide decision-making activities which are usually unstructured and occur on an irregular basis. The decisions made at this level involve high complexity tasks and normally affect the organisation's long-term vision. At management level, there is less complexity compared to the strategic level. People at this level typically work to make sure the organisation is running in line with the visions decided at the strategic level. Lastly, at the operational level, the staff engage with some specific tasks daily, and generally they make decisions at a transactional level which are considered as simple, and structured on a real-time basis (Anthony 1965; Valacich & Schneider 2010).

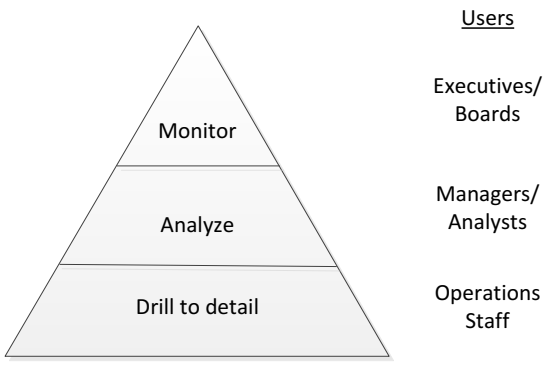


Figure 2.1 MAD framework (Eckerson 2006)

Drawing on Eckerson's (2006) three levels of user and dashboard functionality plus three levels of organisational role Anthony (1965) and Valacich and Schneider (2010), the characteristics of dashboard users for each level are summarised in Table 2.3 below.

Table 2.3 Characteristics of dashboard users (Anthony 1965; Eckerson 2006; Valacich & Schneider 2010)

Users	Roles	Information	Decision-Making	Dashboard Functionality
Executives/Boards	Strategic	Aggregated, Summarised	Unstructured, irregular	Monitor
Analysts/Managers	Management	Function-specific	Semi-structured	Analyse
Workers/Operations	Operational	Task-specific	Repetitive, Structured	Detailed

Few (2006) argued that while everybody wants a dashboard, some organisations were just following the trend, or what Pankaj, Hyde and Rodger (2006, p. 1427) referred to as the "latest management fad". In this case, it might be difficult to find a fit between user requirements and data and features availability on the dashboard (Yigitbasioglu & Velcu 2012b). That is because the exact purposes of the dashboard might not be identified at the outset of the design process "due to fashion and fad motives" (Yigitbasioglu & Velcu 2012b, p. 52). In comparison, Eckerson (2006) mentioned several organisations in which a dashboard was successfully implemented and proven to gain benefits for users. One example was the International Truck and Engine where a management dashboard was reportedly a reliable source of information. Not only does it deliver timely and comprehensive reports or snapshots of information, it also allows users to explore the problem and take some actions to ameliorate the situation (Eckerson 2006). In sum, what matters the most is designing a dashboard that can communicate well and add value to the organisation (Few 2006).

2.2.2 Purpose of dashboards

Dashboards are often used to monitor data that is measured frequently and relates to the health and efficiency of an organisation. Table 2.2 detailed the purpose of dashboards based on the literature. In general, dashboards are used to monitor organisational performance (McKeen, Smith & Singh 2005; Yigitbasioglu & Velcu 2012b) against the goal of the organisation (Dover 2004). An effective dashboard enables organisations to reach a high level with aggregated overview information (Yu & ZhiYong 2013) in a form of metrics (Treude & Storey 2010). It contains data pooled from different sources to get a more holistic view of the performance of organisations rather than looking through separate reports (Dover 2004). Given the common view of organisational performance, dashboards enable users or employees in the organisation to work toward the same goals (Clark, Abela & Ambler 2006; Dover 2004).

Apart from monitoring, dashboards can also provide users with valuable information to support decision making (Eckerson 2011; Pankaj, Hyde & Rodger 2006). Dashboards as a visualisation tool "provide self-service capabilities to end users" (Wang, Wang & Alexander 2015, p. 33). In a way, dashboards enable users to perform quick information analyses (Lawson, Stratton & Hatch 2007), without the need to involve IT support in retrieving data from the database (Dover 2004), or at least with less dependency on the IT department (Lawson, Stratton & Hatch 2007; Wang, Wang & Alexander 2015). Furthermore, dashboards can also "enable users to track their activities, in order to enable self-analysis and comparison with other users" (Verbert et al. 2014, p. 1499).

In the long term, dashboards could drive the organisation into "a culture of transparency" as everyone in the organisation gets access to the information (Dover 2004, p. 44). The dashboard also assists users to be accountable in justifying performance and decision making (Cioffi & Miller 2004), as it provides insights to understand the impact of every action and decision made by the organisation (Dover 2004). Figure 2.2 summarises the purpose of dashboards based on the literature.

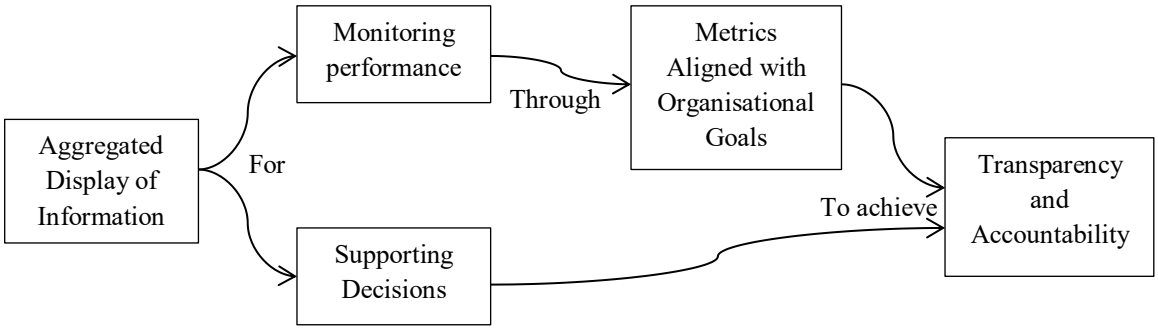


Figure 2.2 Purpose of dashboards

2.2.3 Key components in dashboards

While every organisation may have different goals, generally dashboards display some quantitative measures on the current situation, so the user can see critical information at a glance, for instance: the number of calls per hour, expected sales figures, and network downtime (Few 2006). Also, depending on the aim of a dashboard, some data can be presented better qualitatively. Few (2006) mentioned some examples: top 10 customers, pending jobs, and people to be contacted. Regardless of the type of data being presented, these measures can be displayed in many different ways, such as tables and graphs (Eckerson & Hammond 2011),

gauges and dials (Bose 2006; Mitchell & Ryder 2013), spatial or temporal presentation (Filonik 2012; Verbert et al. 2013), and geographic maps or heatmaps (Eckerson & Hammond 2011; Wang, Wang & Alexander 2015).

Dowding et al. (2015) discussed some aspects to be considered in order for the dashboard to be valuable for users, such as types and design, presentation styles of information, and types of user. Regardless of dashboard types or the metrics used on the dashboards, components of a dashboard typically could be categorised into three main categories (Users, Technologies, and Contents) as described in Figure 2.3. The first category, Users, entails not only dashboard users but also the organisation they belong to. The second category involves technologies in which the dashboard was built upon, including but not limited to database technology, infrastructure, and design and development tools. The third category, Contents, includes other dashboard components such as the data being displayed, features, graphs and metrics.

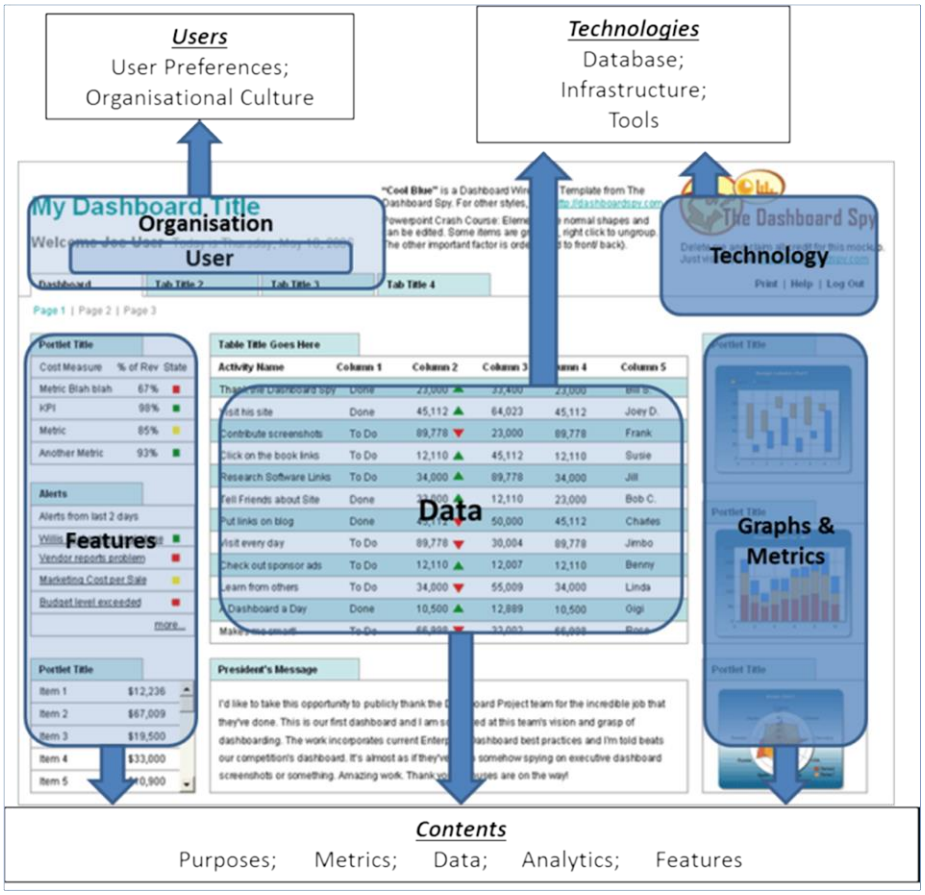


Figure 2.3 Key components of a dashboard

The background dashboard taken from [http://dashboardspy.com/dashboard-screenshot-wireframe-coolblue-template.html)](http://dashboardspy.com/dashboard-screenshot-wireframe-coolblue-template.html)

Users & Organisations

Arguably, in the process of designing a dashboard, these components need to be well understood. Based on the literature, a number of design elements associated with each component that needs to be considered is gathered (Table 2.4). It might be as simple as finding a fit in which all the required data and/or information, and dashboard features are available for users (Yigitbasioglu & Velcu 2012b). Understanding these components and associated elements is critical to the creation of a dashboard. Furthermore, understanding of what data is available, expectations of key users, decision making culture, technological platform of the organisation, and the processes that generate the data required, could become contributing factors when making a design decision leading to the creation of a dashboard.

Data

When it comes to populating a dashboard with data, having baseline or current data is insufficient (Wisan 2002). Defining its relevance to user requirements is also important and should not be determined just because the data can be obtained and measured easily (Verbert et al. 2014). Historical data provide useful insights to be used for trend analyses, while comparative data add value by giving a meaningful comparison of performance with other similar organisations (Lawson, Stratton & Hatch 2007; Wisan 2002). Thus, dashboards carry capability which may enable users to analyse or even perform a what-if analysis with the information (Nagy et al. 2009; Yigitbasioglu & Velcu 2012b). Furthermore, the drill down feature goes hand in hand with the analytics capability which will be critical in assisting analyses (Yigitbasioglu & Velcu 2012b).

Graphs & Metrics

According to Wisan (2002), when a dashboard project is initiated, designers generally would not have a clear idea about the metrics needed to measure organisational performance. Performance metrics is a measurement used to "quantify the efficiency or effectiveness of an activity" (Matthews 2011, p. 86). Often, the designers might opt for standard metrics suggested by the dashboard design tool (Wisan 2002). These standard metrics can be used as a foundation to collaborate with users for further selection and identification. As best practice, each metric

should be owned by a department or group of users (Pankaj, Hyde & Rodger 2006). Furthermore, Matthews (2011) argued that good metrics should strike a balance between financial and non-financial measures, be aligned to the organisation's strategic intent, focus on making improvements, and be easily understood. In addition, having proper domain expertise is key in understanding meanings of data and metrics (Wang, Wang & Alexander 2015).

The number of performance metrics, which represent "the most essential measures of core inputs, outputs, and outcomes", might vary depending on the mission of the organisation. (Mitchell & Ryder 2013, p. 75). Arguably, deciding on the number of metrics to be included in a dashboard is a tricky task, and hence warrants attention to be paid by designers and dashboard users. However, it is best to use a limited number of well-defined KPIs (Mitchell & Ryder 2013). Harel and Sitko (2003) suggest between five and nine indicators, while Seybert (2012) recommends the maximum number of metrics be from 15 to 20. Yigitbasioglu and Velcu (2012b) however suggest no more than four metrics as humans have a limited attention span, and hence designers should focus on giving relevant information to help users in analyses.

As there is no widely accepted 'guideline' on selecting key metrics for the dashboard, this adds to the complexity of dashboard design. Obviously, as mentioned above, some use the standard metrics provided by any dashboard design tools as a baseline (Wisan 2002). But more often than not, organisations are left with more than enough metrics available for selection. This could leave users feeling overwhelmed and cause them to lose perspective on key relationships between metrics (Matthews 2011). It has proven difficult to select and prioritise them, as supported by Wisan (2002). As a result, it can be quite difficult for designers to design a single page dashboard, as defined by Few (2006).

Nonetheless, this study does not focus on defining the right number of metrics in a dashboard. Instead, the emphasis here is on metric selection and identification as part of the dashboard design process. Having too many metrics in a dashboard can distract users' insight (Wisan 2002). Hence Matthews (2011) suggests that key metrics should be determined based on the most prominent goals and strategic intent of the organisation, while Wisan (2002, p. 132) suggests that metrics should be prioritised based on their "ease of use, importance, and clarity".

Table 2.4 Design elements of a dashboard mapped to the dashboard components

Dashboard Components	Design Elements	Reference
Data	Data relevance, data sources, data availability, data quality, data aggregation.	Devillers et al. (2007), Hranac and Petty (2007), Nagy et al. (2008), Olsha-Yehiav et al. (2006), Pauwels et al. (2009), Verbert et al. (2014), Wadsworth et al. (2009)
Technologies	Platform, system architecture, software, information systems, data warehouse, database systems	De Marco, Mangano and Zenezini (2015), Nagy et al. (2008), Olsha-Yehiav et al. (2006), Wadsworth et al. (2009)
User	Characteristics (profile, background, experience, preference)	Hennen (2009), Malik (2005), Pauwels et al. (2009), Yigitbasioglu and Velcu (2012b)
Organisation	User roles, culture, requirements, policy, goals, decision-making style, business rules definition	Clark, Abela and Ambler (2006), Devillers et al. (2007), Eckerson (2006), Hennen (2009), Hranac and Petty (2007), Pauwels et al. (2009), Rasmussen, Bansal and Chen (2009), Yigitbasioglu and Velcu (2012b)
Features	Functionality, drill-down, slice-dice features	Few (2006), Hennen (2009), Hranac and Petty (2007), Malik (2005), Pauwels et al. (2009), Sloane et al. (2006), Wadsworth et al. (2009)
Graphs and Metrics	User interface, metrics selection	Few (2006), De Marco, Mangano and Zenezini (2015), Hranac and Petty (2007), Malik (2005), Nagy et al. (2008), Olsha-Yehiav et al. (2006), Pauwels et al. (2009), Wadsworth et al. (2009), Yigitbasioglu and Velcu (2012b)

Technology & Features

From the literature study, it is evident that data visualisation is the component discussed predominantly as it is an essential feature of dashboards (Dowding et al. 2015; Few 2006; Yigitbasioglu & Velcu 2012b). Data visualisation represents data in an effective and systematic way that is particularly useful in presenting a high volume of data and could facilitate users discovering insights from the data (Wang, Wang & Alexander 2015). It is more about communicating the designer's insights into data as the same set of data can generate many different visualisations (Zhu 2013). Through visualisation, users can discover patterns, exceptions, and other potential insights behind the raw data form (Kirk 2012).

Essentially, the aim of data visualisation is to make users become more informed about a subject (Kirk 2012). Providing interactive data visualisation means much more than the face value of the dashboard user interface (UI) which helps users gain an overview of data and increases the use of a system that requires data analysis as one of its goals (Heinicke et al. 2015). According to Wang, Wang and Alexander (2015), data visualisation tools such as

dashboards could improve decision making, assist in ad hoc data analysis, facilitate information sharing, and provide self-service capabilities to users to get the information needed.

Having said that, it is important to note that data visualisation incorporates the designer's insight into the presentation of data, thus the same set of data can be visualised in many different ways (Zhu 2013). Hence having proper domain expertise (Wang, Wang & Alexander 2015) and a multi-disciplinary team background (Kirk 2012) would be helpful in ensuring that data are being presented in the right context and in a meaningful way (Wang, Wang & Alexander 2015). In addition, the visualisation should also minimise "the amount of thinking or 'working out' that goes into reading and interpreting data and simply let the eyes do their efficient and effective job" (Kirk 2012, p. 18).

Furthermore, Simon (2014) argued that not all data needs to be visualised to reveal insights. Users also need to be aware that visualisation might not always result in good decision making and nor can it always lead to certainty (Simon 2014). This arguably can result in misunderstandings of what users can expect from visualisation. In fact, visualisation is meaningless if it does not deliver meaningful results (Wang, Wang & Alexander 2015). The visual aspect of the user interface complements the functionality of the dashboard (Heinicke et al. 2015; Yigitbasioglu & Velcu 2012b). In other words, there are other components as mentioned in Table 2.4 that warrant the same level of focus as the visual presentation of the dashboard.

The literature has also associated dashboards with scorecards (Bose 2006; Devillers et al. 2007; Nash et al. 2010). It also appears that there is no strong agreement in some organisations when it comes to defining what a dashboard is; the terms 'dashboards' and 'scorecards' are often used interchangeably (Lawson, Stratton & Hatch 2007). The next subsection discusses the relationship between these two terms.

2.3 Dashboards and scorecards

Kaplan and Norton (1996) introduced a notion called the Balanced Scorecard (BSC) to measure performance of an organisation from the perspective of finance, customers, internal business processes, and learning and growth. These four perspectives stem from the idea that organisations have heavily emphasised the financial perspective in assessing organisational

performance (Wisan 2002). The BSC is generally used at a strategic level (Williams & Williams 2003) and is developed to measure the performance of businesses (Wong, Lam & Chan 2009). The scorecard can be used to translate visions and strategies of an organisation into something more tangible and operative (Kaplan & Norton 1996).

Although some would differ, Devillers et al. (2007) use the terms scorecard and dashboard interchangeably, or at least some organisations do so (Lawson, Stratton & Hatch 2007). Likewise, Bose (2006, p. 51) likens an executive dashboard to one of three types of dashboard, as discussed in section 2.2.1, with a "business scorecard" due to their nature to be used by users on the executive level, and their role in monitoring and communicating organisational strategy (p. 51). Pauwels et al. (2009) however argue that the BSC is used to describe organisations' current outlooks and performance which are predominantly internal matters. Dashboards on the other hand provide "the way forward", considering the market situation of the organisations (Pauwels et al. 2009, p. 179).

Dashboards and scorecards are not rivals (Pauwels et al. 2009); in fact they can be complementary (Eckerson 2005; Lawson, Stratton & Hatch 2007; Pauwels et al. 2009) and both can be used to communicate strategic organisational intent (Yigitbasioglu & Velcu 2012b). Lawson, Stratton and Hatch (2007) argued that the main goal of dashboards is to deliver information related to both the health of the business and the organisation while scorecards monitor and communicate strategic plans. Essentially, both are reporting tools (Nash et al. 2010) that can be categorised as advanced Business Intelligence (BI) tools which provide "actionable" information (Eckerson 2005, p. 10). Nonetheless they differ in comparison to a regular management information system (MIS) report in which the information is presented in more detail (Pankaj, Hyde & Rodger 2006).

The introduction of performance measurement tools such as the BSC has become one of the key reasons organisations are interested in designing dashboards, as the these tools emphasise the multifaceted nature of performance measurement (Yigitbasioglu & Velcu 2012a). Furthermore, Resnick (2003) suggests that dashboards can be designed based on quadrants of a BSC. In a way, the scorecard acts as a platform for the organisation to come up with ideas on how dashboards can be designed. Additionally, the past development of Executive Information Systems (EIS), Critical Success Factors (CSF), and the Balanced Scorecard (BSC) along with the advancement of technology has paved the way in interest in dashboard design and development (McKeen, Smith & Singh 2005). Lastly, it is worth mentioning here that

other performance monitoring and management tools such as strategic performance measures and Six Sigma will not be discussed in this thesis. Wisan (2002) discussed these tools when comparing dashboards with the BSC .

In the next section, the history of dashboards and the relationships with Business Intelligence (BI) will be discussed. Subsequently, there will be a discussion on how over the past decade contemporary dashboards provided out of the box as part of enterprise systems can help users in monitoring, analysing, and supporting business processes.

2.4 Dashboards and business intelligence

The history of dashboards dates back to the 1980s during the era of Executive Information Systems (EIS). Users at the executive level could access personalised information from various systems in the organisation and were able to drill down to get more detailed information (McKeen, Smith & Singh 2005). However, EIS was not very successful, as the systems were only used by a few people in each organisation and they were expensive to maintain and modify due to their mainframe infrastructures (Eckerson 2011).

Business Intelligence (BI) however continued to flourish. BI was an 'umbrella' term for systems that support business decision making by using factual data from organisations (Power 2007), including dashboards as one of the components (Watson 2011). Nonetheless, it is worth noting that the tendency has shifted to analytics as the umbrella term (Watson 2011).

BI is considered as a data-driven decision support system which gathers and stores data to enable knowledge users such as executives, managers, and analysts to make decisions (Chaudhuri, Dayal & Narasayya 2011; Negash & Gray 2008b). The BI technology predominantly comprises data sources, data transformation engines, data warehouse servers, mid-level servers (analytics, OLAP, and reporting servers), and front end applications (ad hoc query, dashboards, and other applications) (Chaudhuri, Dayal & Narasayya 2011).

Furthermore, Valacich and Schneider (2010) delineated that BI has three components, namely information extraction, analytics and information visualisation. Each component has different functionality to arrive at a complete BI solution, as shown in Figure 2.4. Although they may sound different, the gist of this 'three BI components' is similar, albeit more streamlined, to the BI technology that was mentioned by Chaudhuri, Dayal and Narasayya (2011).

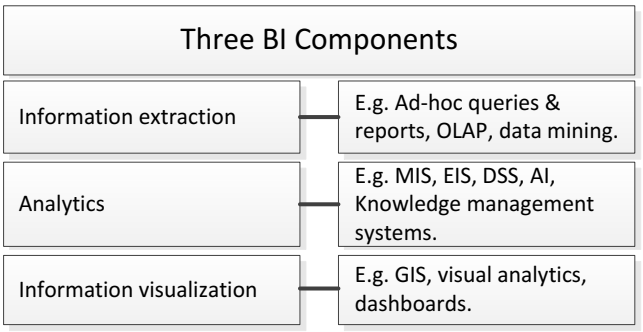


Figure 2.4 Three BI components adapted from Valacich and Schneider (2010)

A decade ago, dashboards were only a small part of a vigilant information system along with BI that was expected to display a graphical representation of data according to Houghton et al. (2004). The vigilant information system has provided users with the capability of observing through key performance indicators (KPIs) monitoring, orienting through the dashboard, and decision making through the analytics feature (Houghton et al. 2004). KPIs are referred to as dashboard indicators and essentially they are "metrics distilled from mission and vision statements, strategic plans, and goals and objectives" reflecting areas and activities where successful performance is key to the organisation's existence (Mitchell & Ryder 2013, p. 75).

The dashboard is one of the BI tools (Pankaj, Hyde & Rodger 2006) in which users can monitor, analyse and manage business activities, processes, and people through performance metrics (Eckerson 2006). In addition, Negash and Gray (2008b) stated that dashboards are the most useful BI analysis tool, capable of monitoring business activities as well as measuring business performance. "Dashboards have come a long way" from a simple display of performance metrics to a sophisticated, interactive, decision support system delivered as part of enterprise systems or BI applications (Yigitbasioglu & Velcu 2012b, p. 51).

Nevertheless, not all dashboards were necessarily built on BI infrastructure (Eckerson 2011). There are dashboards that come in a package as an output of enterprise resource planning (ERP) systems like SAP (SAP 2011) or customer relationship management (CRM) software such as Microsoft Dynamics (Microsoft 2012). The main differences are the types of infrastructure and database management systems that feed the data into dashboards. In addition, a dashboard can even be connected into various data sources, ranging from a relational database to a mere delimited text file (Dundas 2010 2013).

2.5 Dashboard design process

The dashboard design process is rarely a separate or unique activity. It is not uncommon for the process to be considered a subset of an application (e.g. ERP or BI) development project (Eckerson 2006, 2011; Microsoft 2012; SAP 2011) subjected to an appropriate system analysis and design approach. Approaches such as the traditional system development life cycle (SDLC), joint application design (JAD), rapid application design (RAD), or the agile method are prominent in the IS field. The traditional SDLC or a waterfall methodology prescribes a sequence of phases of planning, analysis, design, development, testing, implementation, and maintenance (Valacich & Schneider 2010). JAD emphasises on the process of requirement elicitation involving the system owner and the users to produce specification requirements (Liou & Chen 1993).

RAD and the agile method aim to "accelerate the system development process" (Baltzan, Lynch & Blakey 2013, p. 254). RAD focuses on user involvement in creating a working prototype for the system, while the agile method focuses on iterative process whereby the requirement and the end result co-evolve through collaboration between developers and users (Baltzan, Lynch & Blakey 2013). These approaches share similar dispositions in terms of involving users in the design process through collaboration, gathering specification requirements, and creating prototypes. In-depth discussion on this matter is however beyond the scope of this thesis. This study aims to focus on the dashboard design process regardless of the specific system development methodology and project management approach adopted by organisations.

The term 'designers' used in this thesis refers to those involved in the IS design (ISD) process (Stolterman 1999). Specifically, in dashboard design, a team of designers and developers might include usability experts and should not be limited to only technical personnel (Pankaj, Hyde & Rodger 2006). In the IS field, a design process along with development and maintenance is commonly denoted as systems analysis and design (Valacich & Schneider 2010). This matter will be discussed further in Chapter 3 (see section 3.6). Evidently, a designer role exists in the IS field and IS/IT personnel have taken on the role of designers, even though they have not been formally trained in design (Lindberg et al. 2012).

Driven by the growth of digital information technologies over the past decade, ISD has become a key example in representing "a fundamental shift from design of the material to the

immaterial, with more concern for abstract and animate entities" (McKay, Marshall & Hirschheim 2012, p. 125). Thus, ISD should also deal with the design process rather than focus exclusively on the design product (Jones, Gregor & Lynch 2003). That is what this study is trying to achieve. The focus is not merely on the dashboard as a design product, but also on the dashboard design process.

When designing a dashboard, there may be some intricacy behind the design process. Before dashboard design can be realised, some activities take place. In most cases, the process begins with design problems (e.g. this could be an instruction from an executive to create a dashboard to display KPIs in 'external engagements'). Arguably, there can be many plausible variations. As illustrated in Figure 2.5, there is a possibility that an organisation has not defined their key KPIs or metrics to be monitored and used on their dashboard. In this instance, the KPIs and the dashboard should be designed at the same time. Alternatively, it is quite common for an organisation to have gone through an exercise of constructing their KPIs before designing and implementing dashboards (Pankaj, Hyde & Rodger 2006). The second plausible scenario is the organisation has identified some existing KPIs to be included on the dashboard design. At the same time, during the dashboard design process, they identify new KPIs to be created and applied. Another possible variation is for an organisation to use their existing KPIs to inform the dashboard design. In turn, it is also likely that the dashboard design process provides insights to further improve the organisation's existing KPIs.

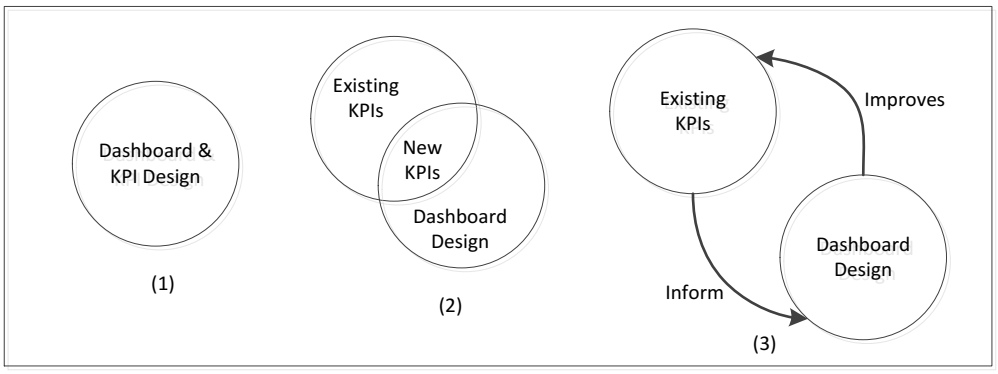


Figure 2.5 Relationships between dashboard design and KPIs

The variations illustrated in Figure 2.5 were merely to demonstrate the complexity behind the dashboard design process. Furthermore, based on the design elements listed in Table 2.4, a discourse and involvement of different parties such as designers, business users, and/or IT/IS personnel can be expected. Lastly, there would also be user and organisational aspects immersed in the dashboard design process.

2.5.1 Importance of the dashboard design process

Dashboard design should transcend beyond user interface design (Pankaj, Hyde & Rodger 2006), because it "is never a plug-and-play solution, and one size does not fit all" (Eckerson & Hammond 2011, p. 3). The design varies greatly depending on the user and organisation types, the aim of the dashboard, the organisational culture, and many more aspects, as discussed in section 2.2.1. Also, as mentioned in section 2.4, a dashboard can be a part of BI systems as well as any enterprise system (Eckerson 2006, 2011; Microsoft 2012; SAP 2011). Generally, dashboards were created through data analysis and used to represent key metrics that matter for decision makers (Howson 2008). These key metrics may be influential in the decision-making activities of the organisation, hence Eckerson and Hammond (2011) argued that solution customisation, user collaboration, and appropriate dashboard design are pivotal to deliver maximum value.

With regards to the issue of dashboard design, according to Resnick (2003), the design of a dashboard can be improved by adopting the way people in demanding situations making a decision naturally (Resnick 2003). Essentially a dashboard in real life, in a car or in an aeroplane, contains vital information such as the speed, machine temperature, oil level and so on. It is purposefully placed in front of a driver to be visible at a glance while the driver is focusing on driving. Thus the driver can make decisions based on information displayed on the dashboard. Likewise, in an organisational context managers use dashboards to support their daily tasks (Rasmussen, Bansal & Chen 2009; Resnick 2003). According to Rasmussen, Bansal and Chen (2009), a well-designed dashboard which displays key information managers need can inform them about their organisation's performance in terms of spotting problems and taking proper action to improve the situation.

Arguably, the creation of a dashboard is a design issue and activity. Fundamentally, design is a basic human activity (Lawson & Dorst 2009; Papanek 1984). As mentioned in the previous chapter, everything around us is a product of design; actually everyone can design and a process of design occurs when "we plan for something new to happen" (Cross 2011, p. 3) or even when we "aimed at changing existing situations into preferred ones" (Simon 1996, p. 111). Once we initiate the preparation of any actions toward a desired and possible end, that starts the design process (Papanek 1984).

As discussed in Chapter 1 section 1.3, the research and publications on dashboards to date have focused on the GUI, functionality and technological aspects. Arguably, there is a wider range of issues and elements that need to be taken into account, for instance, quality, validity, and rigour of the information displayed on the dashboard. By taking a holistic and comprehensive view, value from the design of a dashboard and ultimately the final design artefacts (e.g. the dashboard, the data, and the processes) can be derived. It is important to at least figure out which features work for users and the organisation to achieve its purposes (Yigitbasioglu & Velcu 2012b).

At the same time, it is crucial for designers not to undermine the importance of the user interface design (UID). An ineffective user interface (UI) might result in inefficiencies in terms of the amount of time users spend in attempting to learn to use the systems (Das & Chatterjee 2015). "If the users are unable to perceive the UI as easy to use, problems in user experience (UX) may arise" (Low & See 2015, p. 1932). Essentially, the notion of user interface design (UID) is closely related to user experience design (UXD) which seems to have gained more attention recently (Rusu et al. 2015). Similar to other design tasks, UXD must have a clear goal which basically comprises the intended experience of users when using the system (Kaasinen et al. 2015). UX designers are required to step "into their shoes" in order to really know the actual users and understand user behaviour as part of the design process (Kaasinen et al. 2015, p. 1).

2.5.2 Relationship between design and use of dashboards

Based on the literature review, the issue of system design seems to have a close relationship with the use or adoption of the system at a later stage (Barki & Hartwick 1994; Markus & Mao 2004; Pauwels et al. 2009). Designing a dashboard requires a serious commitment from stakeholders at various levels to ensure the dashboard is perceived to be useful (Wisan 2002). The issue with perceived usefulness "relate directly to the content or the information presented in dashboards" (Pankaj, Hyde & Rodger 2006, p. 1426). A good design starts by examining who the users are, why they need it, and how they use it (Myatt & Johnson 2009). The relationship is materialised in the form of user participation. When users participate on the design and development activities, it creates a sense of involvement, giving them a greater chance in adoption and use of the system (Barki & Hartwick 1994). Through user participation, it also creates a "psychological buy-in" toward the system, which can lead to better design and collaboration between users and system designers (Markus & Mao 2004, p. 515).

Pauwels et al. (2009) argued that getting executive's buy-ins while designing a dashboard can help to gain user acceptance and potentially increase the possibility of future dashboard use. Apart from that, a corporate directive helps in boosting and promoting future dashboard adoption (Pankaj, Hyde & Rodger 2006). Executives' approval warrants the organisation's commitment in allocating appropriate resources for the project, while the design team ensures the dashboard is populated with valid data and key performance metrics plus users are involved in examining the information and confirming its usefulness (Wisan 2002). Moreover, through user participation, the design team obtains all the necessary input to ensure the end result will be high quality. It is important to give users the ability to influence design decisions to value their participation (Markus & Mao 2004).

Dover (2004) suggested the success of dashboard design and implementation relies on the how the dashboard is being used and accepted by users. Furthermore, Treude and Storey (2010) emphasised the importance of various user roles during the dashboard design process, as this will have a significant impact on how the dashboard will be used. Eckerson and Hammond (2011) added that the design team would need to understand the user's work culture within the department or area in order to design the right dashboard for users. As a result, it will significantly increase the rate of use and adoption of the dashboard at a later stage (Eckerson & Hammond 2011) as users understand the benefits of the dashboard (Treude & Storey 2010).

Arguably the relationship between dashboard design and the use of the dashboard needs to be thought of early in the process to circumvent low adoption rates post implementation (Pankaj, Hyde & Rodger 2006). Wang, Wang and Alexander (2015) reported that dynamics are generally the main reason for users shunning dashboards, which means the data being presented was in a fairly static, not actionable or drillable presentation. As a result, users might resort to reports from the data warehouse or other systems for decision making as the dashboard only provided high level information (Pankaj, Hyde & Rodger 2006). This may cause users to view redundant information already available on other systems which creates a lasting perception of dashboards not adding value (Pankaj, Hyde & Rodger 2006).

Another important factor impacting the adoption rate is data quality, as it is not uncommon for some users to be sceptical about the quality of data used on the dashboard (Pankaj, Hyde & Rodger 2006; Wang, Wang & Alexander 2015). Besides quality, the dashboard should display meaningful and relevant information (Wang, Wang & Alexander 2015). When the users failed to see the relationship between the information on the dashboard and organisational strategic

goals, they might not understand the relevance of the dashboard and are therefore not compelled to use it (Pankaj, Hyde & Rodger 2006). Additionally, users should be trained to assist others in understanding the meaning of the data (Pankaj, Hyde & Rodger 2006; Wang, Wang & Alexander 2015).

2.6 Impacts of dashboards on organisations

The rapid adoption and use of IS/IT in organisations have impacted impacts onvarious aspects in organisations, particularly the range of activities and the process of decision making (Gurbaxani & Whang 1991). Gallagher, Mason and Vandenbosch (2004) discuss that Enterprise Resource Planning (ERP) projects that can lead to initiatives that improve current organisational processes and systems. Dashboards can simply make an impact through visualisation which adds new meaning or insights to understanding information (Verbert et al. 2014). Drawing on this understanding, this study aims to explore impacts of designing dashboards tailored to the organisation.

Following Figure 2.2, dashboards mainly relate to performance monitoring and decision-making activities. This study investigates the impact of the dashboard design process on current organisational processes and structures, systems, data, and/or infrastructure. When designing dashboards, arguably the design team should be aware of the impact on current circumstances in organisations, including but not limited to performance monitoring and decision-making activities. Subsequently the design team also needs to examine whether the data required for dashboards are available and currently captured in the organisation's current processes or systems.

2.6.1 Impacts on decision-making activities

De Marco, Mangano and Zenezini (2015) discussed the use of dashboards to identify problematic urban areas needed attention. The dashboard presents various levels of indicators based on incidents that have happened, for instance, street commotions, bar fights, or traffic accidents. From this fairly detailed data, the dashboard aggregates a higher level and more meaningful indicators or metrics such as road safety or personal safety, which can assist users in addressing problems. The information on the dashboard has a twofold impact on users. Firstly, from the urban dwellers' point of view, they can use the information to help decide the safest area for them to live, the time of day to avoid in certain areas to reduce the risks of

getting caught in traffic, or the most attractive areas to run a business. Secondly, the authority could use the information to help plan and conduct proper maintenance of public facilities and take preventative measures to reduce incidents in high risk areas in the city.

As illustrated by De Marco, Mangano and Zenezini (2015), dashboards provide valuable information to support decision making. By using dashboards, people at different levels (executives, managers, operations) in the organisation can access the same information presented at different levels of granularity. This way, the quality and speed of executive and management decision making can be improved, and if necessary some decision-making activities can be delegated to users at the operational level (Gurbaxani & Whang 1991).

Gurbaxani and Whang (1991) note:

> Information systems have reduced decision information costs by allowing decision makers cost-effective access to information and powerful tools for analysing the retrieved information … this improvement in decision quality in turn increases operational efficiency for example accurate forecasting of future demands. (Gurbaxani & Whang 1991, p. 68).

Therefore, having access to information for personnel in organisations to support their decision making is merely a first step (Gurbaxani & Whang 1991). By designing dashboards with analytics and forecasting capabilities, users can take the next step, which is to analyse or even perform a what-if analysis (Nagy et al. 2009). Analytics help in reducing the size and complexity of data and works best with visualisation (Wang, Wang & Alexander 2015). Thus users can subsequently make an informed decision when needed. In the long term, this could potentially increase the quality of decision-making activities for organisations.

Keen (1981) however argued that generally there are many different facets that influence the way people make decisions in organisations. And especially when making decisions under pressure, people might simplify problems by ignoring information, become involved in emotions, and traditionally make decisions based on what has worked before (Keen 1981).

In a way, information is only a part of the equation when it comes to decision making, and there is a possibility that the information might not be used. It is worth noting that while dashboards provide data visualisation, they "cannot replace critical thinking" which warrants an absolute right decision or action (Wang, Wang & Alexander 2015, p. 33). Essentially, dashboards assist and empower users in decision making rather than automate decisions on the user's behalf (Verbert et al. 2013). Therefore, providing an information system, such as

dashboards, to support decision making will not have impact decision-making performance (Yigitbasioglu & Velcu 2012b).

2.6.2 Impacts on organisational performance and current processes

Dowding et al. (2015) conducted a study on the use of dashboards in healthcare organisations. Evidently, the literature suggests a positive impact on organisations providing clinicians, as main users, can have constant and immediate access to the dashboard to see information at a glance. As a result, the use of the dashboard helps them to reduce the turnaround time in report writing and improve the response time for medicine prescriptions, thus improving overall organisational performance.

The example stated by Dowding et al. (2015) emphasised another key purpose of dashboards: to monitor performance of staff and/or departments which contribute to overall organisational performance. Essentially, dashboards can stimulate cultural changes in an organisation so that it becomes more performance oriented (Dover 2004). Information associated with performance measures in the organisation can be displayed on the dashboard through pre-defined metrics. Gurbaxani and Whang (1991) claimed that by having such information, staff are motivated to work more efficiently towards goals and in the long term this constitutes a saving on the cost of labour for the organisation. Depending on the type of business, it could potentially reduce the turnaround time to serve customers. At the end of the day, all the savings can be passed on to customers and increases business.

Having said that, Nagy et al. (2009) mentioned that it is challenging to demonstrate the causal relationship between performance improvements in an organisation and the use of dashboards. It was argued that dashboards did not directly impose changes but rather facilitate the organisation in improving their performance through “knowledge discovery” (Nagy et al. 2009, p.1903). Indeed, dashboards need to be used to promote change or improvement beyond a mere display and in order to make an impact on users and the organisation (Wisan 2002). The information on the dashboard helps people in the organisation monitor its performance, spot problems, and identify root causes. Subsequently, those at management level can make changes or improvements in relation to such problems. Essentially, dashboards enable people in the organisation to fix problems more promptly and increase the accountability of decision makers (Nagy et al. 2009).

Furthermore, Eckerson (2011) suggested dashboards can drive organisational change. Thus designing dashboards can impact or trigger change in various activities and/or processes in organisations. For instance, users might want to display a metric that was not available or captured by existing processes or systems. When data or information needed is not available, some changes might need to be made accordingly as part of dashboard design. These changes are not necessarily in relation to database management or at systems level, but in terms of creating a new process in order to capture the needed data to be displayed on the dashboard.

Such change can also integrate processes, possibly eliminating inefficiency (Nagy et al. 2009), or even through collaboration with another parties (Gurbaxani & Whang 1991). While creating a new process or integrating processes, this would generally involve negotiation and seeking acceptance or approval from different parties in the organisation. Although the degree of impact might not always be the same, it would be sensible if organisations were more aware when designing a dashboard.

At the very least, the organisation could also prepare a pre-emptive measure to ensure it would not affect daily operations or cause minimal impact. It is vital to focus on the main goal during changes, which is to design the dashboard for users in the organisation. These changes might not only benefit dashboard users to support their core business activities, but can be eventually passed on to their customers as overall the business improves (Gurbaxani & Whang 1991).

2.7 Summary

In this chapter, the issue of dashboard design highlighted in the literature review was discussed. Firstly, the definition of dashboards was explained and their relationship with Business Intelligence was described. Secondly, the purpose of dashboards and components in general were discussed. Lastly, the importance of the dashboard design process and the impact of designing a dashboard on organisations were outlined. In the next chapter, theoretical perspectives and the conceptual framework of this study will be discussed.

Chapter 3: Literature Review – Theoretical Perspectives

3.1 Introduction

This study explores the process of designing a dashboard and its design beyond functionality and graphical user interface. The notion of design thinking is used as a theoretical lense to understand the intricacy of dashboard design process. This chapter particularly discusses the notion of design thinking relating to theoretical aspects in this study. First, definition and characteristics of design thinking are described and the importance of design principles in association with design thinking is highlighted. Furthermore, to emphasise the notion of design thinking in the context of dashboard design, the view of design and the role of designers in the Information Systems (IS) field is discussed. Challenges and critical analyses of design thinking will also be discussed. Lastly, the conceptual framework is put forward.

3.2 Design thinking

By definition, design thinking refers to "the cognitive processes that are manifested in design action" (Cross, Dorst & Roozenburg 1992, p. 3). Essentially, thinking is not something which happens solely inside our head, but it is generally done with some interactions with other people and with the help of some tools (Boland & Collopy 2004). Design thinking permeates the design process in solving design problems by utilising some guiding principles to produce solutions (Al-Sayed, Dalton & Holscher 2010).

Definitions of design thinking based on the literature are outlined in Table 3.1. Keywords are identified and highlighted to help understand and break down those definitions.

Table 3.1 Definitions of design thinking based on the literature

Definitions	References
A way of thinking, strategising, approaching **problems** the way **designers** would.	Gloppen (2009), Martin (2010)
A **holistic** design approach to **innovation**, "beyond aesthetic".	Boland et al. (2007), Brown (2008)
"Designerly way of knowing", understanding through design **processes** and **products**.	Cross (2006), Cross (2011)
A **balance** between **analytical** and **intuitive** thinking, a thinking process that moves through a "knowledge funnel".	Martin (2009), Martin and Euchner (2012)

A methodology that **integrates** human, business, and technological factors in defining and solving **problems**, promotes iterations and learning through rapid **prototyping**, embraces multidisciplinary **collaboration**, and aims for **innovation**.	Meinel and Leifer (2011)
An approach that uses designer's **sensibility** to satisfy **user** requirements based on the technology **feasibility** with a possibility of making a practical **business** strategy, creating a prospective market, as well as adding value for customers.	Brown (2008)

Based on the definitions of design thinking in the literature, it can be synthesised that design thinking is an approach to define design problems and to generate solutions that integrate aspects of what users need, technological feasibility, and organisational viability. It promotes iterations and learning through the use of rapid and early prototyping. Fundamentally, it should balance analytical and intuitive thinking by tapping into designers' past experience and by allowing intuition in making design decisions. Additionally, design thinking emphasises the human aspect through multidisciplinary collaboration in the design team in order to achieve innovation as its main aim. Figure 3.1 depicts the definition of design thinking used in this study which has been synthesised from the literature.

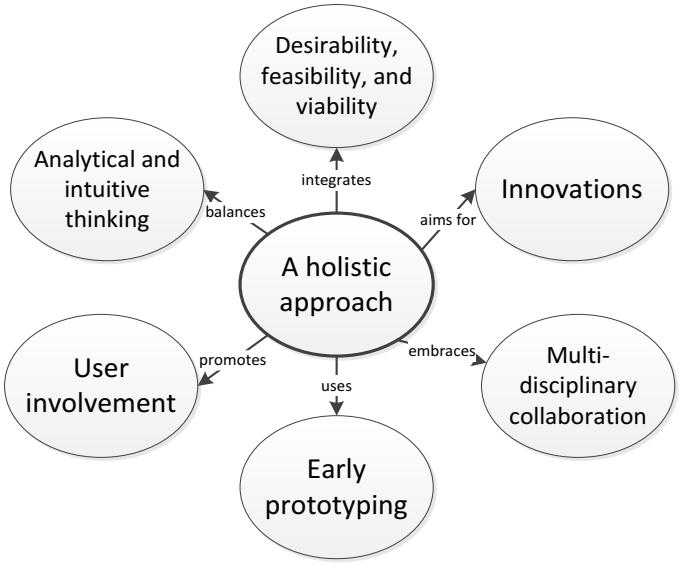


Figure 3.1 Definition of design thinking

Furthermore, the literature has shown practical application of design thinking regarding real world problems. As an illustration, Araujo (2012) conducted an intervention project in a vulnerable community in Sao Paulo, Brazil, where the community lived in a very poor

environment with lack of clean water, a non-existent sewerage system, and exposure to pollution. The project aimed to promote moral education, sustainability and environment awareness for the community by firming the relationship between schools and surrounding communities. To achieve these goals, Araujo (2012) adopted design thinking and problem/project based learning.

Applying the human-centred principle, in which users are considered the centre of the design process, design thinking was established through 'hear, create, and deliver' phases. Firstly, in the 'hear' phase, Araujo (2012) collected stories from the residents to gather information about their needs and what people hoped for in their neighbourhood. Secondly, in the 'create' phase, Araujo transformed what had been heard into working frameworks, opportunities, solutions and prototypes, processes and policies that could improve living conditions and residents' welfare. Thirdly, in the 'deliver' phase, the solution plan was assessed and determined, expenditure was calculated and implementation planned (Araujo 2012).

Bradigan and Rodman (2008) were involved in a renovation project at the Ohio State University library. The key element in the renovation project was to create a single service point called the ASK Desk. This initiation related to recent changes in the library where some sources became available online and IT services had improved significantly. Therefore this project was beyond merely a construction makeover but also a process or library service improvement (Bradigan & Rodman 2008).

In this project, design thinking was conceptualised in five steps, namely: understand, observe, visualise, evaluate/refine, and implement (Bradigan & Rodman 2008). Based on these principles, all the required stages of understanding the needs and challenges of library patrons were related to the renovation project. The researchers observed how library patrons made their daily requests and their activities in the library, as well as gathering feedback and input from them. All these results enabled them to visualise how they could improve library services to fulfil patrons' requirements. The design team, comprised of library staff, conducted a brainstorming session to explore solutions and consulted with a design expert until ideas and concepts were agreed upon and sent to the architects (Bradigan & Rodman 2008).

Subsequently, the architects then worked on initial ideas and provided the architectural plans for evaluation and refinement. Finally, they moved on to the implementation stage and managed to put all the pieces together. Design thinking helped them move from vision to reality and brought a new concept of a consolidated service point to the traditional library.

Since the completion of the renovation project, library usage increased dramatically, with added values for library patrons as well as increased customer satisfactions (Bradigan & Rodman 2008).

The above examples have illustrated some key characteristics of design thinking. To summarise the notion of design thinking based on these and definitions of design thinking shown in Table 3.1 and Figure 3.1, the characteristics are categorised into four main inter-related categories. Each category will now be discussed.

3.2.1 Early prototyping to facilitate idea generation

In design thinking, design problems are generally perceived as wicked (Buchanan 1992). Characteristics of a wicked problem based on Rittel and Webber (1973) are delineated in Figure 3.2.

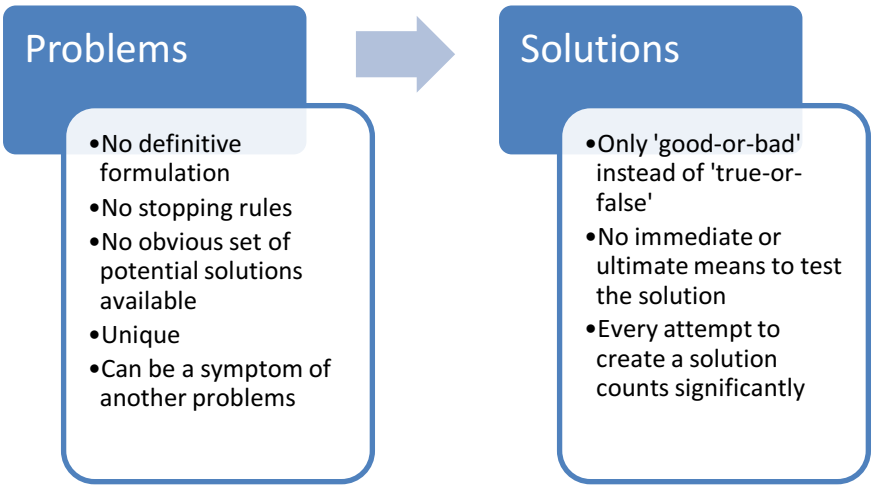


Figure 3.2 Characteristics of wicked problems according to Rittel and Webber (1973)

The complexity behind a dashboard design process was discussed in Chapter 2. Based on the design elements listed in Table 2.4 (Chapter 2), a discourse and involvement by different parties, such as designers, business users, and/or IT/IS personnel, can be expected. Also user and organisational aspects embedded in the design process could not be ignored. It is beneficial to be mindful of the impact of the design process on current technologies and processes in the organisation. Designers need to ensure each and every design element is taken into consideration, so the end result – the dashboard – could eventually deliver value. Hence a holistic and comprehensive assessment is arguably needed to work with this 'wicked' problem.

Essentially, designers should not spend more time analysing design problems, but design thinking promotes co-evolution of problem and solution spaces (Cross 2011). As such, design thinking supports designers to generate ideas and to create various possible solutions to design problems (Brown 2009). Designers build ideas to think and they learn by making or creating prototypes as early as possible (Brown 2009). In a way, the designers use the prototypes or models as tools for thinking instead of merely representing ideas (Boland & Collopy 2004; Boland et al. 2007).

Through early prototyping, designers should also be able to visualise an idea into various prototypes (Owen 2006). Walker, Takayama & Landay (2002) suggested prototyping can be presented in both low and high fidelities, which described the level of similarities of the prototypes compared to the final product. The high-fidelity prototype features real user interface which allows interactions, while the low-fidelity one can be as simple as quick sketches on papers (Walker, Takayama & Landay 2002). As prototyping enables iterations and invites user feedback (Dow & Klemmer 2010), using low-fidelity prototypes benefits in earlier stages of a design process where modifications are required (Walker, Takayama & Landay 2002).

In general, prototyping can help "build empathy for users" (Dow & Klemmer 2010, p. 112), facilitate learning (Lindberg, Meinel & Wagner 2011), and doing it early in the design process is key (Brown 2009). It can lead to a discovery of "unknown attributes, constraints, and opportunities" (Dow & Klemmer 2010, pp. 112-113), or any potential use-case scenarios (Gabrysiak, Giese & Seibel 2011) that may have been missed at an earlier stage or while gathering requirements.

3.2.2 Innovations inspired by constraints

While designing, Boland and Collopy (2004) suggested designers start anew on each design task, and always strive to create something new and innovative. At the same time, designers should respect any special conditions or constraints, but they should not be limited by them. Instead, they should have the ability to exploit contrasting ideas and constraints to create new solutions (Brown 2009). That way they move towards changing things for the better. It is also essential to avoid fixating on a certain idea too soon and to ensure a continual flow of new ideas (Boland & Collopy 2004; Boland et al. 2007).

The ultimate goal in design thinking is about creating innovations (Boland et al. 2007; Brown 2008). Innovation is "never a fad", although some suggest it is a 'buzz word' which can go "in and out of fashion" (Kanter 2011, p. 149). In general, innovation denotes efforts by an organisation to improve the possibility of success of its businesses which includes but is not limited to changing processes to be more effective, productive, and to deliver better product or services (business.gov.au 2014). It "means change: creation of the new and letting go of the old" and notably this is hard to achieve due to the unexpected and disruptive nature that change brings to organisations (Wölbling et al. 2012, p. 122). Alternatively, another way to assess opposing constraints is to strike a balance between desirability, viability and feasibility (Brown 2009).

3.2.3 Human-centred: Empathy and collaboration

Design thinking is human centred, which is achievable through empathy and collaboration (Brown 2009). Being human centred means knowing who the users are, thus anticipating their interests in the design process to create an artifact for users that is useful, fairly easy to interact with, and relevant (Cavoukian & Weiss 2012). Similarly, Brown (2009) described how designers should anticipate what users need or might need and give them a better design by understanding the cultural context and environment. Furthermore, he argued that the role of users in design has shifted from consumption to participation. Hence design is too significant to be left in the hands of designers alone. Instead, users should be involved as part of the collaboration team. Based on the two earlier examples discussed in section 3.2, the human-centred characteristic of design thinking was established through empathy and collaboration between designers and users (Brown 2009).

In IS/IT literature such as Gould and Lewis (1985) and Earthy, Jones & Bevan (2001), it was suggested that the term human-centred had a slight disparity compared to user-centred design. In user-centred design process, designers make a "direct contact" with users to understand requirements from the users' point of view as opposed to making assessment based on the user profiles (Gould and Lewis 1985, p. 301). It appears that human-centred design is at a higher level of abstraction compared to user-centred design (Earthy, Jones & Bevan 2001).

Nonetheless, in the context of design thinking, the term of human-centred design is used to define an approach to design which focuses on users in order to generate tailor made solutions according to their needs (Brown 2009). It involves users actively participating during the

process of design (Knight 2011; Vredenburg et al. 2002) which aims for a strong understanding of user requirements (Vredenburg et al. 2002). Ahmed, McKnight and Oppenheim (2006) suggested an early prototyping approach to support human/user-centred design and for the prototype to be tested with real users. It also helps designers "build empathy for users" (Dow & Klemmer 2010, p. 112). The process would naturally be iterative, accompanied by constant evaluation and multidisciplinary collaboration between designers and users (Vredenburg et al. 2002). Indeed, a small multidisciplinary team "with diverse backgrounds, expertise and experiences can foster team discussions and create a broader range of ideas and solutions than a team of people with similar expertise" (Wölbling et al. 2012, p. 129).

In the context of dashboard design, Eckerson and Hammond (2011) indicate designers would need to understand how users work along with their culture of work within the department or area in order to design the right dashboard for the right users. Subsequently, it is expected that the dashboard use and adoption rate should increase (Eckerson & Hammond 2011) as the users start to appreciate the benefits of the dashboard (Treude & Storey 2010). Moreover, this multidisciplinary approach to user-centred design seems to have a very close relationship to perceived effectiveness of design (Vredenburg et al. 2002).

3.2.4 Balance between analytical and intuitive thinking

Martin (2009) suggested that design thinking could be achieved by balancing analytical and intuitive thinking. On the one hand, analytical thinking involved past-and-proven or tried-and-tested data, rigour and quantitative analysis that potentially have some advantages such as repeatability and scalability. On the other hand, intuitive thinking involved creativity and innovation which Martin (2009, p. 26) referred to as "the art of knowing without reasoning". Comparatively, Papanek (1984, p. 4) delineated that design is "the conscious and intuitive effort to impose meaningful order". Imposing order aided designers to handle uncertainties in design problems (Cross 2011).

Notably, design is a conscious action, which is when designers conduct a research or investigation as part of the design process (Papanek 1984). Furthermore, according to Lawson and Dorst (2009), designers need to make a conscious effort in order to reach their targeted goal. At the same time, designers also paid attention to their intuition. Intuition includes notions and contemplations designers unintentionally composed at a subconscious or

preconscious level (Papanek 1984). In addition, Cross (2011) stated that intuitive thinking might be something that designers possessed naturally or even derived from their experience, prior learning and familiar situations. Design thinking allows intuition to inform the designers while breaking down design problems (Martin & Euchner 2012). Furthermore, design thinking supports co-evolution of problems and solutions (Cross 2011). In a way, it allows designers to iteratively engage in framing/re-framing problems and building solution concepts until the design goal is achieved (Cross 2011; Lindberg et al. 2012).

3.3 Other thinking approaches

To help understand the notion of design thinking, three related thinking approaches, namely decision, analytical, and systems thinking are discussed. In management practice, decision thinking or attitude is more prevalent when it comes to solving problems (Boland & Collopy 2004). Similarly, Brown (2009) called this notion the convergence attitude in which a decision needs to be made to select a solution among several choices (i.e. solutions). It assumes a default problem statement and some alternative course of action ready at hand. All that needs to be done is to rationally choose the best solution out of many alternatives. There is an underlying assumption that it is easy to generate alternative solutions but it is difficult to choose the best one among them. While there may be an inclination for the early closure of the problem solving space, decision thinking works best in a "clearly defined and stable situation" when feasible choices are well-known (Boland & Collopy 2004, p. 9).

In design thinking, design problems are generally wicked (Buchanan 1992). Rittel and Webber (1973, pp. 161-162) use the term 'wicked problem' to describe a problem which naturally has "no definite formulation", is unique yet hard to construct, and the solution to the wicked problem can only be expressed as "good-or-bad" instead of "true-or-false". As such, the solution options may not be clearly articulated or obvious as articulated in decision thinking. Hence design thinking enables designers to diverge by creating various possible solutions to the design problems (Brown 2009). Also, the designers are learning by making prototypes (Brown 2009) or models as tools for thinking instead of merely as ways to represent ideas (Boland & Collopy 2004; Boland et al. 2007).

Martin (2009) defines design thinking as a balance between analytic thinking and intuition. It is not uncommon in the IT industry for the practitioners to use analytical thinking in problem solving (Lindberg et al. 2012). As explained in section 3.2.1, analytical thinking uses data

which has been tested and proven in the past for its rigour and to maintain its repeatability and scalability (Martin 2009). It focuses on a rational approach of defining problems into well-structured ones as to derive solutions subsequently (Lindberg et al. 2012). Furthermore, it often relies on expert knowledge to break down and frame design problems "before the actual problem solving starts" (Lindberg et al. 2012, p. 230).

As for systems thinking, Jackson (2003) discusses managers in various organisations who were facing a great deal of change, and much more complex and varied problems. Recent management trends like benchmarking, total quality management, process re-engineering, balanced scorecards and customer relationship management have offered a rapid resolution but simply failed, due to not being holistic and creative enough (Jackson 2003). Therefore systems thinking fills the gap by embracing creativity, giving a holistic view of an organisation, ensuring that when solving a problem, managers do not merely focus on one specific part of the organisation, but also look at the relationships and interaction with other parts of the organisation as a whole (Jackson 2003).

Taking a broader stance in systems thinking, Checkland (1981) suggested there were three main problems in the science field, namely overall complexity, extending science to embrace social phenomena, and applying science in everyday organisational life. The science method which is generally based on the principle of reductionism, repeatability, and refutation which prevailed in natural science, could not easily be applied to social and management science. Systems thinking tried to preserve some attributes of science in order to unravel the problems which had failed to be solved by applying reductionism through a form of thinking that regards a problem as a system of wholes (Checkland 1981).

Both systems thinking and design thinking could be used as means to solve problems and they use a holistic approach in exploring the problems and finding solutions. Yet it is fair to say there are degrees of difference between them. In particular, systems thinking aims for problem solving which involves "complexity, change, and diversity" (Jackson 2003, p. xv) while design thinking aims for innovation and focuses more on the solution space (Brown 2008). Systems thinking emerged from a scientific background and has had solid scholarly development especially in systems approach (Checkland 1981; Jackson 2003), for example: hard systems thinking, strategic assumption surfacing and testing, and soft systems methodology. Hard systems thinking applied scientific methods to real-life problems through a defined method of

formulating the problem, constructing a mathematical model, deriving the solution, and finally testing and implementing the solution (Jackson 2003).

As for strategic assumption surfacing and testing, it emphasised upfront assumptions while formulating the problem. Different views and assumptions from stakeholders were gathered and discussed before creating strategies to move forward (Jackson 2003). Meanwhile, soft systems methodology, as described by Checkland (1981), used rich pictures to visualise the perceived problem, root definitions to search for available options in the problem state based on its history, culture, and politics, and conceptual models to construct the problem (Jackson 2003). Overall, systems thinking seemed to have a very clear direction on problem formulation, how to solve problems, and step-by-step procedures to deal with problems.

On the other hand, although the term 'design thinking' was coined by Rowe (1987) in the late eighties, the Design Thinking Research Symposia only started in 1991, led by Nigel Cross with Norbert Roozenburg and Kees Dorst at Delft University of Technology, The Netherlands (*Design Thinking Research Symposia* 2012). Even though design thinking has not been discussed in the literature for as long as the other thinking types have been, it is now prevalent everywhere in the economy, in automobile manufacturing, engineering, architecture, policy making, kitchen appliances, and mobile devices (Alexiou et al. 2009; Postrel 2003 cited in Wareham, Busquets & Austin 2009).

3.4 Design thinking strategy

Based on the literature, it is evident there is no specific model that is widely accepted as a representation of the design thinking concept (Brown 2008; Buchanan 1992; Carroll et al. 2010; Dorst 2011; Poulsen & Thogersen 2011; Rowe 1987). In a way, it is up to each organisation to interpret the design thinking concept to meet its own needs (including requirements and constraints). Arguably, design thinking has a degree of flexibility in solving or working with design problems.

One of the models to represent the notion of design thinking is the design strategy model developed by Cross (2011, p. 78), based on his interviews with designers (refer to Figure 3.3).

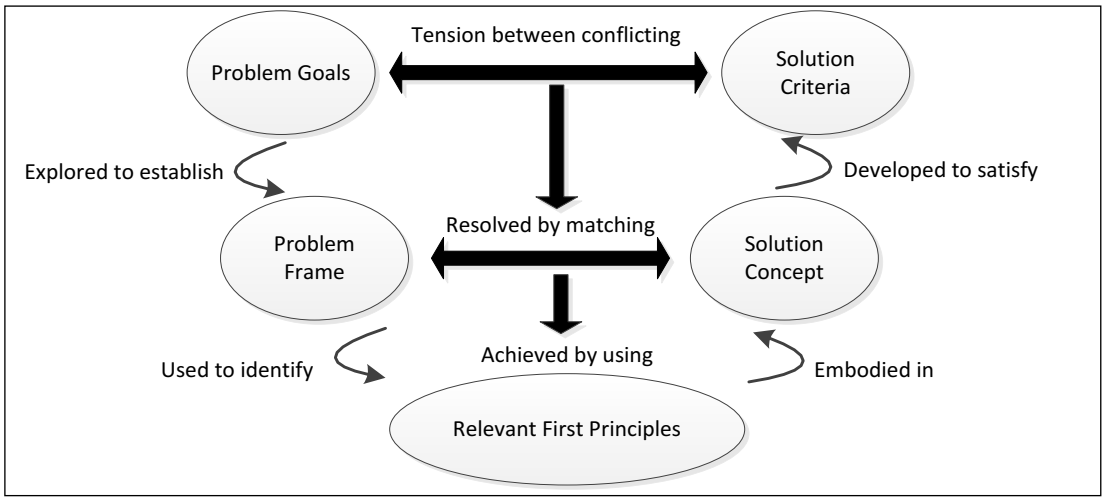


Figure 3.3 Original design thinking strategy model developed by Cross (2011, p. 78)

The main idea was to understand how designers think and based on his studies and observations, three main characteristics were identified. The first characteristic was to take a comprehensive and holistic approach to the problem (as a whole) "rather than accepting narrow problem criteria" (Cross 2011, p. 78). The second characteristic was to frame the problem in a unique and rather subjective way. Last but not least, the third characteristic was to utilise 'first principles' (Cross 2011) which denotes basic design used by the designers (Cross & Cross 1996).

Firstly, designers took a comprehensive and holistic approach to a problem as a whole instead of settling for narrow problem definitions (Cross 2011). An example found in Cross (2011) suggested that when the Formula One racing car designer Gordon Murray designed a race car, he would not regard the design task as a 'piece-part', like making a clutch or other parts of the car. Instead he thought of it as a whole, to make the car function well.

Secondly, designers framed the problem in a unique and rather subjective way (Cross 2011). For example, Paton and Dorst (2011, p. 317) suggested that one of the key features of design thinking was "the ability to reframe a problematic situation in new and interesting ways". The exploration of a problem frame started based on the requirements and inevitably influenced by designers' personal motivation in developing the solution concept (Cross 2011). Essentially, designers needed to get to the problem behind the problem and to have their own view on the problem presented by users (Paton & Dorst 2011). Overall, problem framing was perceived as an important stage that led to the creation of an innovative solution (Cross 2011; Paton & Dorst 2011).

Thirdly, utilising design principles helped designers to bridge the gap between the problem frame and the solution concept. To put it another way, it is evident that some outstanding designers recognised the importance of design principles as part of design thinking strategy. Moreover, it seemed that innovative design matured when designers encountered conflicts between their highest problem goals and users' solution criteria. So they were challenged to explore the problem frame in a very personal way and at the same time develop a solution concept that met with the solution criteria set by users (Cross 2011).

Thus Cross' (2011) design thinking strategy model is relevant to this study, particularly the second research objective. Hence this model will be used to inform the conceptual framework of this study. Based on the recollection of designers during the process of dashboard design, an analysis should be conducted to determine if there were any elements in the design process that indicate the features of design thinking. The extensive discussion on design thinking in this section, especially the definition and the characteristics, informs the development of themes to analyse the data at a later stage.

Accordingly, an adaptation of the model by incorporating the context of dashboard design is created (refer to Figure 3.4). While the original model emphasised the designers' point of view, the focus has now shifted to the participation of users and stakeholders in the dashboard design process.

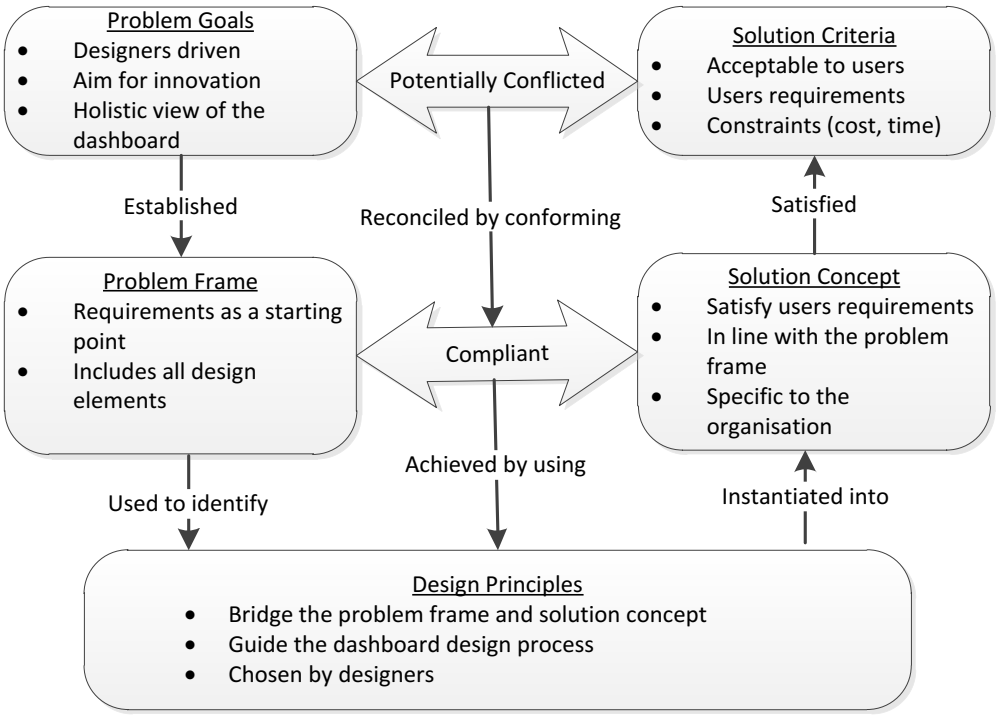


Figure 3.4 Design thinking dashboard development strategy model adapted from Cross (2011)

At the beginning of the design process, a discourse led by designers with a group of users and stakeholders occurs. That is when users state their intentions and needs while stakeholders express their concerns relating to the design initiative. All of this will later be identified as criteria to the solution. Then designers obtain information from various sources in the organisation before outlining their problem goals. There is a likely gap between problem goals and solution criteria. The problem goals in this context signify the designers' whole innovative idea on how the dashboard will be designed. Whereas the solution criteria suggest what is required by and acceptable to users, which also include some constraints. As designers attempt to reconcile the gap, they start exploring the problem area and framing the problem.

According to Dorst (2010), problem framing is to perceive and depict the condition of the problem in a certain way, leading to the possibility to act within the situation. An example from Dorst (2010) was a group of friends going out on the weekend. The so-called 'problem' can be framed into 'looking for a good movie in town', or 'having a good time'. Between the two problem frames, the latter frame appeared to be broader and hence it is more likely to yield more options toward finding a solution. As a result, the designers can move forward to exploring the solution space with the selected second problem frame.

Furthermore, the problem frame can inform designers when choosing the design principles. The principles help designers to instantiate and to generate solution concepts. At this stage, the solution concepts have to be in line with the problem frame (Cross 2011). It is worth noting that it is possible for designers to work back and forth between the problem frame and solution concepts in order to finally design a dashboard that satisfies the solution criteria within acceptable time constraints.

3.5 Design principles

In relation to the original design thinking strategy model developed by Cross (2011), it was mentioned that bringing a personal set of design principles to design problems gave designers an initial point to explore from and look for a possible solution. Design principles contain guidelines that include expectations and constraints (Agrawala, Wilmot & Berthouzoz 2011; Blair-Early & Zender 2008), provide a high-level conceptualisation (Ahmed, McKnight & Oppenheim 2006; Chaturvedi, Dolk & Drnevich 2011; Sein et al. 2011), and cover elements, rules or methods to be considered when making design decisions (Kenna 2011; Kohler et al. 2011; Normark & Gärling 2011). A set of design principles should therefore not be regarded as a complete and final list (Ahmed, McKnight & Oppenheim 2006; Chaturvedi, Dolk & Drnevich 2011; Ross & Keyson 2007) as it is evolving, revisable, and might be evaluated through user feedback to arrive at a better set of principles (Agrawala, Wilmot & Berthouzoz 2011; Ross & Keyson 2007; Schoormans et al. 2010). According to Lidwell, Holden and Butler (2003), the opportunity to succeed in our design can be increased by using some well-founded design principles available. To quote William Strunk[1]:

> The best designers sometimes disregard the principles of design. When they do so, however, there is usually some compensating merit attained at the cost of the violation. Unless you are certain of doing as well, it is best to abide by the principles. (Lidwell, Holden & Butler 2003, p.11)

Tufte (2001, p. 25) suggested that in applying design principles, designers should be sensitive and flexible as those principles should not be "logically or mathematically" followed as-is. Especially in the field of information visualisation, the principles would normally yield some

[1] William Strunk was an American professor of English at Cornell University and one of the authors of the 'The Elements of Style'.

design possibilities and help the designers choose one of them. As a result, designers could come up with a design that depicts complex information in a clear way (Tufte 2001). Some designers brought their own set of guiding principles to help themselves in exploring a problem. Once they were able to start exploring, the principles would reduce the problem to a size that would make it easier to manage. That way, designers would narrow their focus and be able to make a conjecture of possible solutions to the design problems (Cross 2011). This is what Cross (2011) mentioned as one of the key properties of design thinking when dealing with vague design problems.

Myatt and Johnson (2009) discussed some general design principles for data visualisation. Firstly, similar to a principle mentioned by Tufte (2001), it is key to show the data in a substantial manner and to increase the data-to-ink ratio, ensuring the ink used to print the graph is used to represent data rather than noise. That is, to reduce clutter and remove unnecessary lines, graphs, or texts which might hinder users in seeing the data. Secondly, choosing the most simple and efficient graphs helps communicate insights brought by the data to the users. Lastly, be aware that a visual representation can be inconsistent with the numerical representation. With a different ratio or scale in a graph, it could show overstated or understated meanings of data to be represented (Tufte 2001).

It is fair to say that by abiding in design principles, it would help designers in achieving a successful dashboard design (Lidwell, Holden & Butler 2003). To put it into the context of dashboard design and to be aligned with the third research objective, this study will explore key design principles in dashboard design including but not limited to visualisation principles, as discussed earlier. This could be one of those universal design principles but the usage and operationalisation would likely be specific to each organisation. Either way, designers should not blindly translate principles suggested. But rather they should be flexible (Tufte 2001), especially to be in line with user requirements. Supposedly, design principles should help rather than hinder and bring positive impacts (Lidwell, Holden & Butler 2003) to the process of dashboard design.

3.6 Design and design thinking in IS

In the field of Information Systems (IS), a design process together with development and maintenance is commonly denoted as systems analysis and design (Valacich & Schneider 2010). Henderson and Lee (1992) viewed design as a collaborative process, while according

to Bostrom (1980) an IS design process is a change process in an organisation which is carefully planned and politically driven. In Bostrom (1980), based on the design of Management Information Systems (MIS), it was argued that the organisational political order shaped and imposed constraints on the design and use of MIS.

Over the years, engineers in the IS/IT field took on the role of designers, even though they were not formally trained in design (Lindberg et al. 2012). This has resulted in a greater emphasis on technical aspects and subsequently has left out the "social complexity" of software design (Lindberg et al. 2012, p. 230). Taking a different stance, Stolterman (1999) argued that design has a different aspect compared to science or art, which is characterised by limited time and resources, a very complex situation with conflicting requirements. Hence IS designers should have the right skills to transform system concepts and some principles into reality, making it perceptible, communicable, and plausible (Stolterman 1999). It is evident that a designer role exists in the IS field, which generally denotes those involved in the IS design process (Stolterman 1999), IS practitioners and users (McKay, Marshall & Hirschheim 2012), and sometimes, albeit restrictively, systems analysts or programmers (Bostrom 1980).

In this study, the dashboard is the context of the study and at the same time is a part of IS, as dashboards would certainly be produced through some sort of system development process. Normally, early on there is analysis before moving into the design stage, depending on the process adopted by the organisation. Although they should be two distinct stages, it is practically implausible to realise, as requirements and design are intertwined (Kotonya & Sommerville 1998).

The various system development processes could be a traditional system development life cycle (SDLC), rapid application development (RAD), joint application development (JAD), or agile processes (Valacich & Schneider 2010). Rapid application development (RAD) also known as rapid prototyping "emphasises extensive user involvement in the rapid and evolutionary construction of working prototypes of a system to accelerate the system development process" (Baltzan, Lynch & Blakey 2013, p. 254). JAD emphasises the process of requirement elicitation involving the system owner and users to produce a requirements specification and optionally a prototype (Liou & Chen 1993). Agile focuses on iterative development with regular collaboration between the cross-functional team of developers and users, in which both requirements and the end software product evolve continuously (Baltzan, Lynch & Blakey 2013).

As for design thinking, Lindberg, Meinel and Wagner (2011) suggest it can be used to supplement traditional software development approaches in two ways. Firstly, design thinking can be applied as a separate phase at the beginning of the design and development process. This can be achieved through an exercise or a workshop where designers frame design problems, build solution concepts, create prototypes, and collaborate with users. Secondly, design thinking can act as "an integrated development philosophy" which impacts strongly on organisational processes and structures (Lindberg, Meinel & Wagner 2011, p. 15). In a way, it is an overall culture adopted by designers to enable user-centred innovation in the design and development of software (Wölbling et al. 2012).

Wölbling et al. (2012) viewed design thinking as a mindset that can be presented as a framework "that allows people to collaboratively engage in the creative and playful processes of problem solving and out-of-the-box thinking commonly used by designers" (p. 124). In two prominent traditional software development methods, such as waterfall and agile, priority is given to the technical feasibility while design thinking focuses on the desirability aspect in design (Lindberg et al. 2012; Wölbling et al. 2012). Furthermore, design thinking is applied to the design process, which should be regarded as a "system of overlapping spaces rather than a sequence of orderly steps" (Brown & Wyatt 2010, p. 33). It is key for designers to be flexible as "design is rarely a neat, linear process and indeed some of the stages may occasionally switch in sequence and require iteration" (Kirk 2012, p. 20).

Nonetheless, it remains unclear as to what the precise "overlaps" between design thinking and IT design and development are (Lindberg et al. 2012, p. 238). With its uncertain nature of exploring problem and solution spaces, it is not uncommon for design thinking to be perceived as risky to organisations (Lindberg et al. 2012; Wölbling et al. 2012). Risk-adverse organisations might be reluctant to adopt design thinking, despite their awareness of its advantages in supplementing the traditional development approaches (Wölbling et al. 2012). Therefore, a clear leadership commitment from top management would be helpful, especially in big and complex organisations (Wölbling et al. 2012).

Lindberg et al. (2012) categorised four different models for how design thinking can be applied and adopted in organisations and how they relates to IS/IT design and development processes, as follows:

1. *The split project model* handles design thinking as a distinct process performed by a special design thinking team before the actual development process starts. The design thinking team would frame design problems and subsequently hand over solution concepts to the developers.
2. *The overlapping teams model*, similar to the split project, has two distinct teams, but there are some common agents who will be with the rest of the development team to assist with the transition.
3. *The toolbox model* where design thinking is not considered as a separate project or a different process. Instead, it is viewed as a package of methods that developers can use to solve design problems which could not be solved using common IT development techniques.
4. *The unified project model* views design thinking as a fundamental notion of the whole project which includes the design and development process.

The unified project model is the view adopted in this study as this model is aligned with Cross' original design thinking strategy model (Figure 3.3 in section 3.4) to be used to inform the conceptual framework of this study. Figure 3.5 illustrates these four models.

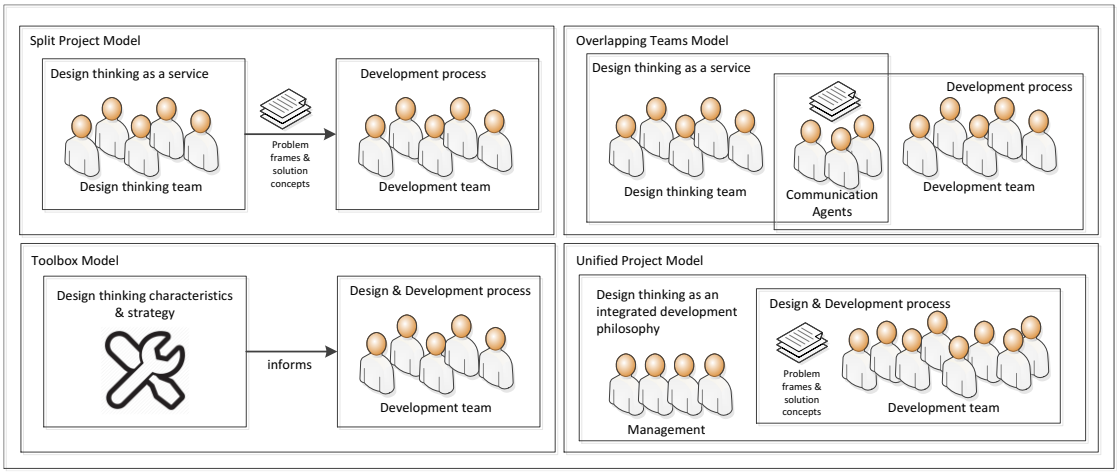


Figure 3.5 Four models of design thinking applications in organisations (Lindberg et al. 2012)

This study subscribes to the view of design thinking as a complementary and integrated development philosophy, as discussed in Lindberg et al. (2012), in which design thinking characteristics are engrained in each phase of the design and development process regardless

of the SDLC method adopted by organisations. Instead of being perceived as yet another IS/IT design and development approach, design thinking can help in tackling technical biases or similar “shortcomings of established IT development approaches” (Lindberg et al. 2012, p. 238).

3.7 Critical analysis in design thinking

The notion of design thinking adopted in this study is based on the literature from Boland & Collopy (2004), Brown (2009), Cross (2011), Lindberg et al. (2012), and Martin (2009)as discussed in section 3.2. In this section, critics of design thinking are discussed to provide a balanced view on design thinking. First, critics from the academic literature such as Johansson-Sköldberg, Woodilla and Çetinkaya (2013), Koh et al. (2015), and Seidel and Fixson (2015) are discussed. The discussion is followed by critics on design thinking from the practitioners’ point of view, such as Nussbaum (2011), Tjendra (2013), and Merholz (2009).

Evidently, the notion of design thinking came to prominence (Koh et al. 2015) in 1999 and reached its highest point in terms of publication by 2009 (Johansson-Sköldberg, Woodilla & Çetinkaya 2013). A couple of years later, design thinking was labelled in the literature as hype or a fad (Nussbaum 2011) with an increasing focus on ‘how to do design thinking’ (Ambrose & Harris 2010; Ogilvie & Liedtka 2011). Mainly, Johansson-Sköldberg, Woodilla and Çetinkaya (2013) criticised Brown’s (2006) notion of design thinking for being developed merely based on practice and anecdotal evidence. With a lack of empirical studies to support this concept, Johansson-Sköldberg, Woodilla and Çetinkaya (2013, p. 131) also examined the current literature relating to innovative design thinking and called it "non-theoretical but popular discourse" (p. 131).

Admittedly, Johansson-Sköldberg, Woodilla and Çetinkaya (2013, p. 129) mentioned that Boland and Collopy’s (2004) discourse on design thinking was “more theoretical” compared to others in the field. However, they also criticised Boland and Collopy's idea that managers are capable of thinking like designers. The argument stems from the complexity of a thinking process and their disagreement in relation to Cross’s (2011) idea that everyone can design, even though they have no design background. Hence, it is strongly suggested that the task of design should not leave designers out (Johansson-Sköldberg, Woodilla & Çetinkaya 2013). Seidel and Fixson (2015) attributed challenges facing people with no design background to comprehend design thinking as their methodical mindset. In a way, they are used to seeing

things in “a linear fashion” which makes it hard to absorb the concept of co-creation of problem and solution spaces in design thinking (Seidel & Fixson 2015, p. 145).

Meanwhile, Koh et al. (2015) offered their perspectives on the works of Simon (1996), Schön (1983), and Cross (2011), whom they identified as three major design theorists. They examined whether Simon’s rational view towards design could leave the design process too formalised and “thus counterproductive in terms of constraining the scope for creativity” needed in the process (Koh et al. 2015, p. 21). Next, Schön’s notion of reflection-in-action as a design activity to understand “a complex situation with no clearly defined problems”, is viewed as having ethical concerns as practitioners continue to negotiate when facing complexity and improvise along the way (Koh et al. 2015, pp. 22-23). Meanwhile, Koh et al. (2015) also criticised Cross’ use of intuition in design thinking as a mischaracterisation of the designer’s thinking process and as an idea which had not been established by research.

From the point of view of practitioners, Nussbaum (2011) refers to design thinking as a failed experiment, as there was more failure than successful absorption of design thinking in organisations. The failure was attributed to a misconception that design thinking can be viewed as a step-by-step methodology which can deliver incremental change and innovation in organisations (Nussbaum 2011). Meanwhile, Tjendra (2013) likens the hype of design thinking to a rise of a dynasty which will fall eventually. He argues that design thinking only covers the creativity part of problem solving through ethnography, conceptualisation, prototyping, and evaluation. As a result, innovation would not happen from these processes unless balanced by the input from analytical thinking (Tjendra 2013).

Taking a similar stance, Merholz (2009) thinks that design thinking is indeed a fad, or yet another recent trendy term that will soon be out of date when another new term comes in. While Merholz (2009) did not disagree with design thinking as human centred and empathetic, his advice was not to shift focus and ditch traditional analytical thinking. Furthermore, diversity in perspectives should be embraced as part of a whole effort to solve challenges and complex problems (Merholz 2009). Both Tjendra (2013) and Merholz (2009) argued that design thinking is another name for creative thinking, which is purely based on intuitions and therefore should be balanced with analytical thinking. This view is also shared by Johansson-Sköldberg, Woodilla and Çetinkaya (2013). However, this view is misleading and is not aligned with Martin (2009) who suggested that design thinking is achievable by balancing analytical and intuitive thinking, as discussed in section 3.2.4.

Furthermore, Tjendra (2013) mentioned that one of the reasons why design thinking could not work is because it suggests co-creation of problems and solutions at the end of the design process. The co-creation stage is where designers and users as subject matter experts work together in collaboration. Tjendra (2013) advocates that the designers should get the user buy-ins early in the process instead of later as suggested by design thinking. However, it may not necessarily be accurate to say that design thinking advises co-creation at the end of the design process. As discussed earlier in section 3.4, the design thinking strategy model developed by Cross (2011) describes the co-creation of problem and solution spaces as an ongoing core process in design thinking.

It is noteworthy that practitioner-based critics seemed to form their views based on anecdotal evidence which adds more emphasis on research to build an empirical grounding on design thinking. Generally, Johansson-Sköldberg, Woodilla and Çetinkaya (2013) call for more empirical research to sustain the discourse in design thinking. Additionally, research in design thinking should not use one specific perspective out of major design thinking discourses such as Cross (2011), Brown (2006), Simon (1996), and so on. This study redresses the gap as it embraces and synthesises multiple perspectives on the notion of design thinking, as discussed earlier in section 3.2.

3.8 Conceptual framework

As mentioned in section 3.6, the view adopted in this study is the unified project model which regards design thinking as a fundamental notion of the whole project including the design and development process. The model presented in Figure 3.4 (refer to section 3.4) re-emphasises the complementary aspect of design thinking to IS design and development approaches. It also highlights the importance of empathy and collaboration with users through discourse and by addressing possible tensions due to conflicting interests and resources. Strong empathy assists with a challenging situation when designing a system, such as a dashboard, that requires interaction with users (Ottersten & Balic 2007). Furthermore, the model embraces holistic and innovation-driven approaches to design problems while being pragmatic regarding constraints.

Using the design thinking dashboard development strategy model described in Figure 3.4 as a foundation, a conceptual framework for this study is put forward (Figure 3.6). The conceptual framework is developed from the extensive literature review and takes account of all three research questions in this study, as discussed in Chapter 1. This framework will serve as a

guide to conduct the study, inform the process of data collection, and the protocol for analysing the data.

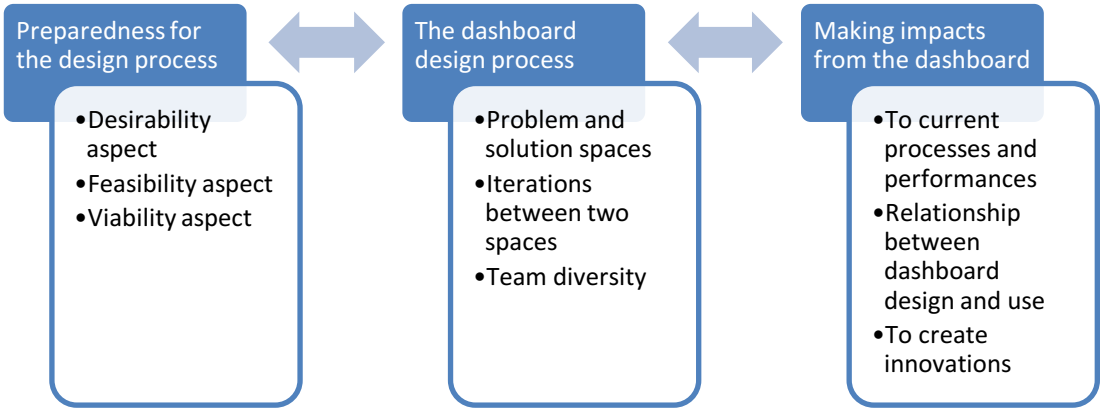


Figure 3.6 Conceptual framework

The conceptual framework has three interrelated elements, namely preparedness of the design process, the dashboard design process, and making impacts from the dashboard. The first element covers three important aspects to be taken into consideration prior to the design process. These three aspects, *desirability*, *feasibility*, and *viability*, are adopted from the notion of design thinking by Brown (2009). The second element covers the actual design process, in which the design thinking strategy model discussed earlier (Figure 3.4 in section 3.4) can be applied. The third element is rooted in the notion that design thinking strives for innovation. As such, the design of the dashboard and the dashboard itself should impact users and/or their organisations.

Although in Figure 3.6 each element is positioned adjacent to the next, they should not be viewed as steps or phases to be completed in sequence. Instead, each element informs the other and the double directional arrows between elements suggest iterations when necessary for further improvement. Each element is discussed separately in the following subsections.

3.8.1 Preparedness for the design process

According to Brown (2009), design thinking is about balancing what users desire in design, what is feasible in terms of technologies, and viability of design from the organisation's point of view to achieve innovation. This study utilises these three aspects to check and gauge the

preparedness of an organisation, as a whole, to start a dashboard design process. In the context of dashboards, as discussed in Chapter 2 (refer to Figure 2.3), components of a dashboard are categorised as users, technologies, and contents. Hence, the desirability aspect relates to the contents of the dashboard, while the feasibility and viability aspects relate to technologies and users respectively.

The desirability aspect this translates user requirements, dashboard purposes, and goals. The feasibility aspect concerns matters in relation to data/information, database and infrastructure technologies required to design and develop the dashboard. The viability aspect however includes constraints set by key users and the organisation. These three aspects can be used as a means to help designers in managing the preparedness of their team and organisation before they design the dashboard. However, in no way should it be viewed as a mandatory step to conduct prior to starting a dashboard design process.

3.8.2 Dashboard design process

As mentioned earlier in section 3.6, this study views design thinking as a complementary and integrated design and development philosophy, as discussed in Lindberg et al. (2012). Instead of replacing existing traditional design and development approaches, design thinking can help in dealing with "technical bias" in the usual IT design process, in which there is an inclination to favour technical more than social complexity (Lindberg et al. 2012, p. 230). Design thinking supports exploration in problem and solution spaces, allows iterative alignment between the two spaces, and builds on team diversity (Lindberg, Meinel & Wagner 2011).

In the context of the dashboard design process, the exploration of the problem space allows designers to learn about users and their requirements so a shared understanding of dashboard design can be established. The exploration of the solution space encourages ideas generation through early prototyping. Iterations between the problem and solution spaces are achieved through user involvement and feedback to improve the design of the dashboard. Furthermore, design thinking supports team diversity to facilitate interdisciplinary collaboration and to understand users through empathy.

3.8.3 Impacts from dashboard design and Use

Earlier in section 3.2.2, it was established that innovation can form out of something (products, processes, or services) totally new (Cross 2011, p. 3) or as improvements into "preferred ones"

(Simon 1996, p. 111). Arguably, this new creation or improvements in an organisation will likely impact current or existing situations (systems or processes). In the context of clinical health dashboards, as previously mentioned, Dowding et al. (2015) suggested that a dashboard provides a positive impact to the organisation as clinicians can have constant and immediate access to information. Dashboards can also facilitate the organisation in improving their performance through "knowledge discovery" (Nagy et al. 2009, p.1903). As a result, it can be established that the design of the dashboard makes an impact on users and the organisation.

The notion of design seems to have a close relationship with the use or adoption of the system at a later stage (Pauwels et al. 2009). The relationship materialises in the form of user participation. When users participate in the design and development activities, it creates a sense of involvement, giving them a higher success rate in adoption and use of the system (Barki & Hartwick 1994). Through user participation, it also creates a "psychological buy-in" toward the system, which can lead to better design and collaboration between users and system designers (Markus & Mao 2004, p. 515). Therefore, it is arguably critical to start thinking about how design and the use of dashboards might impact users and the organisation right from the beginning of the design process.

3.9 Summary

The theoretical aspects of this study have been discussed in this chapter. Subsequently, characteristics of design thinking and comparisons with other thinking approaches were highlighted. Furthermore, the importance of design principles and the association with design thinking were discussed. To emphasise the notion of design thinking in the context of dashboard design, the view of design in, as well as, the existence of a designer role in the IS field were conversed. Lastly, a conceptual framework of this study has been put forward.

In Chapter 4, the research paradigm, methods, and design of this study will be discussed. Chapters 5 and 6 present case studies conducted in UniOne and CareOne respectively.

Chapter 4: Research Paradigm, Methods and Design

4.1 Introduction

This chapter discusses methods and design of this study. Research design involves "deciding upon all the various components of a research project" including philosophical assumptions, the research method, data collection techniques and qualitative data analysis approaches used in the study, and the approach to writing (Myers 2009, p. 19). As mentioned at the end of Chapter 1 (Figure 1.1), key steps and strategy to conduct this study are summarised and described in Figure 4.1.

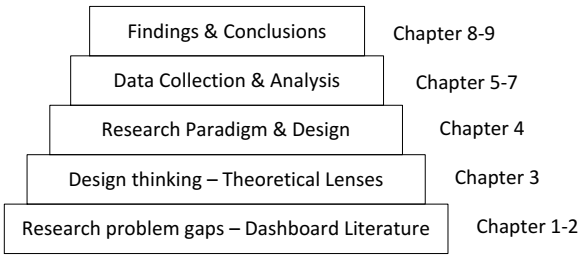


Figure 4.1 Key steps and strategy to conduct the research

This chapter is structured as follows. Firstly, the research paradigms and the philosophical assumptions are discussed followed by justifications for interpretive research. Secondly, the selection of research methods to be used for this study is explained followed by a discussion of the issue of quality research. Next, the definition of a 'case' is outlined followed by a discussion on the strategy of data collection and data analysis. The chapter concludes with a description of the coding process, discussion on the development of themes, and the cross-case analysis approach adopted in this study.

4.2 Research paradigms and philosophical assumptions

Guba and Lincoln (1994, p. 105) described research paradigms as "the basic belief systems or worldview". It comprises "a set of assumptions and perceptual orientations shared by members of a research community" (Donmoyer 2008, p. 591). Fundamentally, it directs researchers in every aspect of the study (Guba & Lincoln 1994), determines how researchers study the phenomena (Donmoyer 2008) as well as includes choosing research methods to study those

phenomena (Donmoyer 2008; Guba & Lincoln 1994). Creswell (2009) added that our fields of work, for example, Engineering, Computer Science, or Information Systems, would generally influence and inform our worldview.

There are three main questions used to understand research paradigms and to recognise some of the assumptions of different paradigms, such as: ontological, epistemological, and methodological questions (Guba & Lincoln 1994). Ontology is concerned with the form and nature of reality (Guba & Lincoln 1994; Walsham 1995b). Reality can be among other things regarded as a tangible process or structure, as socially constructed situations, or as something imagined by people (Morgan & Smircich 1980). According to Guba and Lincoln (1994), the answers to the ontological questions would then limit the answers researchers give to the epistemological questions which are concerned with the relationship between researcher and knowledge. Depending on the ontological stance, the researcher might be attached to or detached from knowledge. Where objectivity is possible, the researchers are considered to be detached from the findings of the study, otherwise the researchers' subjectivity might impact their interpretation of the results of the study (Lincoln & Guba 1985; Maykut & Morehouse 1994). Lastly, methodological questions describe how the researcher finds the knowledge guided by researcher's ontological and the epistemological stances, for example, by hypotheses verification or seeking discoveries through interpretations of texts, verbal and non-verbal communication (Guba & Lincoln 1994).

There are two main competing paradigms, namely positivism and interpretivism (Maykut & Morehouse 1994), although Orlikowski and Baroudi (1991) suggested a third prominent paradigm, which is critical research. Whilst the positivist aims for generalization and replication, the interpretivist on the other hand seeks to understand the phenomena under study more deeply (Chen & Hirschheim 2004). Although traditionally positivism was the prevailing paradigm in IS research (Chen & Hirschheim 2004; Orlikowski & Baroudi 1991), Walsham (1995a) indicates that interpretivism subsequently emerged in IS research. To understand these two paradigms, Table 4.1 below shows the contrast between two paradigms based on ontology, epistemology, and methodology. The table does not include the critical research in comparison to the two dominant paradigms in IS research based on Orlikowski and Baroudi (1991) as well as Chen and Hirschheim (2004). Essentially, critical research has the same epistemological inquiries with interpretivism, but its main goals are to carry out social critique as well as propose social improvements to the current situation (Myers 2009).

Table 4.1 Comparisons between positivism and interpretivism

(adapted from: Lincoln & Guba 1985; Maykut & Morehouse 1994; Ponterotto & Grieger 2007)

Paradigm	Positivism	Interpretivism
Ontology (the nature of reality)	A single reality that is one tangible.	There are multiple realities.
Epistemology (the relationships of the researcher and the knowledge)	The researcher is detached to the knowledge therefore objectivity is possible.	The researcher is attached to the knowledge.
Methodology (how the researcher finds the knowledge)	Finding proof.	Seek discoveries.

Positivists believe in a single reality that is tangible (Guba & Lincoln 1994), and can be measured by researchers independently (Myers 1997). Generally, positivists perform theory tests to find proof in order to understand the research phenomena. As the researchers can be completely detached from the knowledge, the study performed under the positivism paradigm could possibly be free from researchers' subjectivity. On the other hand, interpretivists assumed multiple realities that can be socially constructed though 'language, consciousness, and shared meanings' (Myers 1997). Researchers are attached to the knowledge and regarded as an entity in the process of understanding the research phenomena. Therefore, it is not possible to exclude researchers' interpretation from the study which should be described and explained in detail.

From a slightly different perspective, MacLachlan and Reid (1994) suggested that when researchers undertake research, they bring their visions into the study. These visions include some personal biases, life experiences, values and beliefs, prior knowledge, ethnicity, culture, age, socio-economic class, personality, and gender. Essentially, these things are about who they are as researchers. This notion of 'research frames' consists of four framing types; extra textual, intra textual, inter textual, and circumtextual. The extra textual frame comes from our accumulated knowledge and life experiences. Often, we tend to make a comparison or reference to our past experience when we observe a phenomenon. In that instance, we are tapping into our extra textual frame to interpret and make sense of the situation. The intra textual frame arises from something we were born with such as age or gender. While the intertextual frame relates to the specific field or discipline of the study. Lastly, the

circumtextual frame comes from our motivation and personal situation at the time we interpret something or, in this case, undertake the study (Grbich 2013; MacLachlan & Reid 1994).

The notion of research frames as suggested by MacLachlan and Reid (1994) is not contradictory to what Creswell (2009) suggested: that our worldviews are shaped by our field of work (i.e. inter textual) as well as our past research experience (i.e. extra textual). Essentially, the idea behind these research frames is such that "no communication can take place without interpretation, and no interpretation can take place without framing" (MacLachlan & Reid 1994, p.85). Using these four types of framing, visions brought into this study can be reflected and identified. As this might help complement the justification for the research design and if any, address researcher's personal biases that may impact their attitude and interpretation of the study. Although this notion seems to lean towards interpretivism, the notion of research frames is one of many ways to understand research paradigms.

Comparing MacLachlan and Reid (1994) with the three assumptions detailed in Table 4.1 in relation to choice of paradigms, MacLachlan and Reid (1994) presented four frames that could be addressed loosely. Not all are applicable to all researchers. For instance, the intra textual (ethnic, cultures, age, socio-economic class, personality, and gender) might not impact the way IS researchers perform their interpretation as much as other social researchers. Thus "meanings are generated at the point where various frames meet" (MacLachlan & Reid 1994, p. 86). Hence different frames compete. In the end, the most greatly impacts the way meanings are interpreted in this study.

Grbich (2013) advised researchers to disclose and explore each applicable frame to describe any aspects or background information which might influence the researchers in interpreting results or research findings. In the next section, this will be discussed further along with justifications for adopting the interpretive research paradigm.

4.2.1 Justifications for the interpretive research paradigm

This study subscribes to Lincoln and Guba (1985) whom suggested the interpretive research paradigm that deals with a 'human instrument' in a 'natural setting', as this study will be exploring a dashboard design process in organisations. As data were gathered through interviews with participants from each organisation, each participant would have different backgrounds and roles in the organisation and in the dashboard design process. Hence different views on the design process and their impact on the current business processes and/or systems

in the organisation would be assumed. This would in fact reflect multiple realities in this study as part of its ontological assumptions.

Furthermore, this study involves interaction with participants, hence it is impossible for a researcher to be detached from the context. Researcher's prior knowledge and experience may inform the way data is gathered and analysed (Klenke 2008). Lastly, in terms of the methodology, this study explored and attempted to discover knowledge and insights from the participants through their recollection of events during the process of designing dashboards in their organisation. Hence, choosing interpretivism as a research paradigm in this study enables researchers to focus on the research subjects and achieve an understanding of experience from the participants' point of view (Maykut & Morehouse 1994). Justifications for selecting the interpretive research paradigm are summarised in Table 4.2.

Table 4.2 Justifications for interpretive research paradigm

Assumptions	**Interpretivism**	**Justification**
Ontology	There are multiple realities.	The multiple realities were reflected on different views from participants who had come from diverse backgrounds and were in various roles in an organisation.
Epistemology	The researcher is attached to the knowledge.	This study involves interaction with the participants through interviews hence it is impossible for the researcher to be detached from the context.
Methodology	Seek discoveries.	This study would explore and try to discover knowledge and insights from the participants through their recollection of events during the process of designing dashboards in their organisation.

Meanwhile, a conscious effort has been made to identify research frames based on MacLachlan and Reid's (1994) four frame types. This exercise is considered to be essential, as it would help make sense of the interpretation process and to be aware of the research frames used by researchers. First and foremost, two dominant frames influencing the way this study was conducted were identified, namely extra textual and circumtextual. In the early stages, this study pursued the topic of dashboard design process due to the researcher's past experience as a dashboard designer. Subsequently, a literature review was conducted to identify gaps and current research relevant to dashboard design. When building research

objectives, each objective was carefully contemplated, framed, and informed by the researcher's accumulated knowledge from past experience as well as reviewing the literature. The crafted objectives were operationalised into practical research questions and potential contributions were determined based on the interpretivist case study research framework and within the context of the IS field.

4.2.2 Selection of research method

In the previous section (4.2.1), the prominent paradigms in IS research were discussed. Three key inquiries used to understand research paradigms and to recognize some of the assumptions about each paradigm were highlighted, namely: ontological, epistemological, and methodological questions. Subsequently, the researcher's stance under the philosophical assumptions of the interpretivist paradigm was justified. The next stage is to choose a research method. A research method is an approach of enquiry to find the data used in a study. It is dependent on the fundamental paradigm adopted by the researcher and affects how the researcher gathers the data (Myers 2009).

Research methods are generally classified as qualitative and quantitative (Creswell 2009; Myers 1997) or referred to as idiographic and nomothetic (Burrell & Morgan 1979; Holden & Lynch 2004). Idiographic research, or qualitative research, studies a phenomenon in its context, in which researchers make an in-depth investigation towards a specific event (Benbasat, Goldstein & Mead 1987). More importantly, it emphasises the participant's accounts towards a specific phenomenon that is being researched (Burrell & Morgan 1979). Some examples of qualitative research methods would be action research, case studies, and ethnography (Myers 1997). While quantitative research methods were at first established in the natural sciences to study natural phenomena (Myers 1997), they are now well recognized and used in the social sciences through their foundation of using "systematic protocol and technique", as well as hypotheses testing (Burrell & Morgan 1979, p.7). Some examples of quantitative research methods would be surveys, laboratory experiments, formal methods and numerical methods (Burrell & Morgan 1979; Myers 1997).

When it comes to selecting a research method, a taxonomy of IS research approaches created by Galliers (1991) can be used to inform the selection process. The taxonomy suggested to select a research method is based on the characteristics of the study, whether the focus is on individuals or organisations, or if the study is associated with understanding technologies or methodologies or the goal of the study is to determine theory building, theory testing, or theory

extension. From these selection criteria, a comparison was conducted on the characteristics of this study.

Firstly, this study focuses on the organisational level, as impacts of a dashboard design process to the current organisational processes were explored. Secondly, key principles in the design of the dashboard were also explored. In this case, the methodological considerations are greater than the technology itself. Last but not least, this study is concerned with theory building, as there is an analysis to determine if there were elements in the design process indicative of the characteristics of design thinking (see Chapter 3, section 3.2). Accordingly, the taxonomy developed by Galliers (1991) informed the selection of survey research, case study or action research, as summarised in Table 4.3.

Table 4.3 Selection of research method based on Galliers (1991)

Considerations	**Case Study**	**Survey**	**Action Research**
Organisation	Yes	Yes	Yes
Individual	Possibly	Possibly	Possibly
Technology	No	Possibly	No
Methodology	Yes	Yes	Yes
Theory Building	Yes	Yes	Yes
Theory Testing	Possibly	Possibly	Possibly
Theory Extension	Possibly	Possibly	Possibly

Survey research was ruled out as it belongs to quantitative research. As this study subscribes to the interpretivist paradigm, the selection of research methods falls under the umbrella of qualitative research methods, as suggested by Holden and Lynch (2004) as well as Maykut and Morehouse (1994). Furthermore, Franz and Robey (1984) supported this notion through their advice on employing an idiographic approach in IS research in which data were collected through observations, interviews, and memos and documents examination.

With regards to case study research, Benbasat, Goldstein and Mead (2002) argued that it is suitable for IS research as researchers could perform the study in the organisation as a natural setting. As a result, insights could be gleaned and generated from ‘practice’. In comparison, action research is comparable to case study and both were considered suitable for a study of

organisations, which potentially leads to theory building (Galliers 1991). However, during the process, the researcher was researcher and participant at the same time, entering a "real-world situation" and aiming to "improve it and to acquire knowledge" (Checkland & Holwell 1998, p. 9). Since there is no intent to change or improve organisations, action research was therefore ruled out as the research method.

Meanwhile Yin (1993) compared case study with ethnographic research. Even though both consisted of observational works and apparently comparable activities, they were based on different grounds. Ethnographic research gained "a close-up detailed rendition of the real world" done in a practically unstructured way (Yin 1993, p. 46). Moreover, it enabled us as researchers to become immersed in organisations to get a thick description of what was really happening in the organisations (Franz & Robey 1984). However, ethnography was not selected as the research method for this study as gaining access to perform this kind of research in organisations would be very difficult. Also, as ethnography can continue over a long period of time, this method may not be suitable for some PhD research.

As a result, it has been justified that case study research was the appropriate research method for this study, mainly as the phenomenon being studied cannot be removed from its context (Yin 2003), and as it aims to achieve a deeper understanding and richer description of the research topic in a real-world context (Yin 2012). Case study research aims to understand the intricacy of the processes going on in the organisation by addressing 'how' and 'why' questions, and by focusing more on organisational rather than technological issues (Benbasat, Goldstein & Mead 1987).

4.2.3 Quality of the research

In the field of interpretive research, the issue of quality has been a major discussion, especially on the validity of qualitative research (Angen 2000; Maxwell 2002) and is highly contested among qualitative researchers (Miles, Huberman & Saldaña 2014). Angen (2000) argued that using criteria to judge the validity of research would reinforce positivist assumptions on the existence of a basic reality that cannot be tainted by subjective interpretation. Regardless, qualitative researchers continue using the term 'validity' as "it suggests a more rigorous stance" towards the study (Miles, Huberman & Saldaña 2014, p.313). The concept of validity is needed in all research, to ensure outcomes are a true reflection of the data collected (Harding 2013).

Validity in quantitative research relies on "rigorous adherence to methodological rules and standards" which cannot be applied to qualitative works (Angen 2000, p. 379). Nonetheless, according to Harding (2013), qualitative researchers need to make sure that our research is not conducted randomly and arbitrarily. Researchers need to ensure that conclusions drawn from the study are "a correct explanation of what happens and why" (Harding 2013, p.5). More importantly, researchers seek assurance that "we [researchers] have done the right thing" (Angen 2000, p. 380).

Qualitative research has been questioned over its legitimacy due to "the absence of 'standard' means of assuring validity" (Maxwell 2002, p. 37). Qualitative researchers have different responses ranging from disregarding validity as an issue at all, direct adoption to the concept of validity from the positivist cohort, or arguing that qualitative research has different approaches when it comes to maintaining validity (Angen 2000; Hammersley 2007; Maxwell 2002).

Fundamentally, in positivism, validity has been portrayed as truth, therefore it gives certainty (Angen 2000). But Hammersley (2007) argued that as interpretivists, we could only comprehend reality through our own perceptions. Therefore, validity should be redefined as 'confidence' instead of certainty (Hammersley 1995 cited in Angen 2000). In other words, trustworthiness matters and the question we should be asking is "to what extent can we place confidence in the outcomes of the study?" (Maykut & Morehouse 1994, p. 145).

In quantitative research, quality is measured through validity, reliability and generalizability (Angen 2000; Kitto, Chesters & Grbich 2008). The same could not be applied to qualitative research due to "different frameworks, sampling approaches, size of sample and goals of qualitative research"; therefore in qualitative research, quality or trustworthiness is determined through rigour, credibility, and relevance (Kitto, Chesters & Grbich 2008, p. 243). In addition transferability is often used in discussing quality in qualitative research to describe "the range and limitations for application of the study findings, beyond the context in which the study was done" (Malterud 2001, p. 484). Regardless of what it is called, Miles, Huberman and Saldaña (2014) argued that it is the final written report itself that matters eventually.

This study summarised criteria suggested by various qualitative researchers to improve and address the issue of quality as shown in Table 4.4. In the far right column, techniques used in this study are described. Self-examination will be conducted as the study progresses based on these proposed techniques. It is essential to start thinking about the quality issue right from the

beginning of the study (Angen 2000). Research is a complex activity and, "it is easy to overlook what one would, in other circumstances, routinely take into consideration" (Malterud 2001, p. 289). Using criteria, such as those detailed in Table 4.4, is an effective way to remind researchers of how they assess their own research (Malterud 2001). Furthermore, the criteria can also be used as a reflective instrument in this study (Barbour 2001). After all, if the study is worth doing, it should be well done. Further reflections on the issue of quality are discussed more thoroughly in Chapter 9.

Table 4.4 Criteria to increase and ways to address the quality of the research

Criteria	**References**	**Proposed techniques**
Reflexivity	Mays and Pope (2000), Harding (2013), Malterud (2001), Lincoln and Guba (1985), Kitto, Chesters and Grbich (2008)	A memo has been created as an audit trail to record data analysis activities in the qualitative data analysis software (NVivo). A journal was maintained to write down thoughts and decisions made throughout the research journey. Figure 4.2 shows a screen-shot of an audit trail created using NVivo software to note down changes made in coding.
Participant checks	Harding (2013), Lincoln and Guba (1985), Kitto, Chesters and Grbich (2008), Mays and Pope (2000), Miles, Huberman and Saldaña (2014)	Confirmation has been sought from key participants in regards to research results.
Consider rival explanations	Miles, Huberman and Saldaña (2014), Mays and Pope (2000)	In Chapter 2, rival theories specifically on critics of design thinking, analytical thinking, decisions thinking, and systems thinking have been discussed.
Triangulation	Harding (2013), Lincoln and Guba (1985), Kitto, Chesters and Grbich (2008), Mays and Pope (2000), Miles, Huberman and Saldaña (2014)	Possible ways to collect data: interview, observation, follow-up emails. Information on participants' background situations and positions in terms of their jobs were collected. This is to see if there is a possible source of bias.

Reflexivity refers to "open acknowledgement of the complex influences" identified by researchers towards research topics as well as the results of the study (Kitto, Chesters & Grbich 2008, p. 243). We should be sensitive to the ways we as researchers bring our prior experience and assumptions into the study, as this may shape how we collect the data and could potentially influence the way we analyse the data (Mays & Pope 2000). In a way, we recognising our biases as a part of the research contribution and as such valued, not to be mistakenly identified

as objectivity between researchers and research (Angen 2000). Addressing self-reflexivity can be done in many ways, for instance, key decisions made during the course of research can be recorded in the form of an audit trail (refer to Figure 4.2), a research journal or diary (Harding 2013), as well as to specifically clarify and discuss our personal values and characteristics that could lead to biases (Mays & Pope 2000).

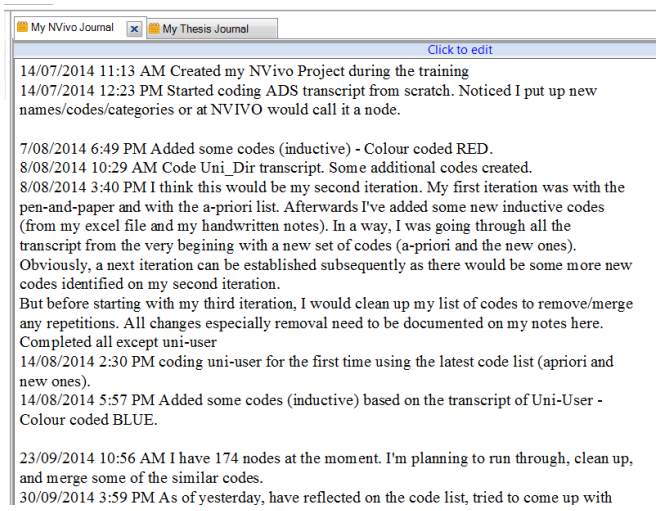


Figure 4.2 Audit trail recording changes made in coding

Meanwhile, participant or member checking is another way to improve rigour and can be achieved by offering research participants an opportunity to view the interview transcripts (Kitto, Chesters & Grbich 2008) or the research findings (Mays & Pope 2000). Furthermore, this technique would later incorporate feedback from the participants regarding the findings (Mays & Pope 2000). However, researchers need to be careful as a participant might change their views or actions (Miles, Huberman & Saldaña 2014), instead being influenced by the presented findings which were concluded based on the accounts of all participants (Mays & Pope 2000).

Additionally, the quality of the research can be improved by examining rival explanations. It is necessary to confirm our understanding, especially when forming early conclusions (Miles, Huberman & Saldaña 2014). Rival explanations allow researchers to critically reflect on arguments from other researchers giving them a check-and-balance to increase the trustworthiness of the research results (Tobin 2010).

Lastly, triangulation could be used to achieve a more comprehensive dataset by obtaining data from multiple sources (Mays & Pope 2000), or by using various ways of collecting data,

multiple theories (Denzin 2001), as well as data types (Miles, Huberman & Saldaña 2014). It allows us to address research questions by means of different perspectives (Barbour 2001). Additionally, Sarker and Sarker (2009) suggest researchers are "suspicious about evidence" (p. 446), as participants can bring biases to interview due to their current positions or situations at work. Hence researchers should always be consciously aware of possible participant biases (Klein & Myers 1999) and use triangulation to gain insights from other data sources (Sarker & Sarker 2009).

Triangulation is expected to have an agreement from at least three different sources which in this case might increase the trustworthiness of our analysis (Miles, Huberman & Saldaña 2014). Though in some instances, it is not uncommon to find conflicts or inconsistencies from a different data source. Barbour (2001) suggested that it simply offered room to further refine the research results. Tobin and Begley (2004, p. 393) added that triangulation is crucial in qualitative research as it is "offering completeness rather than confirmation", to recognise multiple realities as the nature of qualitative research. Thus, it is "enlarging the landscape of their inquiry, offering a deeper and more comprehensive picture" which can be regarded as an opportunity to explore the possibility of new findings (Tobin & Begley 2004, p. 393).

The criteria in Table 4.4 should be treated as guidelines, hence they should not be used as a checklist or be mandated for use by researchers (Angen 2000). As Barbour (2001) mentioned, an obsessive and overly prescriptive use of such a checklist could be counterproductive and does not guarantee good research. According to Malterud (2001), it is difficult to find agreement in judging 'good' quality work in qualitative research, as there are "divergent conceptions of the requirements of rigorous enquiry to be found amongst qualitative researchers" (p. 297). Consequently, these criteria should be incorporated into a comprehensive structure of research design and data analysis in order to help strengthen the rigour of the research (Barbour 2001).

4.3 Research design: case study research

Research design contains the plan of the whole research project, including the adopted paradigm, research method, data collection and analysis techniques (Myers 2009). It is more than just a 'work plan', as it relates the research questions to the data being collected and analysed, and eventually to the end of the study as stated in its objectives (Yin 2003). For this

study, case study research was conducted with multiple cases and cross-case analysis was subsequently carried out.

4.3.1 'Case' definition

A case is "a phenomenon of some sort occurring in a bounded context" and effectively a unit of analysis (Miles & Huberman 1994, p. 25). As such it denotes the level of focus which is normally determined by the research questions (Myers 2009). According to Yin (1993), the unit will be used to analyse the case study, and there may be more than one unit of analysis in a case study. These units can refer to individuals, groups, programs, organisations, communities, decisions, processes as well as projects (Forman & Damschroder 2008; Miles & Huberman 1994; Myers 2009; Yin 2003). In the context of IS, it could be the corporate networks, the software development process, or information workflows in an organisation (Yin 1993).

In this study, data from each member of the dashboard design team and typical users in the organisation were gathered. Analyses focused on the detailed process of designing a dashboard and current organisational processes impacted by this process. The bounded context or unit of analysis for this case study is an organisation. Therefore, the data was collected, analysed, and presented as a single case for each organisation. Furthermore, cross-case analysis was also performed by comparing and contrasting the data between cases.

Figure 4.3 depicts the boundary and definition of the research case in general. The main focus is the dashboard design process which is illustrated in the centre of the diagram. It involves interactions between members of the design team internally and externally with the users. The diagram also includes the three research objectives to be achieved through this case study. Firstly, impacts of dashboard design process in relation to current organisational processes are explored. Secondly, analyses are conducted to examine if there are elements in the design process indicative of the concept of design thinking. Lastly, key aspects and principles in dashboard design process are explored.

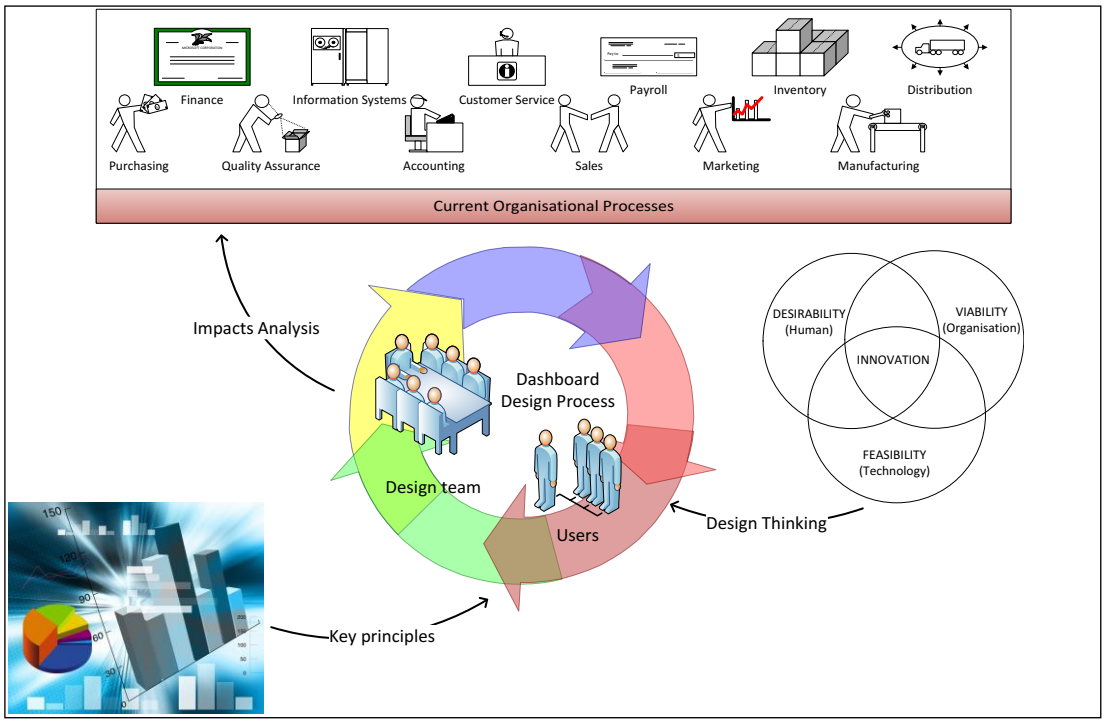


Figure 4.3 Case boundary

This study uses two different groups, the design team and users, as per Gallagher, Mason and Vandenbosch (2004) in which groups were depicted as "distinct communities whose knowledge of systems is formulated by their experiences, giving them very different perspectives" (p. 2). The design team could be either a dedicated team that was formed solely for the purpose of designing a dashboard for the organisation, or it could be a cross-functional team in which each person has their own main job responsibility. In the latter team, designing the dashboard is merely a part of their work portfolio.

4.3.2 Multiple case study

This study constitutes multiple case study research. There are some advantages in using more than one case. Miles, Huberman and Saldaña (2014) suggested that a multiple case study reassures us that what has occurred in a case might not be entirely distinctive, and by seeing processes and results across multiple cases helps build deeper understanding, more articulate descriptions as well as more convincing explanations. Furthermore, the use of multiple case studies allows cross-case analysis for richer descriptions in this kind of research (Perry 1998). Before cross-case analysis is performed, an analysis of each case or within-case analysis need to be completed (Miles & Huberman 1994).

While employing multiple case studies, Yin (2012) advocates using replication logic that treats each case as a separate entity in which a theoretical framework is used to study the first case in depth, and subsequently, to see if the pattern compared to the previous case is evident (Miles, Huberman & Saldaña 2014; Yin 2003). Key activities in this study design which include the use of multiple cases and cross-case analysis are illustrated in Figure 4.4.

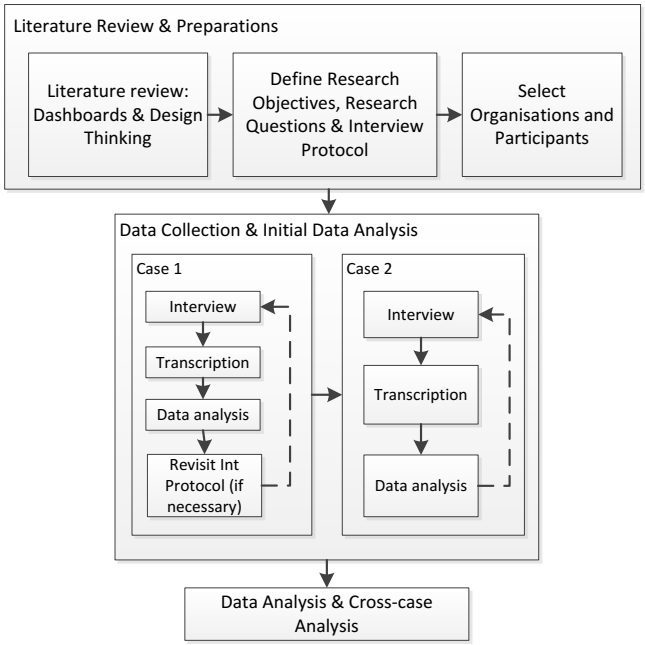


Figure 4.4 Research design

4.3.3 Data collection

In qualitative research, purposive sampling is used to deliberately select the most appropriate participants based on the purpose of the study (Harding 2013). Mainly in purposive sampling, there are three selection strategies, namely selecting extreme cases, selecting typical cases (Harding 2013; Maykut & Morehouse 1994), and the most prominent and useful strategy, seeking maximum variation in the sample (Maykut & Morehouse 1994). In reality, however, qualitative sampling normally requires a more "flexible and pragmatic" approach, for example, by combining convenience and purposive techniques (Marshall 1996, p. 524). Eisenhardt (1989, p. 533) added that a "flexible and opportunistic" data collection "allows investigators to take advantage of emergent themes and unique case features".

Sampling Strategy

In this study, criteria were established for selecting potential participants. Firstly, the organisation must have designed or be in the process of designing a dashboard (not necessarily a BI dashboard). The design could be done either by themselves (an internal team) or by an outsourced designer, so long as the organisation's key persons were involved in making design decisions. Secondly, the organisation must be willing to grant access to the key persons in the design team (process owners and designers), analysts, and business users at management and operational levels.

The initial sampling strategy leaned towards the typical cases selection, but whenever possible, a maximum variation in the selection of participants is sought. The variation can be seen through different types of dashboard (strategic, management, or operational dashboards), implementation styles (BI or non BI), or even size and type of organisations. Also, a particular purposive sampling technique called snowball sampling is attempted, in which potential candidates for the study were obtained through referral (Grbich 2013; Marshall 1996), to obtain a contact from key personnel of other organisations that have already implemented a dashboard. In general, data for this study is collected from organisations selected based on purposive and convenience techniques, as suggested by Marshall (1996), considering the research timeline as well.

In multiple case study design, the cases need to be comparable in some ways (Stake 2013). There are no specific guidelines when it comes to the number of cases to be included in qualitative case study research (Perry 1998). Cases should be added until "theoretical saturation" is reached (Eisenhardt 1989, p. 545) or "to the point of redundancy" (Lincoln & Guba 1985, p. 204). Perry (1998) recognised the real constraints in terms of funding and time limitation in research by suggesting a minimum of two cases as a rule of thumb. Most importantly, the main goal in qualitative research should be to achieve in-depth and richness of information rather than the highest number of cases (Perry 1998).

Following the sample selection strategy discussed earlier, UniOne and CareOne have been selected as two organisations to participate in this study. UniOne is a university, while CareOne is a not-for-profit organisation that provides support to aged-care communities and people with disabilities. Both organisations have an interest in dashboards. UniOne has had their dashboards designed and implemented, while CareOne was in the initial stages of designing and implementing a dashboard along with their Enterprise Resource Planning (ERP)

project. Further information on UniOne and CareOne's organisational background will be discussed in Chapters 5 and 6 respectively.

Semi-structured Interviews

The qualitative data for this study is gathered through semi-structured interviews. This type of interviewing was chosen based on the purpose discussed by Gallagher, Mason and Vandenbosch (2004) as follows.

> The purpose of the interviews was to elicit the project participants' experiences and perceptions in a system development process. The interviews were designed to offer the interviewees the opportunity to reflect on their experiences and surface their insights about the project. (p. 4)

The in-depth interviews were conducted with key personnel in the design team (process owner and designer), analysts, and business users at executive, management, and/or operational levels. Prior to beginning the interview process, university ethics approval was gained (see Appendix A). In general, the duration of each interview was approximately one hour and was recorded using a digital audio recorder. Participants were advised beforehand on the use of the audio recorder for interviews. Follow-up interviews were scheduled for a later date, if necessary. In this study, permission for observations was not granted at the time of data collection due to the sensitive nature of the data in the dashboards. Nevertheless, a short demo of the dashboard use was conducted with Uni-CFO and Uni-User2. Table 4.5 summarised the interview details completed in UniOne and CareOne. Further information on each interviewee will be provided in Chapter 5 and 6.

Table 4.5 Summary of Interview Details

Organisation	Participant	No of Interview	Length of Interview
UniOne	Uni-Dir	1	1 hour
	Uni-Mgr1	2	1 hour 20 mins, 45 mins
	Uni-Mgr2	1	1 hour
	Uni-An1	1	1 hour
	Uni-An2	1	1 hour
	Uni-CFO	1	1 hour
	Uni-User1	1	1 hour
	Uni-User2	1	1 hour
CareOne	Care-CEO	1	1 hour
	Care-Mgr	2	1 hour 15 mins, 45 mins
	Care-Proj-Lead	1	1 hour 15 mins

	Care-User-Strat	1	45 mins
	Care-User-GMOps	1	30 mins
	Care-User-GMBiz	1	45 mins
	Care-User-HR	1	30 mins
	Care-User-Prac	1	1 hour

Interview questions were an operationalization of research questions defined in Chapter 1. The first research question of this study asks "*How does the dashboard design process affect the organisation in terms of its existing systems and processes?"* This research question was prepared to obtain information from the design team on the detailed design process. A design team could consist of designers, managers, users, and other stakeholders (Stolterman 1999). The interview questions were around the relationships between the process of designing a dashboard with the current processes, IS/IT environment, and/or other matters in the organisation. First, participants were asked to describe business processes which related to the dashboard design initiative, changes (if any) needed in the business processes required to achieve the design of the dashboard, and to what extent the use of the dashboard resulted any changes in the organisation. Second, participants were also asked about the impacts of designing a dashboard on current business processes. Last, participants were asked about the outcome and perceived value from dashboard use.

The second research question asks "*In what ways does the design process corroborate with the fundamental characteristics of design thinking?"* To operationalise, firstly the design team is inquired on the thinking process or any discourse that involves not only analytical thinking but also intuition during dashboard design process. The main goal of the design process is also explored whether or not the design team would favour choosing the best solution from some available alternatives/solutions; or generating a fresh new solution for each design task. While the design team described details on the design process, characteristics of design thinking are probed with follow up questions. Secondly, from the business users and stakeholders, this study checks whether participants found any value from dashboard use. As a result, insights and understandings can be gained through this second research question to see if the design process confirms with the concept of design thinking. Additionally, according to Johansson-Sköldberg, Woodilla and Çetinkaya (2013), more empirical study is needed, as the notion of design thinking has been generally developed merely based on practice. Therefore, this study would also contribute as an empirical review of the notion of design thinking.

Lastly, the third research question asks "*What are the key design principles and elements in a dashboard design?"* Questions on areas of the design process, considerations, collaborations, conflicts or discourses relevant to the process of designing and developing a dashboard were asked. Furthermore, participants were asked about key aspects and design principles used by the organisation including design best practice, guidance, rules and constraints as well as elements to be considered when making design decisions. Participants were also asked to describe reasons they considered those aspects important. Lastly, they were given a chance to discuss on other considerations in dashboard design along with concerns and interesting insights that have happened during the design process. The full interview protocol is available in Appendix B along with the mapping of research objectives regarding respective research questions and interview questions.

4.3.4 Data analysis

Once interviews were completed, the next step was to conduct thorough data analysis. It is strongly recommended that data should be analysed concurrently with data collection (Forman & Damschroder 2008; Miles, Huberman & Saldaña 2014) as it helps us to reflect on the existing data and rethink the strategies for collecting new data (Miles, Huberman & Saldaña 2014). A verbatim transcription on each interview was completed before data analysis could begin. With transcripts ready, the next step is finding a strategy and techniques to make sense of the data (Harding 2013). For the data analysis, qualitative content analysis is used to analyse the research data. In qualitative content analysis, generally data is coded using codes defined inductively from the data, although our conceptual framework could also inform the data codes (Forman & Damschroder 2008).

This study used qualitative content analysis which is commonly used to analyse an extensive range of textual data including interview transcripts and notes on observations, and could also be employed regardless of research methods and design (Julien 2008). Such analysis focuses on the content and contextual meaning of a text (Hsieh & Shannon 2005), in particular, by examining the text in depth for the purpose of categorising parts of the text with similar meaning into a number of categories (Weber 1990). Furthermore, qualitative content analysis involves close reading of the textual data, assignment of codes into clusters of text which are later transformed into themes (Julien 2008), as well as grouping "similarly coded data" into categories (Saldaña 2013, p. 8).

Generally, qualitative content analysis can be carried out inductively and deductively (Elo & Kyngas 2008; Mayring 2000). In inductive analysis, codes and categories are generated from the data, while in deductive analysis codes are prepared and produced from research questions, the theoretical framework, as well as relevant prior research (Forman & Damschroder 2008; Mayring 2000). Nonetheless, according to Perry (1998) as well as Forman and Damschroder (2008) both approaches in qualitative content analysis can be combined by using a priori or initial codes to start coding the data, while at the same time new codes are identified inductively to improve the initial codes. From the list of codes, the researcher should be able to link back to the relevant interview transcript (Dierckx de Casterlé et al. 2012). In the long run, it should be considered as a continuous process to categorise the codes and review the list of codes and categories as well.

Finally, the rigour of this study can be maintained by keeping a record of every step taken during data analysis and reporting them in the writing (Grbich 2013). The success of the data analysis process depends on the skills of the researcher and the quality of the research team. Regardless of the data analysis methods or techniques used by the researchers, it could not automatically warrant a quality of results (Dierckx de Casterlé et al. 2012). At the end of the day, the success of the data analysis and the quality of results contribute to the overall quality of this study.

4.4 Process of coding

A code is defined as "a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data" (Saldaña 2013, p.3). Whereas coding is a "deep reflection", as well as "analysis and interpretation of data meaning" (Miles, Huberman & Saldaña 2014, p. 72). As codes are applied to the data, "similarly coded data" is organised and grouped into categories as they share some attributes (Saldaña 2013, p. 9). Undoubtedly, coding is an iterative process in which data can be re-coded and re-categorised and at the same time codes and categories are refined (Saldaña 2013).

Themes are "derived from codes" (Firmin 2008, p. 868). Saldaña (2013) however argued that themes were not merely a translation of codes, and thus they were not coded; instead, themes were the results of coding, categorisation, analysis, and reflection. In sum, this study agrees with the way Saldaña (2013) explained and described the difference between codes, categories,

and themes in Figure 4.5, in which he also highlighted how themes, with a higher level of abstraction, were developed from codes and categories.

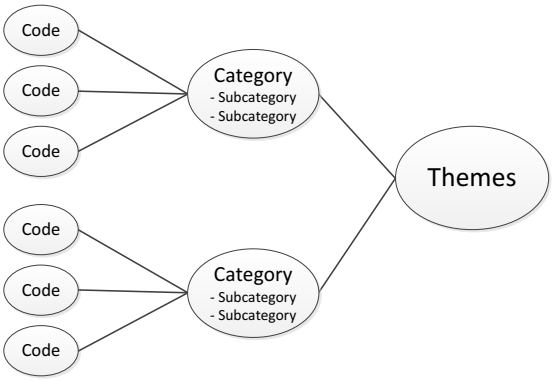


Figure 4.5 From code to theme (Saldaña 2013)

The coding process according to Miles, Huberman and Saldaña (2014) involves the first and second cycle of coding. In the first cycle coding is a way to summarise fragments of data, while in the second cycle those summaries were grouped into categories (Miles, Huberman & Saldaña 2014) and later on developed themes (Saldaña 2013). In subsequent subsections, the detailed activities on the first and second coding cycle will be discussed, as well as how themes emerging from the data were developed.

NVivo, qualitative data analysis software, was used in this study to assist with the first cycle of coding. Firstly, the software was used to compile and manage interview transcripts. Secondly, a pilot test was conducted to code some of the interview transcripts using the software. (Figure 4.6 shows a screenshot of a coded interview transcript in NVivo.)

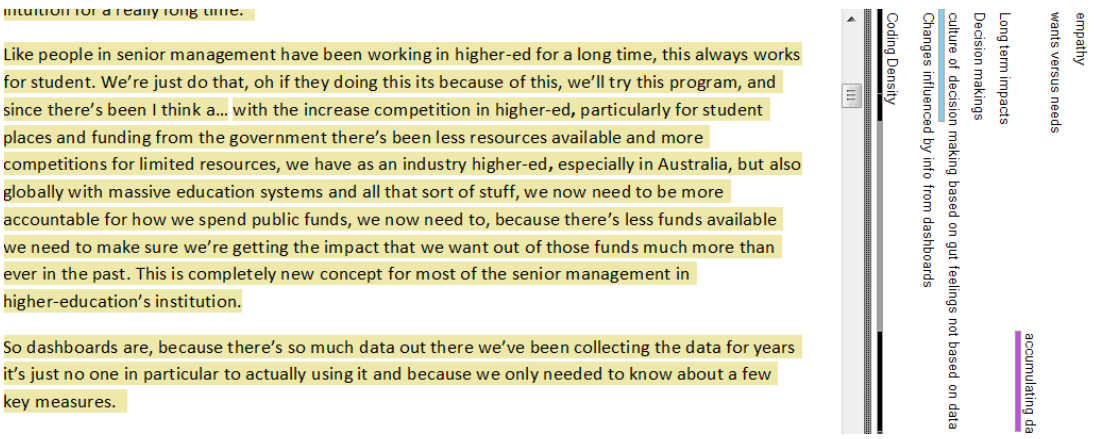


Figure 4.6 Screenshot of coded interview transcript in NVivo

Subsequently, it was decided that the coding would be done manually with pen-and-paper as this allowed more flexibility in circling, underlying, marking, and applying codes to the interview transcripts as well as identifying emergent codes. The pen-and-paper approach also makes it easier to write researcher's notes alongside coded data. Figure 4.7 illustrates this process. Nonetheless, NVivo software was still used in tandem, particularly to maintain the list of initial codes and some additional emergent codes from the data.

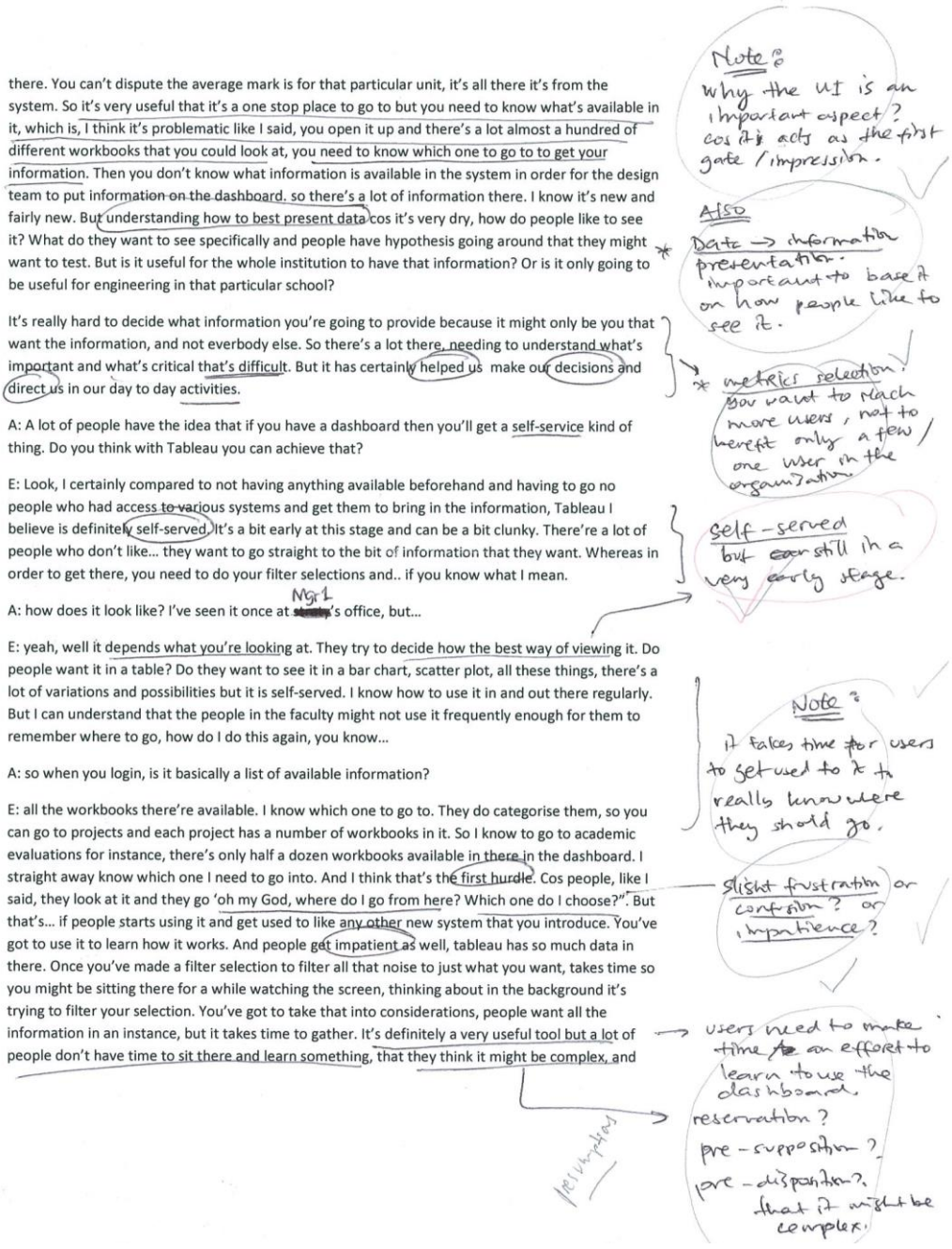


Figure 4.7 Example of a coded interview transcript

Once the first cycle of coding was completed, the software was used to print the list of codes along with their corresponding coded data. Afterwards, the second cycle of coding was done without the assistance of the software. As it involved the process where categories and themes were developed, arguably it is a crucial step to reflect, analyse and understand the meaning and context of the data in order to categorise coded data and identify themes that emerge.

Hence, a simple spreadsheet program such as Microsoft Excel was selected to assist with management of themes, categories, and codes from this stage onwards (refer to Figure 4.8 in the next section).

The approach of two-cycle coding is comparable to the Adapted Grounded Theory approach by Sarker, Lau and Sahay (2000). The approach uses open coding and axial coding as the first two steps with selective coding to follow. While open coding is carried out inductively, the first cycle of coding employs a combination of deductive and inductive approaches. Axial coding identifies "categories and sub-categories, and arranging them conceptually in a hierarchy" (Sarker, Lau & Sahay 2000, p. 53). Similarly, a second cycle of coding also classifies the codes into categories and subcategories to assist the last stage in developing themes. This will be further discussed in the following subsections.

4.4.1 First cycle of coding

Before analysis starts, Harding (2013) suggests to write summaries of each interview or each case in order to identify key themes and reduce repetition regarding research objectives and questions. Dierckx de Casterlé et al. (2012) suggested a similar process called preparation of the coding process that is supposedly done before the actual coding process. Similar to Harding (2013), the preparation involves creating an interview report, identifying conceptual themes, testing the themes with the research questions and linking back to interview data, and lastly performing constant comparison within and across cases (Dierckx de Casterlé et al. 2012).

Following Harding (2013) and Dierckx de Casterlé et al. (2012), the data is prepared by creating a one-page summary for each interview transcript. This is a good exercise in which to immerse oneself by reading and re-reading the transcripts while writing the summaries. At the same time, thoughts are noted down, potential new codes are circled, and repeated ideas in the interview transcripts are identified. Ideas that have not been covered in earlier interviews are also identified for inclusion in follow-up interviews, if necessary. As a result, a table to summarise the data for each participant was prepared. The summarised data was organised based on initial codes for each research question. The preparation of this table also helped to identify new codes and potential categories for the later stage.

Figure 4.8 shows a part of the table that illustrates the summarising process of UniOne's interview transcripts. (The full table can be found in Appendix D.)

Summarised Data organised by Codes

About impacts/changes related to dashboards (RQ1)

	Uni-Mgr1	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Long term impacts	Having a *transparency* of information through dashboards, BI, or analytics.				to reach transparency of information and dashboards help to reach that goal.
Issues detection	People can see information and be *proactive* when they encountered *issues with their processes*. Metrics help them detect issues that might result in an undesired repercussion.	Dashboards help investigate a root cause of an issue	Dashboards help identify/spot issues.		
Changes to dashboards		Changes in the uni prompted them to do adjustments to data structures, etc. to fit into the new structures.	Changes in the uni triggered her to perform impact analysis on dashboards and adjust them accordingly to reflect the changes.		
Decision makings	Information provided them a real *evidence* to base their decision makings on. It is important to have the right information so that we can make sense of the information and could base our decisions on it.	Dashboards support *big decision* makings & make improvement plans.		Unknown to her if users had made decisions in relation to the changes purely based on the dashboard.	Positive impacts: supports users making informed decisions.
Due to data unavailability			If data unavailable, inform data/process owners to collect the data in a good quality.		If data unavailable -> contact data/process owners to negotiate/work on solutions -> if changes needed to be done, the effort depends on the priority/importance of the requests (and the requesters).
Due to user requirements			Changes on her side as she needed to change and manipulate data to suit the needs.		

About Design Thinking (RQ2)

	Uni-Mgr1	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Wicked problems	*Struggling* with unclear (wicked) requirements and in some cases with time and resource constraints.	A difficult exercise: dealing with different users (with different preferences).		A wicked problem due to office politics involved that could potentially hinder the effort to collaborate with users, as well as data ownerships and accountability.	An *extremely complex* task (wicked).
Different approaches to different problems			Always start from scratch (start anew), use different approach for different users/requests.	She has a diverse type of users therefore she would approach every task in a different way.	Need to *approach it with fresh eyes as that was a new problem every time*. But for regular requests, reuse the *already available* solutions rather than build it entirely new every time.

Figure 4.8 Summary table for UniOne

Subsequently, initial data analysis or the first cycle of coding, to use the term by Miles, Huberman and Saldaña (2014, p. 86) which refers to a way to "summarize segments of data", begins with a deductive approach by preparing a list of initial codes. These initial codes are prepared based on the literature review and the conceptual framework, as discussed earlier in Chapters 2 and 3. The conceptual framework and literature review have informed the development of interview questions used during data collection. As advised by Bloomberg and Volpe (2012, p. 142), the conceptual framework informs the coding scheme, as "a centerpiece in managing and reducing the data", and the coding scheme in turn helps identify themes at a later stage.

Bloomberg and Volpe (2012) suggested codes and categories used as the coding scheme are directly related to research questions. Miles, Huberman and Saldaña (2014) added that the conceptual framework and the research questions assist researchers in dealing with information overload, especially during early stages of the data analysis. Initial codes are then arranged and categorised based on research questions.

The first research question (RQ1) is concerned with 'impacts' as this study explores and attempts to understand the extent of the impacts of a dashboard design process on the organisational performance, processes, and IS/IT environment. Particularly, the question probes how the dashboard design process affects the organisation in terms of its existing processes. To answer this question, codes listed in Table 4.6 below are applied to the interview data.

Table 4.6 List of initial codes related to RQ 1

Codes	**Sub-codes/Descriptions**	**Reference**
Decision-making activities	A different level of granularities, improving the quality of decision makings, having an access to information, a single source of information, 'what-if' analysis	Keen (1981), Hennen (2009), Gurbaxani and Whang (1991), Nagy et al. (2009)
Organisational processes	Process changes, process integration, collaboration, positive impacts, adding values to businesses, eliminate inefficient processes	Gurbaxani and Whang (1991), Nagy et al. (2009)
Organisational performance	Performance monitoring, self-monitoring, being aware of organisation's performance, knowledge discovery, root-cause finding, performance improvement, increase accountability	Nagy et al. (2009), Gurbaxani and Whang (1991)

The second research question (RQ2) concerns 'elements' on the dashboard design process that indicate the concept of design thinking. Specifically, this study explores the ways in which the

design process corroborates with a holistic approach to achieve innovation, and/or balancing the analytical and intuitive thinking as the fundamental characteristics of the concept of design thinking. To answer this question, codes listed in Table 4.7 below are applied to the interview data.

Table 4.7 List of initial codes related to RQ 2

Codes	Sub-codes/Descriptions	Reference
Idea generation	Building the solutions by thinking and making, early prototyping, creating many choices	Brown(2009), Boland and Collopy (2004), Boland et al. (2007)
Innovation inspired by constraints	Creating something new and 'remarkable', start anew on each design task, exploit contrasting ideas and constraints, keep new ideas flowing, balance between the desirability, viability, and the feasibility	Brown(2009), Boland and Collopy (2004), Boland et al. (2007)
Human-centred design	Empathy and collaboration, understanding the cultural context and environment, users participation	Brown(2009)
Balance between analytical and intuitive thinking	Analytical thinking involved past-and-proven or tried-and-tested data, intuitive thinking involved creativity and innovation, designer's principles as an initial point of solution explorations, intuition derived from their experience, prior learning and familiar situations	Martin (2009), Cross (2011)
Design thinking strategy	Holistic approach to design problems, frame/reframe the problem in a unique and subjective way, utilise "first principles"	Cross (2011), (Lindberg et al. 2010)

The third research question (RQ3) is concerned with 'key aspects and principles' associated with the perceived successful design and implementation of a dashboard. There are a number of aspects to be considered when it comes to designing a dashboard. Those aspects essentially could become the contributing factors when making a design decision that leads to the production of a dashboard. The literature has suggested some key aspects in relation to dashboard design. These aspects are summarised in a list of codes in Table 4.8 to be applied to the interview data.

Table 4.8 List of initial codes related to RQ 3

Codes	Sub-codes/Descriptions	Reference

Importance of quality data and infrastructure technologies	Data warehouse, database systems, data quality, platform, system architecture, software, information systems	Nagy et al. (2008), Olsha-Yehiav et al. (2006), Wadsworth et al. (2009), Hranac and Petty (2007), Devillers et al. (2007), Pauwels et al. (2009)
Roles of users and organisations in a dashboard design process	User characteristics (profile, background, experience, preference), user roles in organisations, organisational culture, requirements, policy, goals, decision-making style, business rules definition	Malik (2005), Yigitbasioglu and Velcu (2012b), Hennen (2009), Pauwels et al. (2009), Clark, Abela and Ambler (2006), Eckerson (2006), Hranac and Petty (2007), Rasmussen, Bansal and Chen (2009), Devillers et al. (2007)
Intuitive and flexible features	Functionality, flexible drill-down and/or slice-dice features, intuitive user interface, various metrics selections	Malik (2005), Hennen (2009), Sloane et al. (2006), Wadsworth et al. (2009), Few (2006), Hranac and Petty (2007), Pauwels et al. (2009)

The first cycle of coding is generally applied to blocks of data (Miles, Huberman & Saldaña 2014). Saldaña (2013) discussed more than twenty different approaches of coding that can be selected depending on the nature and aims of the study. Each serves a specific purpose and can be used along with other approaches. Mainly Miles, Huberman and Saldaña (2014) mentioned three fundamental approaches, namely descriptive, in-vivo, and process coding.

Descriptive coding mostly uses nouns in a word or a short phrase to describe the data based on the topic (Miles, Huberman & Saldaña 2014). It is both a straightforward and basic approach in qualitative research (Wolcott 1994) that also serves as a good foundation for the second cycle of coding (Saldaña 2013). In-vivo coding uses exact terms used by research participants as an effort to perform inductive analysis (Bloomberg & Volpe 2012; Saldaña 2013). This approach helps balancing the risk of the deductive approach using predetermined initial codes as according to Bloomberg and Volpe (2012), data might get coded based on what the researcher has anticipated to find. Process coding uses gerunds to describe actions and it is commonly used in grounded theory (Saldaña 2013; Sarker, Lau & Sahay 2000).

This study mainly uses descriptive and in-vivo coding approaches. The descriptive codes contain mostly the initial codes with some new ones derived from the data. The in-vivo codes were identified inductively from the data or the interview transcripts. (Some of the new codes and sub-codes can be found in Table 4.9, while the full list of codes can be found in Appendix E.)

Table 4.9 Newly identified codes

RQ	Codes	Sub-codes/Descriptions
RQ 1	Decision making	A real evidence to base decision making on
		Bust myths with evidence
		Culture of decision making based on gut feelings
	Performance monitoring	Enable staff performance self-monitoring
		Enable a reality check
RQ 2	User-centred approach	Collaboration to fine tune user's requirements and to design a dashboard fits for its purpose
		Engage and collaborate with users to get their feedback and confidence
	Innovation & constraints	Constraints distilled design problems
		Constraints forced innovations
		Creating a better design with limited resources
	Efforts leading to innovation	Change the way users think about data
		Change user's perception about the value of information
		Diversity on a team to support innovation
RQ 3	Visions of the dashboard	One source of truth
		Self-service dashboards
	Challenges with the design process	Getting the buy-in from executive users
		The approach has not been done strategically
		Struggling to select suitable metrics
	Design team	Design team speaks the same "language" with users
		Needs to vary expectations depending user roles and functions in the organisation

Next, the second cycle of coding is described and how themes for this study were developed.

4.4.2 Second cycle of coding

As a continuation from the first cycle, Saldaña (2013) suggested a few different approaches, namely pattern, focused, axial, theoretical, elaborative, and longitudinal coding. Pattern coding is applied as the main method of second cycle coding as suggested by Miles, Huberman and Saldaña (2014), in which segments of data coded (with initial and newly identified codes) in the first cycle

were essentially grouped into a number of categories or themes. Pattern codes help identify emergent themes from the data by grouping a lot of coded data into more significant and manageable units of analysis (Miles, Huberman & Saldaña 2014; Saldaña 2013). They also help with multiple case study research in forming a foundation to focus on subsequent fieldworks and while performing cross-case analysis at a later stage (Miles, Huberman & Saldaña 2014).

Furthermore, pattern coding plays an important role in developing "major themes" from the data (Saldaña 2013, p. 210). Pattern codes summarise data based on "categories or themes, causes or explanations, relationships among people, and theoretical constructs" (Miles, Huberman & Saldaña 2014, p. 87). Generally, pattern codes were applied based on categories or themes of previously coded interview transcripts. Figure 4.9 depicts the process of pattern codes development. Some codes and their respective coded data might fit under more than one category (Bloomberg & Volpe 2012).

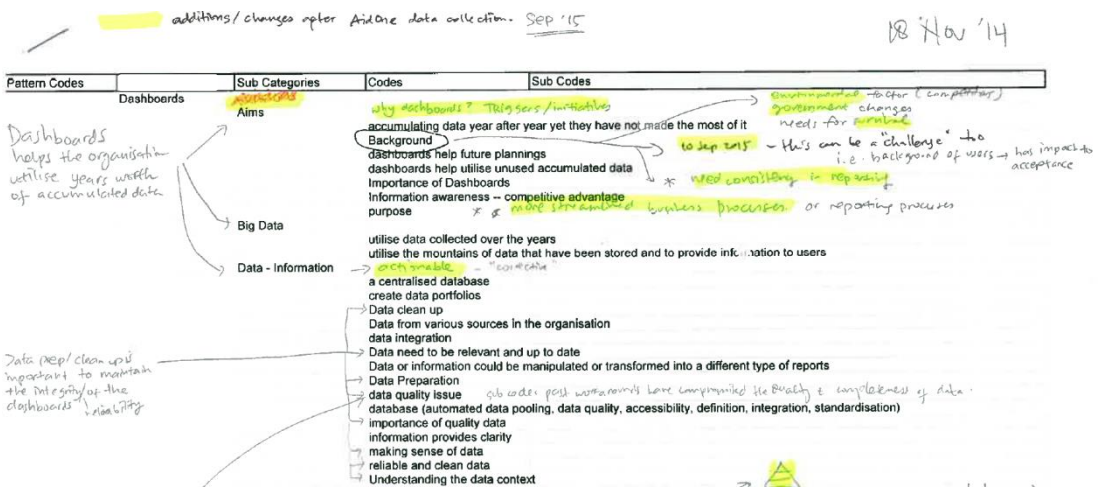


Figure 4.9 Example of pattern codes development

(The categories (pattern codes) and some of their respective codes can be found in Table 4.10, while the full list of the codes can be found in Appendix E.)

Table 4.10 Pattern codes

No.	Categories (Pattern Codes)	Codes	Sub-Codes
1	The use of dashboards enables transparency and accountability of information	Performance monitoring	Enable staff performance self-monitoring Enable a reality check

		Indirect impacts	Indirect impacts on reputation in the long term, social impacts as reasons for existence
2	The use of information on the dashboard supports evidence based decision making	Decision making	The need for a real evidence to base their decision making on, unknown if decisions made purely based on dashboards
		Culture in decision making	Gut feelings, anecdotal evidence, past experience
3	An interdisciplinary communication skill in user-centred dashboard design	User-centred approach	Collaboration to fine tune user's requirements and to design a dashboard fits for its purpose Engage and collaborate with users to get their feedback and confidence
		Design team	Design team speaks the same "language" with users Needs to vary expectations depending on user roles and functions in the organisation
4	Early prototyping as a collaboration tool on the dashboard design process	Innovation & constraints	Constraints distilled design problems Constraints forced innovations Creating a better design with limited resources
		Efforts leading to innovation	Change the way users think about data Change user's perception about the value of information Diversity on a team to support innovations
5	Challenges in realising the desired dashboard design	Visions of the dashboard	One source of truth Self-service dashboards
		Challenges on the design process	Getting the buy-in from executive users The approach has not been done strategically Struggling to select suitable metrics
6		Balancing act	Tapping into past experiences and combine with new tools

	Co-evolution of problem and solution spaces on the dashboard design process	Problem and solution spaces	A back-and-forth communication to improve the design of the dashboard, envisioning the end results
7	Feasibility and viability become less of an issue	Technology	The use of design tools, resources, data/system integration
		Organisational issues	Getting executive buy-ins, endorsement to use the dashboard
8	Focusing on user needs supports a journey on the road to innovations	User expectations	To increase user's accountability, predictive analytics features, user-friendly
9	Key design principles support the process of designing a dashboard	Features & metrics	Analytics, drill-down, pyramid approach, leading indicators, metrics selection.
		Design principles	User-friendly, usefulness, 80-20 rule, consistency
10	Choosing the right metrics enables a delivery of the right information to the right people	Metric definitions	Meaning of indicators, using a well-known model to define KPIs
		Metric selection	Pyramid approach, user requirements
11	Data quality and integrity ensure the reliability of the dashboards	Data integration	Sourcing data from various systems/databases, standardisation process, data preparation
		Data quality	Relevance, currency, context/meaning of data, reliability, cleanliness
12	Dashboards help the organisation utilise years' worth of accumulated data	Aims	Use of historical data, making use of existing databases, unused accumulated data, future planning
13	Latest technologies provide advanced lead time in dashboards implementation	Technology	Use of design tools, resources, data/system integration
		Use	To encourage a fast start, ease of use
14	Groundwork activities in preparation of the design process	Data integration	Sourcing data from various systems/databases, data preparation.
		Process improvement	Standardisation process
15	Dashboards enable the use of integrated data to inform decision making	Culture in decision making	Gut feelings, anecdotal evidence, past experiences
		Features	Analytics, drill-down, predictive analysis, comparative analysis
16	Dashboards support and enable business process improvements	Process improvement	Standardisation process, Using the dashboard as part of the new process

		Dashboards as catalyst for change	Dashboards as enablers, use of dashboards embedded with the new process
17	Users and culture in the organisation play an important role in dashboard use	User role and background in the organisation	User roles, user backgrounds, user expectations, user culture
		Culture in decision making	Gut feelings, anecdotal evidence, past experiences
18	Issues impacting the design of the dashboard	Internal issues	Process changes, organisational Changes, other system changes
		External issues	Government changes, pressure from competitions
19	Dashboards as a platform to monitor progress towards organisation's strategic goals	Performance monitoring	Enable staff performance self-monitoring, enable department performance monitoring, health of the organisation

In the next section, the development of themes for this study is discussed.

4.4.3 Themes development

As described in the previous section, themes are developed as a result of the second cycle of coding. There are five themes identified and developed as a result of the data analysis. Table 4.11 lists these themes with some corresponding categories and codes. The full list can be found in Appendix E. These five themes will be used as a framework and a storyline to present each case study in Chapters 5 and 6, as well as cross-case analysis in Chapter 7. Each case study will be described as a narrative description accompanied with sample quotes from interview transcripts, as it is "customary in interpretative studies" (Sarker & Sarker 2009, p. 444).

A narrative description is chosen to present the case studies as Henfridsson (2014) advocated:

> A powerful story can inform and explain. A powerful story can guide, intervene, and come with policy implications. However, most importantly, it may inspire us to take action, whether it is within the realm of knowledge, the realm of practice, or at the intersection between the two. (p. 356)

Table 4.11 Themes developed from codes and categories

Themes	Categories (Shortened)	Codes
The notion of impact on dashboard design and use	Impacts on organisational performance	Performance monitoring
	Impacts on decision-making Activities	A real evidence to base decision making on
Designing a more user-centred dashboard design	Design thinking characteristics	Empathy & collaboration
		Innovation & constraints
		Balance between desirability, viability, and feasibility
Key aspects and principles in dashboard design	Dashboard design process	Visions of the dashboard
		Design team speaks the same "language" with users
	Organisational Issue	Culture
		Current processes
The aims of designing a dashboard for an organisation	Aims	Information awareness
	Visions	One source of truth
		Self-service dashboards
Ways to deal with challenges in realising a desired dashboard design	Challenges	Metrics selection
	Early prototyping	Learning by making
		Gather user feedback and expectations

Along with the narrative description, a diagram can be used to describe relationships between themes and/or categories in the form of networks where each might "interact and interplay in complex pathways" (Saldaña 2013, p. 252). In Appendix E.2.1, relationships between categories listed in Table 4.10 were drawn. Subsequently, in Appendix E.2.2, the process of developing themes from the categories were depicted. Figure 4.10 displays the relationships between the five themes in this study, listed in Table 4.11. The arrows between themes by no means suggest causal relationships. They simply represent relationships between themes in which one might be a

precursor of others. These arrows eventually help with the narrative or write-up of case studies in subsequent chapters.

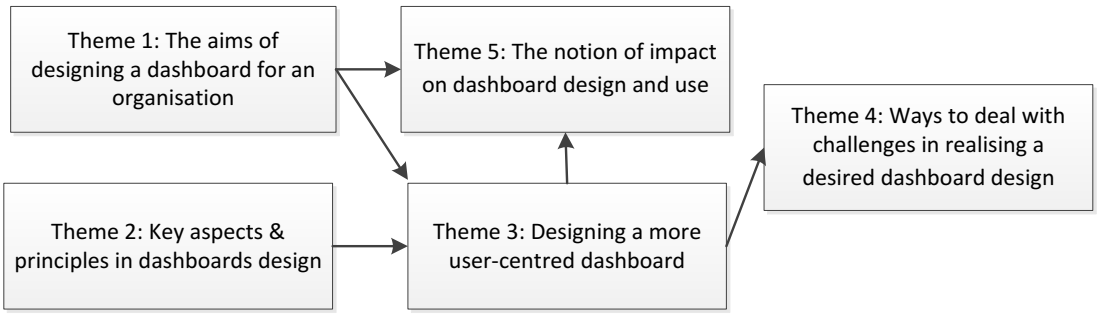


Figure 4.10 Relationships between themes

Theme 1 is the broadest and relates well with all three research questions. Themes 2 and 3 are related to RQ 3, while themes 3 and 4 relate well to RQ 2. The last theme essentially relates to RQ 1 which looks at the impact of the dashboard design process on existing organisational processes or systems.

Next, the analysis between multiple case studies is discussed.

4.5 Cross-case analysis

In multiple case study, the cases need to be comparable so cross-case analysis can be conducted (Stake 2013). There are two main reasons to undertake cross-case analysis according to Miles, Huberman and Saldaña (2014). The first one is to increase the transferability of the findings to other contexts of research. This ensures the study is not "wholly idiosyncratic" (Miles, Huberman & Saldaña 2014, p. 101). The second reason is to increase understanding of insights by examining similarities and differences between multiple cases (Miles, Huberman & Saldaña 2014). Harding (2013) suggested each case could be summarised from which comparisons could be made by listing similarities and differences.

Miles, Huberman and Saldaña (2014) categorised cross-case analysis into two approaches, namely case and variable oriented. The former approach "considers the case as a whole entity" (Miles, Huberman & Saldaña 2014, p. 102). This is similar to the case-comparison approach discussed by Yin (1981) in which an analysis needs to be completed for each case before continuing with cross-case analysis. Fundamentally, it looks for "underlying similarities and constant associations" (Miles, Huberman & Saldaña 2014, p. 102) and replicates analysis from one case to the next while keeping it flexible to discover new themes (Yin 1981). The

juxtaposition between multiple cases enables researchers to gain a deeper understanding which could result in finding new categories or themes (Eisenhardt 1989).

The second approach is variable-oriented, which essentially is "conceptual and theory centred" from the very beginning (Miles, Huberman & Saldaña 2014, p. 102). This approach is comparable with the case survey approach introduced by Yin (1981), and although it is not always so, generally this approach uses a large number of cases. Basically, the approach has pre-defined variables in the form of themes, categories or dimensions in the data across all cases (Eisenhardt 1989). Since its focus is more on variables and their interrelationships, a comparison between cases can be kept to minimum (Miles, Huberman & Saldaña 2014).

Two case studies have been completed for this study in UniOne and CareOne. This study used the first approach to perform cross-case analysis. In general, cross-case analysis helps researchers in avoiding impulsive and possibly inaccurate conclusions by "counteracting these tendencies by looking at the data in many divergent ways" (Eisenhardt 1989, p. 538). Furthermore, it also increases the chances of capturing fresh and novel findings which might exist in the data (Bourgeois III & Eisenhardt 1988). Regardless of the strategy selected for conducting cross-case analysis, researchers must be prepared to present a "chain of evidence" to describe connections from the data collection, single case analysis and cross-case analysis, to findings and conclusions (Yin 1981, p. 63).

Table 4.12 describes the themes, respective categories, and their applicability in each case. In presenting insights from each case analysis in Chapters 5 and 6, each theme is broken down to closely related categories in order to organise and present the narrative description in a more coherent manner.

Table 4.12 Themes and categories applicable in UniOne and CareOne

Themes	Categories	UniOne	CareOne
The notion of impact on dashboard design and use	Use of dashboards enables performance monitoring and increases accountability in the organisation	√	√
	Use of information on the dashboard supports evidence based decision making in the organisation	√	√
	Issues impacting the design of the dashboard	√	√
Designing a more user-centred dashboard design	An interdisciplinary communication skill in a user-centred dashboards design	√	X

	Focusing on user needs supports a journey on the road to innovation	√	√
	Feasibility and viability become less of an issue	√	√
	Latest technologies provide advanced lead time in dashboard implementation	√	X
	Co-evolution of problem and solution spaces on the dashboard design process	√	√ [New]
	Groundwork activities in preparation of the design process	X	√ [New]
Key aspects and principles in dashboard design	Choosing the right metrics enables a delivery of the right information to the right people	√	√
	Key design principles support the process of designing a dashboard	√	√
	Users and culture in the organisation play an important role in dashboard use	√	√
	Data quality and integrity ensure the reliability of dashboards	√	√
Aims of designing a dashboard for an organisation	Dashboards help the organisation utilise a years' worth of accumulated data	√	X
	Dashboards enable the use of integrated data to inform decision making	√	√
	Dashboards as a platform to monitor progress towards organisation's strategic goals	√	√
	Dashboards support and enable business process improvements	X	√ [New]
Ways to deal with challenges in realising a desired dashboard design	Challenges in realising the desired dashboard design	√	√
	Early prototyping as a collaboration tool on the dashboard design process	√	√

Cross-case analysis will be discussed in more detail in Chapter 7.

4.6 Summary

This chapter has discussed research paradigms in general and the philosophical assumption for this study. The subscription to interpretive research and the selection of case study research as the research method were explained and justified. The issue of quality in qualitative research was

outlined and ways to address the quality issue were proposed. In Chapter 9, this will be discussed and justified further.

Furthermore, the design of the case study research was discussed. Data were collected through semi-structured interviews and analysed using qualitative content analysis. The first and second cycles of the coding process were described followed by the delineation of the development of themes for this study. The chapter concluded with a discussion about the cross-case analysis approach.

The next chapter outlines analyses of three case studies performed for this study. Chapters 5 and 6 present case studies conducted for UniOne and CareOne respectively.

Chapter 5: UniOne

5.1 Introduction

In this chapter, emerging insights from the first case study are discussed. In total, two case studies were completed in UniOne (discussed in this chapter) and CareOne (refer to Chapter 6). These particular chapters use the following structure. First, the background information on the organisation, relevant business processes and general organisational structure of the departments are provided. Second, further information on research participants, particularly their roles and responsibilities are described. Lastly, themes which have emerged as a result of the data analysis are discussed.

5.2 Background information

UniOne is an Australian university established more than twenty years ago. It employs more than 2,500 staff and has more than 30,000 students enrolled across its campuses in an Australian capital city and overseas. The university delivers high quality teaching and research by combining in-class study with industry engagement. In the long term, it has aspired to be one of the most prominent leading universities in innovation, learning and technology in Australia.[2]

At the time of interviews (early 2014), the university was undergoing a structural change as a result of a financial and performance review. It was also coincidentally in line with the recent Australian Government funding regulation changes (Universities Australia 2014). Previously, the structure of the organisation was separated into faculties whereby each would have its own administrative office and professional staff to support daily operations in designing and delivering courses and programs for students. Subsequently, the university changed the structure by reducing the number of faculties and incorporated the administrative office and professional staff into a centralised structure. By doing so, they hoped to create a much more efficient way of running the business and to be in line with the university's long-term strategic plans.

With all the changes that have taken place and recent funding cuts by the Australian Government (Universities Australia 2014), the competition for available government funding is increased. Consequently, it has forced UniOne to reassess its budget and funding allocation, and to be more accountable in terms of how it allocates funds across different areas over a period of time. Hence, UniOne has chosen to increase the use of information by referring to reports and using dashboards

[2] This information is intentionally not referenced to avoid identification of the University.

in the organisation to support decision making and business processes. The use of information management tools, such as dashboards and key performance indicators (KPIs), has proven helpful to policymakers and other stakeholders in the university environment (Wisan 2002). At the moment, the finance department has its planning and performance team responsible for providing information for all users throughout the organisation. In addition, some users at UniOne might have their own source of information from the legacy systems used in their own departments.

For this study, interviews were performed with the planning and performance team responsible for designing dashboards, hereafter referred to as the 'design team'. It is worth noting that this team does not exclusively perform dedicated tasks in designing dashboards. In fact, this design team is a cross-functional team, in which each person has their own main job responsibility. Designing the dashboard is merely a part of their work portfolio. Interviews were also conducted with the Chief Financial Officer (CFO) as the main user, and two other users from the Education and Quality department.

The design team works with users in the university at different levels (executive, managerial, and operational) to provide necessary information in various reporting formats or via dashboards. Prior to that, the team needed to consolidate data from various sources throughout the university as well as from external sources. The data would then be prepared, cleaned and transformed before the team could use the data to create reports and design dashboards for users.

Prior to the interviews, the design team has been using Tableau for more than two years. Tableau software is tool to design a dashboard to enable data visualisation and to help people in organisations understand data (Tableau Software 2015). It is the leader in the market according to the annual Gartner report on BI and analytics in terms of ease of use, accessibility, and simplicity in integration with organisation's current systems (Sallam et al. 2015). Figure 5.1 shows an example of dashboards created using Tableau for higher education institutions.

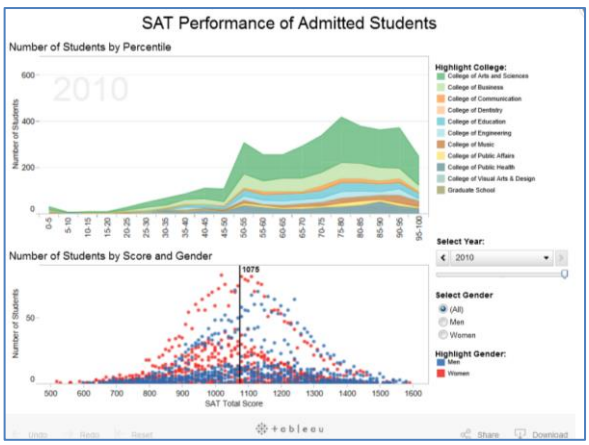


Figure 5.1 Example of tableau dashboards for higher education institutions (Tableau 2015)

In the past, the design team served users with statistical data analysis and delivered the results though Excel files. With Tableau, it allowed them to provide their users with more capabilities than Excel in terms of data presentation and visualisation. It is worth noting that this team has the expertise in numerical and statistical analysis. Although they were not specifically trained in IT/IS or design fields, they were able to utilise the Tableau application to deliver useful information for users.

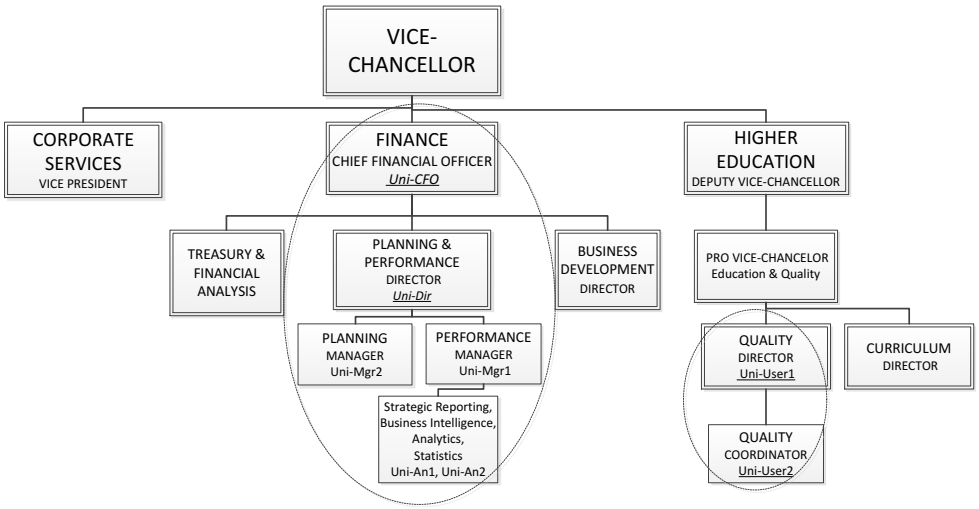


Figure 5.2 Structure of the design team under UniOne's finance department

In Figure 5.2, a simplified organisational structure of UniOne covering both finance and higher education departments is delineated. Two oval-shaped circles overlaid on the figure indicate areas of interest where interviews have been conducted. Further information about each research participant is discussed in the following section.

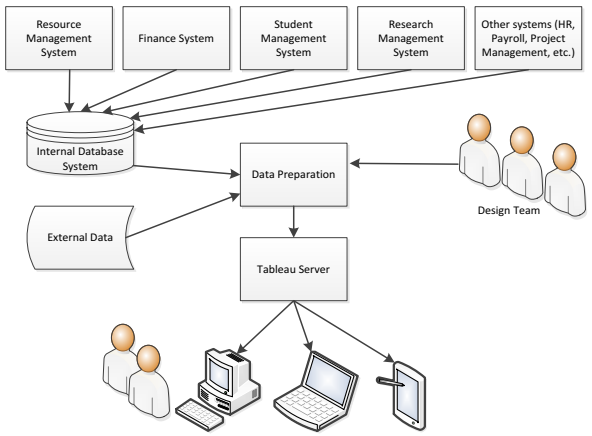


Figure 5.3 Implementation diagram of UniOne's dashboard

Figure 5.3 delineates a simple implementation diagram of UniOne's dashboard. This diagram illustrates how various data sources, internal and external of the organisation, were gathered and prepared before being used by the Tableau server to design the dashboard.

5.3 Information on research participants

As mentioned in Chapter 4 (section 4.3.3), data for this study was gathered through semi-structured interviews with key personnel involved in the process of designing a dashboard for the organisation. Table 5.1 summarises relevant information on each participant and their job roles in relation to the dashboard design process. As a starting point, the interviews were conducted with the head of the team and the Chief Financial Officer (CFO) to gain insights at a higher level of abstraction on the dashboard design process, the notion of design thinking, as well as changes or impacts in the organisation in relation to dashboards.

Subsequently, the interviews were conducted with managers and analysts in the team to obtain a more detailed understanding of the design process, and if there were any impacts of the dashboard design process on existing business processes. Lastly, two users were interviewed to capture their experiences of using the dashboard in their respective roles, or as part of their daily responsibilities in the organisation.

Table 5.1 Summary of interview participants in UniOne

Participant	**Job title**	**Role description**
Uni-Dir	Director	The head of the planning and performance team. The main responsibilities of the team are to manage data from internal and external resources and to support users from different levels in the university in making sure that they get the information they need.
Uni-Mgr1	Manager, Performance Team	Uni-Mgr1 has been working in the university for more than twenty years. Although the current job title is as a manager, Uni-Mgr1 performs various roles as an analyst, a designer as well as a team lead. Uni-Mgr1's department is responsible for several tasks, such as reports preparation and development, statistical and trend analysis, metrics and dashboard design and delivery, data cleansing and integration, and many more.
Uni-Mgr2	Manager, Planning Team	Uni-Mgr2 is a manager of the finance planning department. Uni-Mgr2 involves in setting strategies and measures in the university, and makes sure that those strategies and measures were aligned with the university's strategic plan. Uni-Mgr2 also works with the reporting team, Uni-Mgr1 and the team, in developing metrics and measures, making sure that data were collected from appropriate and valid sources, and aligning those metrics with the university's *strategic intent*. To Uni-Mgr2, dashboards were *central* to Uni-Mgr2's work.

		Uni-Mgr2 is not only part of a dashboard design team, but also a dashboard user.
Uni-An1	Analyst	Uni-An1 is one of Uni-Mgr1's team members. Uni-An1's role mainly has been as a reports/dashboards analyst. Prior to publishing reports or dashboards, Uni-An1 has to collect the necessary data from different sources in the university and perform *data cleaning and manipulation*. Once the preparation is done, Uni-An1 used Tableau to design and develop the dashboards for the users.
Uni-An2	Analyst	Uni-An2 is also one of Uni-Mgr1's team members. Uni-An2's role is similar to Uni-An1. Both of them handled different types of data and information.
Uni-CFO	Chief Financial Officer (CFO)	Uni-CFO does not only function as the head of the finance department but Uni-CFO is also a dashboard user. Uni-CFO actively utilised information on the current systems in UniOne to support decision making activities in daily basis.
Uni-User1	User	Uni-User1 is a quality director in the education and quality department. Uni-User1's main responsibility is to monitor course and unit performances and to create improvement plans for under-performing areas. To achieve that, Uni-User1 uses the dashboard to get the necessary information. Uni-User1 also works with the faculties responsible to deliver the courses and units to students to make sure a good performance is achieved and student satisfaction rates remain at a healthy level.
Uni-User2	User	Uni-User2 works in the same team as Uni-User1 as a quality coordinator in the education and quality department. Uni-User2 assists Uni-User1 and helps users in the faculties in using the dashboard to get necessary information to monitor the performance of courses and units. Uni-User2 also uses the dashboard to support the daily job in identifying areas of improvement. Apart from that, Uni-User2 becomes a liaison between the users in the faculties with the design team to help with the design process.

A second interview with Uni-Mgr1 was conducted more than a year after the initial interview to obtain further insights on how the dashboard design project evolved. Figure 5.4 illustrates the interview timeline with participants in UniOne. The decision to conduct the second interview with Uni-Mgr1 was mainly due to the fact that this manager was in charge of UniOne's dashboard design and implementation. In addition, staff turnover had occurred among the design team, and hence some were not available for the second interview. Interviews with the two users were also conducted twelve months after interviewing the design team, to allow sufficient time for them to use the dashboards.

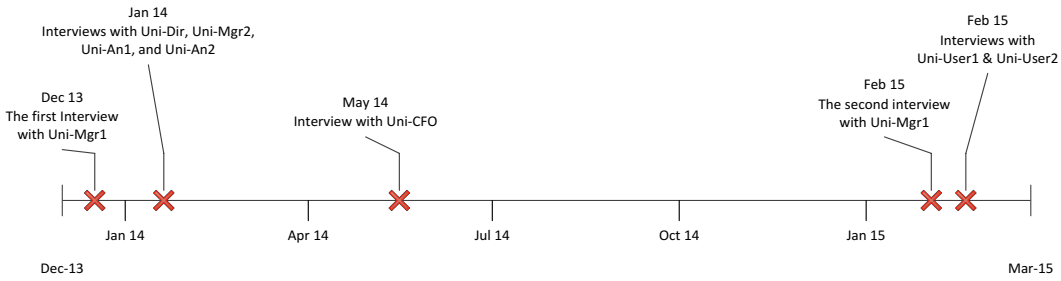


Figure 5.4 Interview timeline with research participants in UniOne

5.4 Themes emerging from the research

As explained in Chapter 4, five themes were identified and developed as a result of the second cycle of coding, in which data based on "categories or themes, causes or explanations, relationships among people, and theoretical constructs" was summarised (Miles, Huberman & Saldaña 2014, p. 87). Theme 1 is the broadest and relates well with all three research questions. Theme 2 and 3 are related to the third research question, while theme 3 and 4 relate well to the second research question. The last theme is essentially related to the first research question of this study which looks at the impact of the dashboard design process on the existing organisational processes or systems. Based on the interviews, it is gathered that the notion of impacts can happen *both* ways. Firstly, the current organisational processes, systems, and/or cultures might influence the dashboard design. Hence various issues impacting the design of the dashboard will be discussed. And on the other hand, the use of the dashboard would have impact current organisational processes, systems, and/or culture. In the following subsections, these five themes will be explored in more detail.

5.4.1 Theme 1: The aims of designing a dashboard for an organisation

In this theme, the aims of designing and developing dashboards are outlined from the point of view of the design team as well as the CFO as one of their executive users. Based on the interviews, the design team viewed the dashboards as a platform to monitor the 'health' of the organisation. This refers to how the organisation has performed, monitored through the organisation's key performance indicators (KPI). This is also applicable to the performance of departments, units, and courses. Hence, they see aligning the dashboard design with the organisational long-term strategic plan as important.

As briefly mentioned in background information (section 5.2), UniOne's long-term strategic plan is one of the most prominent universities in innovation, learning and technology in Australia. This high level plan is operationalised into department-specific or faculty-specific strategic goals.

These would then be monitored using appropriate key performance indicators, including but not limited to student satisfaction rates, the overall university ranking internationally, research outcomes, and financial performance. Combined, these would contribute to UniOne's organisational performance that can be checked against the strategic plan as their performance target.

The design team also suggested that data had accumulated over the years in UniOne from the use of existing legacy systems and obtained from external sources. Therefore they would like to integrate these various internal and external databases and use the dashboard as a one-stop platform to utilise the data and to display useful information. The dashboard can also be used to establish information trends and enable users to access and utilise such information to support decision making. In the long term, the design team envisions the users will be able to analyse the information on the dashboard on their own. Users' views will also be discussed accordingly.

5.4.1.1 Dashboards as a platform to monitor progress towards organisation's strategic goals

One of the purpose of dashboards is to enable executive users to monitor the "health and wealth" of the organisation and drive "a culture of transparency and accountability" as they compare their progress against the institution's organisational goals (Dover 2004, p. 44). The same applies to UniOne according to Uni-CFO. As a CFO, Uni-CFO is a very avid user of UniOne's current financial system and directly involved in the effort of designing dashboards for UniOne. Uni-CFO maintained that by looking at information, presented in charts, diagrams, or any kind of visualisation technique, Uni-CFO would be able to gain insights into the overall health of the organisation. Additionally, Uni-CFO would also be able to get an indication of particular issues that require attention.

> *I monitor the health of [UniOne], the financial health of [UniOne], by looking at this information. [Uni-CFO]*

The design team's ultimate goal of providing information via the dashboard is for users to have self-service access and support data-driven decision making. The term 'data-driven decision making' refers to a conscious effort that is entrenched in organisational culture to analyse and make choices based on various data sources (O'Neal 2012). Although data can support decision making, it does not warrant an effective decision-making process, as it would be heavily dependent on how the data is being used to help improve the situation (Marsh, Pane & Hamilton 2006). This highlights the importance of the issue of use, to be discussed later in Theme 5.

Subsequently, the design team expected that users could perform their own analysis, queries, and later enable them to make decisions based on that information. Essentially, they wanted the dashboard to eventually become their '*one source of truth'* as stated by Uni-Mgr1 and Uni-An1 where user would go to every time they needed information.

> *... if they're produced centrally or in an isolated area that might duplicate information that might have repercussions, because you need one source of truth when it comes to information delivery. [Uni-Mgr1]*

However, Uni-User1 added that in order to achieve self-service ability, users need to be provided with extensive training, assistance during the incubation period, and help tools for future reference. Nah, Zuckweiler and Lau (2003) highlighted that providing training and support as part of the change management process is crucial, as the use of the system to support decision making might impact other business processes in the organisation, or how the system might change current business processes. This was also mentioned by Nah, Lau and Kuang (2001, p. 4) to help with hiccups in the system and "temporary inefficiencies" during the transition period from the new system going live until users can comfortably use it.

As opposed to giving the users ad hoc reports to be prepared as requested individually, designing a dashboard for the organisation enables different users in the organisation to look at the same consistent information. This corroborates with Dover (2004), who indicated that dashboards enable organisations to pool data and/or information from different sources and put them together to have a wider or more holistic view of the performance of the organisations than looking through separate reports.

> *... the main thing to be clear on is where you wanna get to, ... but if we could come up with this new [initiative], what's really driving the business and get the majority of people focusing on the same things with the assistance of dashboards, as an organisation. So it's nice to be able to do the ad hoc reporting that is individually requested, but to me the big value comes when we've got a consistent set of views across the organisation. [Uni-CFO]*

Uni-CFO also concurred that it is important to understand organisational business goals and drivers. One of Uni-Mgr2's responsibilities is to transform organisational strategic business goals and drivers into each department's goals, so it would make more sense to the users. By having enough clarity on those essentials, it could subsequently help the design team design a dashboard that focuses more on appropriate measures. This was also reinforced by Uni-Mgr2 who suggested

the team think through the most important performance metrics or measures in UniOne based on their strategic vision of the organisation.

> *My preference would be that it wasn't just an informed opinion and intuitive as it is, that we actually sat down and we think this is the most important. And this is why this is aligned with university strategic in this way, and we think we also need to keep an eye on this thing due to key indicators for future performance in this areas. [Uni-Mgr2]*

Thus, Uni-Mgr2 maintained that when designing a dashboard, it is important that the purpose is in line with UniOne's strategic goals and objectives. That way, it is easier to reach out to different levels of user in the organisation as everyone could relate to their day-to-day tasks.

> *And a very convenient way to do that is through a hierarchy of dashboards. So that at a very high level, you'll have a high level dashboard that might be aligned to the major strategic plans of the organisation, but you've got to be able to drill all the way down to a much lower level of data for people that need more detail. [Uni-Dir]*

The dashboard itself could then be designed to present information with a level of detail corresponding to the needs of users according to their roles. Users at the executive level should expect to see the information summarised with an ability to drill-down to get more detailed information, while managers and users at the operational level should be able to see the information in much more detail. To operationalise this idea might not be a straightforward task according to Uni-User1. Uni-User1 argued that when it comes to metrics selection, stakeholders in UniOne have varied requirements and expectations. Therefore, it is important that the design team understand user requirements and business processes from the users' perspective. That way, they can translate into dashboard design accordingly.

5.4.1.2 Dashboards help organisations utilise years' worth of accumulated data

Over the years, UniOne has accumulated data from various sources inside and outside the organisation. Internally, they have their existing finance management system, student management system, payroll system, as well as other legacy systems (i.e. research management, resource management, etc.) used by different areas and departments within the organisation. The design team also obtained some external data (e.g. data obtained from the Victorian Tertiary Admissions Centre on students' course preferences) they normally used for benchmarking and competitive analysis, not to mention data generated from UniOne's social media. Yet, the design

team concurred they had not made the most of the data. Therefore, they wanted to use dashboards as a one-stop platform to utilise the data, to establish information trends, and to be able to support decision making.

Uni-Dir also mentioned that some sort of data warehousing might be necessary to maintain the data in raw form. Due to the variability of data sources, it is inevitable the data would have different formats and standards. Therefore, the design team needs to prepare the data to ensure it is consistent and ready to be used for dashboards. This will be discussed further in Theme 2.

> *So the challenge is to take the mountains of data that we have, [and] basically put it into some form of storage or some sort of warehouse in a disaggregated form as possible and use that warehouse or draw from that warehouse using business intelligence software and otherwise to provide the information that people need. And a very convenient way to do that is through a hierarchy of dashboards. [Uni-Dir]*

Apart from that, Uni-Mgr1 emphasised that the design team should utilise data collected over the years to optimal capacity. Uni-Mgr1 maintained that the data could be transformed into useful information to inform users on the current state or performance of the organisation. As a result, having access to the information presented on the dashboard could potentially help users in decision making.

> *Because there's a lot of data that's sitting idle that we're not tapping into, or can make really good use of in helping the university manage resources. Like we said, data is a resource that isn't used towards its optimum. ... Because as humans, we've got the technology, we [have] got heaps of data. But just as humans we're not doing a complete job of tying it all back together properly. ... Because the current state of affairs is, if we don't pass enough information to make decisions on and then make the appropriate changes, things will change in a rapid way and you'll fall behind in the industry. [Uni-Mgr1]*

Moreover, with the new and latest technologies available on the market, Uni-Mgr1 believed it would be easier for UniOne to design and develop the dashboard. In this information age, Uni-Mgr1 considered information awareness as a competitive advantage for UniOne to strive towards a rapidly changing industry.

5.4.1.3 Interpretations and analyses

Dashboard Purposes

Based on Uni-Mgr1's account, it appears that one of the many reasons for designing a dashboard for users are the many ad hoc requests from various departments. The users requested Uni-Mgr1 and the team to provide them with reports containing diverse of information for all sorts of reasons. This has prompted an initiative to manage user requests better by providing a single platform where users can access information when required. In addition, Uni-Mgr1 has to prepare external reports for government bodies on organisational performance and other matters relating to public education funding. Furthermore, with recent Australian government funding regulation changes in early 2014 in which certain subsidies were significantly reduced (Universities Australia 2014), this forces UniOne to reassess their budget allocation and to be more accountable in how the money is spent across different areas. Therefore, it is fair to say that this situation has added more pressure for UniOne to provide reliable information reporting and access for all users.

In the higher education field, dashboards began appearing in the late 1990s in response to the demand for accountability and the view that universities were a financial burden(Mitchell & Ryder 2013). This is supported by Eckerson (2011) who argued that dashboard projects normally require a strong and pressing need to succeed, for instance, restructuring of the organisation. In this case, decision makers expect the dashboard to explain rationale and to monitor the efficacy of decisions made (Eckerson 2011). Not only that, UniOne is also extending and sharing the access of information to all users through the use of the dashboard. The dashboard acts as a platform to provide information, so users can monitor their performance or the performance of their department against targets set for them. These measures and targets have been defined based on organisational strategic goals, as explained by Uni-Mgr2. Overall, this will ensure the design of the dashboard is aligned with organisational strategic goals.

Dashboard Composition

Furthermore, it seems thin UniOne has adopted a textbook approach in dashboard design. It is what the design team called '*a hierarchy of dashboards'* in which the dashboard would have an aggregated form of information for executive users and a more detailed form for users in management and at the operational level. This concept is tied to types of dashboard as discussed in the literature (Eckerson 2011; Ruuskanen 2012). The rationale is that because the design team want users at different levels to access the same information throughout the organisation. This notion resonates with Clark, Abela and Ambler (2006), who indicate a dashboard enables an organisation to have the same view of its performance metrics and underlying drivers. Regardless of user roles in the organisation, dashboard users move towards the same goals (Clark, Abela &

Ambler 2006). Based on this premise as well as the accounts from research participants in UniOne, we learn the significance of aligning the design of the dashboard with core business goals and processes. Not only does this help identify the important metrics to be used, but all users in the organisation access the same information about organisational performance.

However, it would be an arguably difficult task to make this idea a reality given the number and variety of users and departments in UniOne. One department (e.g. research department) would have very disparate performance measures compared to others (e.g. human resources, finance, or accounting departments). As mentioned by Uni-Mgr1, there are more than fifty metrics available on their Tableau dashboard to be used by various different users. To ensure all users have that same view of information on organisational performance, the design team needs to make sure that each metric is aligned with UniOne's strategic plans.

To achieve strategic alignment, it is important for the design team to understand core business processes from the users' point of view as raised by Uni-User1. Through these business processes, users work daily to achieve their performance targets. According to Uni-Mgr2, one of Uni-Mgr2's responsibilities is to ensure that users are measuring their performance against appropriate targets aligned with the organisation's strategic plans and goals. These strategic plans and goals act as the big picture that users need to be aware when setting their targets and defining their performance measures. At this point, Uni-Mgr2 has been working on an organisation-wide Business Intelligence (BI) strategy to be implemented along with the dashboard design process. With that, the design team and the users can collaboratively define and select proper performance metrics to be used on the dashboard.

Single Source of Truth

Essentially, Uni-Mgr1 and Uni-An1 stated that the dashboard would be the '*one source of truth'* for all users in UniOne who seek out information. It means that "everyone is looking at the same thing", which is the information displayed on the dashboard (Pankaj, Hyde & Rodger 2006, p. 1427). The idea is not dissimilar to the term 'single source of truth' from the data warehousing literature (Baltzan, Lynch & Blakey 2013; Bose 2006; Lawyer & Chowdhury 2004). The term represents the data warehouse as an organisation-wide data repository, hence it results in more consistent information across the organisation (Baltzan, Lynch & Blakey 2013; Bose 2006; Lawyer & Chowdhury 2004). The term is also used in Service-Oriented Architecture (SOA) literature where it signifies the importance of a single data repository to reduce redundancy and

inaccuracy (Pang & Szafron 2014; Phelps & Busby 2007). For UniOne's design team to have such ideas it is evident they follow a textbook approach, or best practice in dashboard design.

Furthermore, UniOne's ultimate goal of providing information via the dashboard is for users to access self-service. Subsequently, they expect that users will be able to perform their own analysis, queries, and later make decisions based on that information. Dashboards as a visualisation tool "provide self-service capabilities to end users" (Wang, Wang & Alexander 2015, p. 33) without the need to involve IT support in retrieving the data from the database (Dover 2004). It is worth noting that this is the ideal situation thin UniOne expected to have. In practice, how it would be operationalised and whether it is a realistic expectation is another issue altogether.

The Ideal Dashboard Design

According to Eckerson (2011) there are three levels of dashboard users: executive, management, and operational levels. In UniOne, an example of an operational use would be a metric on the dashboard that shows the performance of a course at the end of semester. In this case, the users might be course coordinators or course designers. It is a pretty straightforward task to use the dashboard to get the information needed to make informed decisions with regards to course performance accordingly.

Meanwhile, an example of management level metrics is student engagement and the attrition rate used by a head of department. Undoubtedly, there would be many factors contributing to such a metric which need to be discussed between the users and the design team. A drill-down feature on the dashboard should help users at management level to see detailed information and perform further analyses should they need to, and a corrective action can be planned accordingly. An example of the attrition rate was mentioned by Uni-Mgr1. The student attrition rate is normally higher for students in their first year at university. The management level user could investigate and find the specific group of students with lower VCE (Victorian Certificate of Education) scores in mathematics that might have caused a spike in the attrition rate. A maths tutor group would then be established to help first year students, which in turn would see an expectation to address the low attrition rate.

For executive level users, the kind of information they are interested in must be highly aggregated, as generally users at this level are responsible for making strategic decision for the organisation. An example of executive metrics would be graduate employment outcomes to be used by Faculty Deans. As mentioned by Uni-Dir, the Deans would not only be interested at looking at what the faculty has delivered, but they would also look at graduate employment outcomes as one of their

performance metrics. This particular metric includes a comparison with the outcome of other faculties in UniOne and other universities in Australia.

Ideally, executive level users should be proficient like Uni-CFO in accessing high level information that can support their decision making activities. Uni-CFO monitors the overall financial health of UniOne on a daily basis based on the information on the dashboard and UniOne's financial system. When encountering issues, Uni-CFO would drill down further and look at other related metrics in order to understand the issues. Because Uni-CFO is very familiar with how the information was collated, Uni-CFO feels confident in making decisions based on such information.

However, it might not be the case for all executive level users as admitted by Uni-CFO. According to Uni-User2, some would delegate the task of extracting information from the dashboard to their executive assistants. This has not been discussed by members of the design team during interviews. It seems that the practicality of the idea of having a self-service dashboard might be debatable from the users' perspective. The design team would need to accommodate this new insight where some executive users would not use the dashboard directly but rather with the help of their assistants. Further discussions on different types of users will be covered in Theme 2.

Self-Service Feature

Currently, the self-service idea has not worked well according to Uni-User1, due to lack of training, assistance during the incubation period, and help tools for future references. As a result, Uni-User2 has stepped in and provided training and assistance for users at the faculty level to increase the use of the dashboard. Uni-User1 emphasised that training is not merely on how to use Tableau, but instead it is supposed to educate users in understanding and interpreting the information on the dashboard.

Undoubtedly, if the design team could accommodate different types of users and provide sufficient assistance, UniOne could certainly achieve their ultimate goal of providing self-service access to information through the delivery of the dashboard. The dashboard would serve a purpose as it utilises data that has been collected over the years to help support decision making and business processes. Given the size of the organisation, it is arguably going to be a big task for the design team to reach out to all users to promote the use of the dashboard.

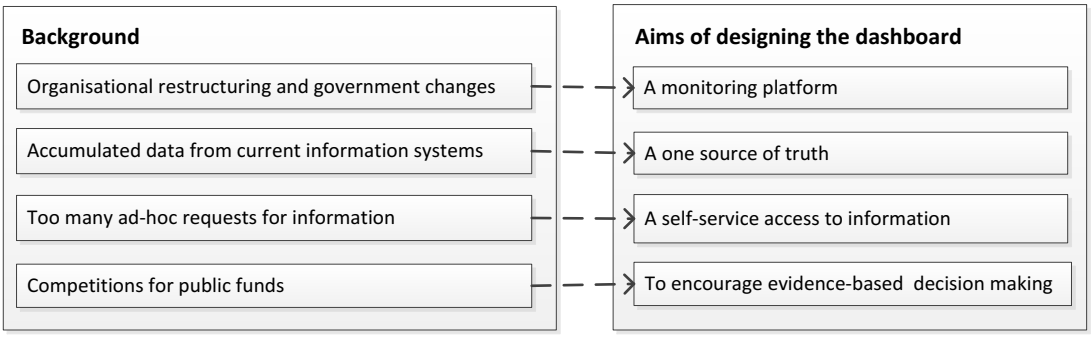


Figure 5.5 Takeaways from Theme 1

Figure 5.5 summarises key points as takeaways from the first theme. In theme 2 which follows, key aspects and principles in designing the dashboard are explored. Largely, it encompasses the preparation of data, choosing the most important metrics to be displayed, as well as other aspects related to users and the organisation.

5.4.2 Theme 2: Key aspects and principles in dashboard design

While responses from participants tend to indicate that dashboards have been valuable, it can also lead to information overload for users.

> *Yes, I think the dashboard has definitely made life easier. But there's a lot of information there and you can go absolutely crazy trying to find stuff. [Uni-User2]*

Therefore, it is clearly evident that the design team needs to ensure that dashboard design does not overwhelm users. In this theme, key aspects and principles in dashboard design are discussed. These relate closely to the dashboard components mentioned in Table 2.4 in Chapter 2. The following discussion will go beyond the graphical user interface (GUI) aspect of design. Nonetheless, this should not undermine the importance of the GUI. In fact, Uni-User2 pointed out that the user interface acts as the first entry for users to access all the important information presented through metrics.

5.4.2.1 Data quality and integrity ensure reliability

Despite the users' eagerness to access more dashboards and particularly more reports via dashboards, accessing reliable and clean data has been a struggle according to Uni-Mgr1. The design team needed to ensure that data from various sources in the organisation were pooled, integrated, and standardised before they linked them to the dashboards as illustrated earlier in Figure 5.3. Uni-An1 argued that the design team needs to work with data owners to ensure they are accountable. So in the end, dashboards display consistent, accurate, and reliable information.

In some ways we all have to work together to make sure all [this] report is relevant and showing the right information. ... So we have to put a lot of effort [in]to clean[ing] up and gather[ing] all the trend comparisons. So that's quite time consuming, and users might not recognise that the fact that much work [goes on] behind the scene[s] on that. [Uni-An1]

Most importantly, Uni-Mgr1 stressed that among other considerations, the quality of the dashboards also depends on the currency and integrity of the data. Data currency refers to the temporal property of the data which ideally should be as up-to-date as possible (Fan, Geerts & Wijsen 2011) while data integrity relates to the accuracy and consistency of the data across different databases (Baltzan, Lynch & Blakey 2013). The key is to strike a balance between those two data attributes when delivering information via the dashboard. Up-to-date data can be meaningless if the data is incorrect and inconsistent, and likewise a correct set of data would not be as useful if obsolete. A good balance and combination of currency and integrity of the data would not lead to a misleading set of information.

So we've got a bit of the right balance between the data quality and completeness that we wanna put in our reports. ... timely information is critical, it's a priority. But you still gotta balance out that with quality data, you can't put in data that's not complete and it misinforms areas. So, we've gotta strike that right balance in delivering some of our reports. [Uni-Mgr1]

In relation to this comment by Uni-Mgr1, another vital aspect in delivering dashboards to the user is the database technology and infrastructure in the organisation. Although Uni-Dir stated that the organisation provides the financial support for the dashboard design process, Uni-An1 and Uni-An2 consider that database technology and infrastructure in UniOne are still lacking to a certain extent. The design team had to source data from disparate and decentralised databases as well as legacy systems. In some cases, this task must be done manually. By having a robust infrastructure such as a data warehouse system, both of the analysts in UniOne concurred it would help in delivering dashboards to the users.

Having said that, Uni-Mgr1 stated UniOne used a logical data warehouse rather than a physical one due to implementation costs and resources in the design team.

There's a bit of manual work involved but you can't design an old physical type of warehouse: it's too expensive, it's unmanageable, and as soon as you finish the project, it's out of date. [Uni-Mgr1]

All the efforts put in place to make sure the data is current and complete should be coupled with considerations about the validity and reliability of the data. Uni-User1 explained it by giving an an example of measuring a student satisfaction rate based on survey results. The data could well be up-to-date and complete, but the validity and the reliability of the data would be dependent on the survey response rate. If the response rate was low, then the metric to measure the student satisfaction rate might potentially display misleading information.

> *We can have the best data in the world but unless it's valid or reliable then it's just noise. [Uni-User1]*

Having a good understanding of the context and meaning of the data is also an important aspect in designing the dashboard according to some research participants. Uni-User1, in particular, thinks that it is a fundamental issue on the dashboard design process. As UniOne has a vast amount of datasets, it is also important to make sure that the information required by users is fulfilled by feeding accurate data into the dashboard.

Furthermore, Uni-User1 argued that it is insufficient to merely have a design team that are familiar and knowledgeable about the data. The design team needs to make an effort to educate the users. In UniOne's case, Uni-User1 and Uni-User2 helped the design team with that responsibility. At the end of the day, the users need to understand how to interpret and make sense of the information on the dashboard in order to support them in making decisions.

5.4.2.2 Choosing the right metrics

Apart from data preparation, the literature suggests other important aspects in dashboard design, as discussed earlier in Chapter 2, such as features and metrics. In terms of features, the research participants agreed that the dashboard must have a drill-down feature. As discussed in subsection 5.4.1.1, UniOne aimed for the dashboard to reach out to different levels of users in the organisation so everyone could relate to their day-to-day tasks. With the drill-down feature, they can show different granularities or different levels of data and detail for users at different levels (executive, managerial, and operational levels). Furthermore, Uni-Dir mentioned that the drill-down feature would help find a root cause when users were investigating a phenomenon, which in turn would assist them in making a remedial action or to rule out a false alarm. As a result, the drill-down feature enabled users to get more clarity from the information presented on the dashboard.

So if your employment rates are down, or student satisfaction rates are down, they'll try to drill down further into the data and try to work out just what it is. Why students are unhappy with the subject or, and then develop the improvement plans. [Uni-Dir]

Another important aspect is the metrics to be displayed on the dashboard. Uni-Dir emphasised the need for standardising the meaning, scope, and data source for all metrics. This is in line with what has been advised by Eckerson (2011) as one of the keys to success in dashboard design.

... whatever measure you're talking about you need to have a glossary that defines that measure and the scope of the measure very clearly, and the source of data for that measure must be clear, because there are a million variances of all the measures we have. [Uni-Dir]

Meanwhile, deciding and choosing the most crucial metrics to be used has proven to be difficult and argued by Uni-Dir as there are varied kinds of users at UniOne. Hence arriving at a consensus on selecting key metrics to be used on the dashboard would not be an easy task according to Uni-CFO.

...but the real challenge is deciding what information is the most important and going to be the most useful and for whom. [Uni-Dir]

Essentially, the design team needed to identify the business drivers in order to be able to evaluate the efficiency of various areas in the organisation. When it comes to identifying the most important metrics, Uni-Mgr1 argued that the design team needs to understand the purposes of the metrics as well as relevancy for users. For that reason, Uni-Mgr2 added that dashboard design needs to be aligned with the strategic intent of the organisation. This is supported by Matthews (2011) who suggested that the process of identifying performance metrics should be carefully planned and be linked to the organisation's visions, strategic goals, and objectives.

In a way, strategic intent informs the indicators that measure performance of certain areas in the organisation. Indeed, the process of choosing the metrics should involve users so they can confirm and agree on design decisions. However, Uni-User1 argued that most users might not have an understanding of how to select the metrics to monitor performance in the organisation. Uni-User1 maintained that a fundamental understanding of the underlying data would inform users regarding metric selections.

So management was really interested in what they call the success rate which is essentially the number of units ... the number of students passing units. Whereas if you're looking to improve the units, it actually doesn't tell you anything, because

students can drop out for a number of reasons; they can drop out because they didn't like the unit so they can drop out before the census date, before they have to pay for it, or they can drop out after the census date and they may not even have attempted [the unit]. [Uni-User1]

Furthermore, when choosing metrics for users, Uni-Mgr2 argued that it is better to provide the most relevant metrics in relation to what users were doing on a daily basis. If the users could relate to the information displayed in terms of metrics with the work they do, they would be inclined to see that the dashboard is useful for them.

... if we're providing a lot of data that people are looking at and.., well that's interesting, that's great, but it's not useful. It's not really the key objective of the dashboards from my perspective. [Uni-Mgr2]

Uni-User1 suggested asking the 'why do you need it?' question to ensure the usefulness of the metrics. That also serves to confirm that the metrics would not be created for a short-term project or to test 'hunches' [Uni-User1]. The aim of metrics should be for performance monitoring of departments, areas, and the organisation as a whole.

Uni-CFO suggested the use of leading indicators in metrics to help users perform a predictive analysis of the business. Uni-CFO however emphasised that to understand the notion of leading indicators, they need to understand the business processes very well. Especially in UniOne's case, where they have a vast number of datasets, it can be argued that it is important that the design team collaborates with the users to identify those leading indicators. With the predictive analysis feature, it adds value to the dashboard as the information potentially informs where the business is heading, or at least for users to make action plans based on leadindicators.

... the toughest stuff to get is your lead indicators. ... it's not a prophecy, it's not absolutely 100%. But it's a pointer of how things are going, so that's the sort of stuff we want to be able to do. [Uni-CFO]

At the moment there are more than sixty KPIs identified for the dashboard according to Uni-Mgr1. Most of the KPIs were at operational and management levels, but they would be summarised and presented as executive level KPIs. The design team were working to fulfil and present those KPIs as metrics on the dashboard. Uni-Mgr1 stated that some KPIs would be dependent on others. Thus, these metrics would have to become a set of metrics so that users can make sense of the information properly. They cannot make inferences based on a particular metric alone without considering the related ones.

... for instance, publication per income, number of publications, how much income or how much is spent per publication and then see if that has been tracking okay for the research area. So these sort of measures can be traced as a trend over a period of time. So, people might like a statement saying that "oh yeah, publication and citation decreased over the years", but the number of academics and staff have decreased as well. [Uni-Mgr1]

Good quality data supported by strong database infrastructure serves as a solid foundation of dashboard design. Carefully selected metrics coupled with drill-down and predictive analysis features could warrant the usefulness of the dashboard. They are all closely related and every aspect would work together to enable the design team to deliver the right information to the right people, when they need it. When the dashboard is readily available on mobile devices, it could especially enable users to perform a quick check on key metrics that matter for them instantly.

5.4.2.3 Users and culture in the organisation

According to Uni-Mgr1, the design team has been currently actively encouraging, giving advices, and promoting the use of various sorts of reports, predictive models, and dashboards. Uni-Mgr1 argued that users were not going to get a maximum amount of information or see the value of the dashboard unless the culture in the organisation changes. Uni-An2 also pointed out the need to change organisational culture amongst users at UniOne such that they would not work in an isolated way or in silos. The current situation according to Uni-An2 is that some users in various areas or departments produce their own reports. Dashboards can definitely enable cross-departmental integration in performance reporting (Pauwels et al. 2009).

And also sometimes they probably weren't aware there's some other useful data that's actually hiding somewhere. This changes the attitude of people and makes them aware that at the end of the day it would benefit all of us. [Uni-An2]

Uni-An1 also concurred that some of the users might not be aware of the extent of data the design team could access. By designing the dashboard for users, Uni-An2 hoped they could view information from a wider perspective, as the design team has access to various data sources across UniOne and beyond. With that, not only do users have the capability to view information from a much more comprehensive scope, but they are able to perform a comparative analysis from the dataset outside the organisation.

However, there is a fundamental issue with users before they are willing to use the dashboard, according to Uni-User2. They need to be given a considerable amount of learning time along with

proper training by the design team. This has been discussed earlier in Theme 1 where proper training supports UniOne's ultimate goals to provide a self-service dashboard. Some users would have a reservation before using the dashboard, thinking this might be difficult and would take too much of their time to learn. Uni-User2 stated that the current design of the dashboard has led to confusion and impatience for users. Hence, the user interface of the dashboard needs to be enticing and acts as the first entry for users to access important information. As first impressions matter, the design team needs to make sure users do not get too overwhelmed.

At times it might simply be a fear of new technologies that prevents the use of dashboards.

> *... there are a lot of people who are afraid of technology and won't go there. Even though they probably know it's their job to do that. So they'll get their assistant to do the work for them and pull out the information. [Uni-User2]*

Some users who were not *technologically-savvy* may show resistance, according to Uni-User2. But Uni-User2 argued that users need to make an effort to at least learn about the dashboard. Once they are willing to login and use the dashboard for the first time, they become aware of the range of information available to them. Every so often, Uni-User2 found that users were *eager to use it* and be *appreciative* of the dashboard.

Meanwhile, Uni-Dir pointed out another issue with regards to the culture of decision making with a cohort of users at UniOne. Uni-Dir suggested some users, particularly those at senior level, liked to make decisions based on gut feelings. This was also supported by Uni-Mgr2 who stated that the notion of using information presented as a report or displayed on a dashboard is still fairly new to some senior staff at UniOne. According to Uni-Mgr2, they preferred to make decisions based on what has worked in the past.

> *But getting people within the university at a very senior level to pay attention to the data ... it's not as much a part of the organisational culture as I'd like it to be. So a lot of what occurs in a place still I think is more gut feeling and based on a lot of things and not enough looking at the hard numbers [statistics] about something. [Uni-Dir]*

Uni-Dir thought this had something to do with an ageing workforce. While the younger users looked for information in a database, the older ones preferred to call and ask for information. With every new system, Gallagher, Mason and Vandenbosch (2004) argued that users would use related business processes and their current legacy system as a point of reference. Thus UniOne's users would inevitably compare what the dashboard could provide them with and what they were used

to doing in order to access information or reports. Nonetheless, Uni-Dir has witnessed a genuine effort from the organisation to encourage evidence based decision making for all users by providing the dashboard. This resonates with what Uni-User1 discussed, whereby the culture in UniOne seemed to change with users expecting the right information to support their decision making.

One way to increase user awareness regarding the UniOne dashboard project was their approach in showing them what the dashboard could do. Not just in terms of functionality, but they wanted users to be aware of the extent and meaning of information they could access. As a result, some users have shown their appreciation towards the whole effort, according to Uni-Mgr2. More importantly, as Uni-User1 pointed out, the intention is such that users understand the meaning of information and later take further action based on that meaning.

> *That said though, people in key positions do come back to us with feedback, going "that was really interesting to see that piece of information". ... The people that are in a senior management [role] all understand and appreciate. ... But just providing that simple piece of information in a format that people can interpret, senior management have been going "yeah right. ... I can see that. We need to do something with that." [Uni-Mgr2]*

Furthermore, Uni-CFO believed the design team needs to prepare a strategy to sell the notion of dashboard use before they expect any cultural change in the organisation. As they try to figure out that strategy, day-to-day business and operations have to run as usual. As a result, they must serve their users by providing information requested on an ad hoc basis. But Uni-CFO added that if they could provide easy access to the dashboard for all users, it would definitely boost dashboard use in future.

> *... we haven't been able to get absolute clarity on this, we haven't done a lot of training. So what that means is we are still in the situation where we are responding to a lot of requests for data that people could find out for themselves, but we do not want to start a big training effort until we clarify our position on key messages ..., we've got to sell a concept at the same time, together with the system. ... And we are getting closer to that. ... By, if it's accessible on things like this [referring to an iPad and opening a Tableau app on his iPad] there is less and less excuse for people to tick the box. [Uni-CFO]*

Twelve months after initial interviews with the design team, there has been an increased awareness about the extent of information available on the dashboard, according to Uni-Mgr1.

Uni-Mgr1 also reported that users have started showing interest in the dashboard design process by providing feedback to improve current design and by requesting new metrics requirements to be included on the dashboard.

5.4.2.4 Key design principles support the design process

Referring to Figure 5.6 and in particular Design Principles, in relation to the design thinking dashboard development strategy model (discussed in Chapter 3), Cross (2011) suggests that utilising design principles helped designers to bridge the gap between the problem frame and the solution concept. Some of these principles are gathered based on what the research participants thought to be essential when designing the dashboard at UniOne.

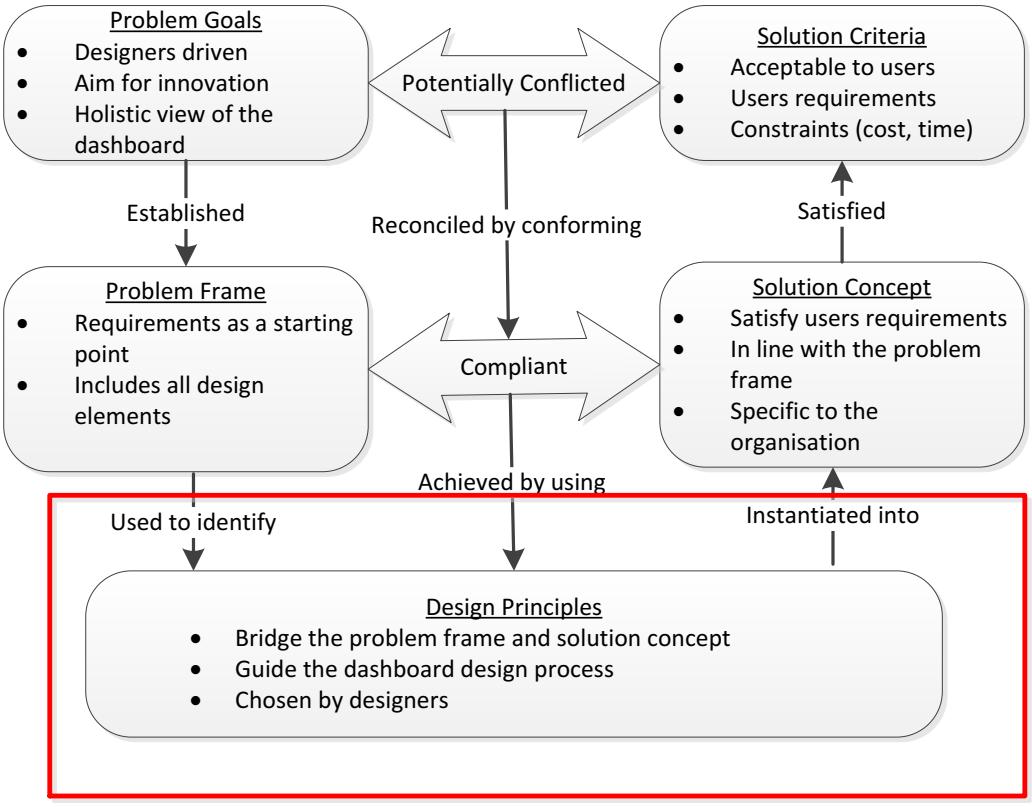


Figure 5.6 Design thinking dashboard development strategy model adapted from Cross (2011)

According to Uni-Mgr2, whenever there was feedback or a request on what metrics should be put on the dashboard, Uni-Mgr2 associated this with requests from other users. The idea is to combine similar requests and explore the possibility of reusing existing metrics. Uni-User2 also agreed. Not only is it an effective process of designing a dashboard based on user need, it would also be more efficient in terms of efforts and resources with more effective dashboard reach.

> *I think my rule of thumb has always been what we have said . Do we really have this in a slightly different form somewhere else, is there a way that we can make that*

dashboard better to suit more needs for more users, or do we not want to conflate the dashboard issue and confuse what's being presented and keep it separate? [Uni-Mgr2]

Meanwhile, most research participants emphasised the need to keep it simple when it comes to dashboard design. Although Uni-CFO admitted it is a difficult task to compress a lot of information into a single page on the dashboard. That has been a real challenge for the design team in UniOne, given the extensive sets of metrics they owned. Nevertheless, they should not attempt to present too many metrics which might confuse dashboard users. Therefore, choosing the right metrics, as discussed earlier in section 5.4.2.2, is a crucial task for the design team, working with users.

... to keep everything simple 'cos sometimes you can clutter the dashboard. People want to see a lot of stuff; but at the same time when you have too much different information going in one dashboard, the user can get easily lost in all of that information ..., if we try to put everything in one dashboard that would be cluttered and doesn't tell us anything. [Uni-An2]

Having too many metrics on the dashboard could lead to *analysis paralysis* as mentioned by Uni-User1 and can be overwhelming. As a result, users may not be able to make sense of or use the information accordingly. Uni-User1suggested the design team should adopt the 80-20 rule as a guide to determine the metrics to select. This rule, one of a vast number of universal design principles, states that 80% of impacts come from 20% of sources (Lidwell, Holden & Butler 2003). Ideally, most information needed by users would be sourced by about 20% of the metrics on the dashboard. Although Uni-User1 concurred that this was not yet the case at UniOne.

So you can actually collect too much information, you really don't know what's important. ... so my question would be "of all the metrics we've got, what are the 20% that provide the 80% of information. I would argue we're probably doing it the other way round, we've got 80% of the metrics supplying 20% information. [Uni-User1]

That said, the presentation of information should not be overly simplistic. Particularly for Uni-CFO, a visual representation of information needs to be accompanied by some sort of explanation or context. Otherwise, it is possible that people might interpret the information differently. To complement the work that the design team has done, Uni-User1 and Uni-User2 acted as intermediaries between other users and the design team. They felt they could contribute to the design team by demonstrating understanding about how and what data were being accessed by

users. That way, they hope to achieve a better presentation of information on the dashboard in a way that users understand. Uni-User1 added that users would need some help and assistance to use the dashboard and make sense of the information being presented.

> *So if you put graphs in Tableau, there's this sort of meta-knowledge required on how to read graphs and that sort of thing. So you can't just put it out there without training. And again I would argue that… unless you go out there and explain the definition and run training on how to do it, then people don't use it. [Uni-User1]*

Apart from that, all the information presented has to be meaningful. For instance, when displaying a number in a metric, there also has to be comparative information, such as comparison against the budgeted/targeted number or the same metric in previous years. This sort of presentation would be more valuable for users, according to Uni-CFO.

> *But to think that in a complex organisation you can really get it down to either green or yellow or red, NAH! It doesn't work for me. … to try and have a single thing that shows the overall health of the organisation, I don't buy into that. So I need to see some data trends; I need to see it compared against the budget, for it to benefit me. [Uni-CFO]*

Moreover, consistency is crucial in designing each and every component of the dashboard. That includes being consistent in how information is being presented as well as designing the user interface. Uni-Dir highlighted that we need to make sure users feel at ease navigating in and around the dashboard. Uni-Dir also mentioned that consistency needs to persist in the definition and scope of metrics. Uni-User2 added that the user interface can be greatly improved, as some users have expressed a feeling of being overwhelmed about how metrics or information are currently presented. Lastly, Uni-An2 stressed that every single component existing on the dashboard needs to serve a purpose, otherwise it would be pointless to have one.

In relation to consistency in metrics scope and definition, Uni-User1 advised it should not be seen as a one-size-fits-all approach. Uni-User1 argued for a fundamental understanding of the data needed in order to make sense of the metrics, especially those with a threshold or flag indicating areas requiring attention. Uni-User1 used a metric of student satisfaction rate as an example.

> *The problem is that different cohorts of students mark differently when they rate [sic]. Engineering students are notoriously hard markers when it comes to student's satisfaction level, so they always mark harder. So what that means, if we put an absolute threshold in place, then all engineering courses would be flagged as requiring action, which is actually not the case. [Uni-User1]*

Therefore, consistency must be balanced with flexibility for users to be able to adjust certain metric thresholds on the dashboard, as needed. Failure to do so may cause an unnecessary flagging and/or course of action.

5.4.2.5 Interpretations and analyses

In Chapter 2 (refer to section 2.2.3) components of a dashboard based on the literature were outlined including the data, technologies, users, organisations, features, and metrics. Those dashboard components need to be well understood, as it is arguably critical to the creation of a dashboard regarding design decisions.

Based on the interviews with the design team and users at UniOne, key aspects in dashboard design can be summarised into three main categories, namely technologies, contents, and users as described in Figure 5.7. In terms of technologies, UniOne is mainly using Tableau to design and develop the dashboard. The discourse on contents comprises data, metrics, drill-down feature, and analytics capability of the dashboard. The last category discusses users and organisational matters. They are interrelated and put together to contribute to a better dashboard design. Key aspects support UniOne's goal of having a dashboard in the first place.

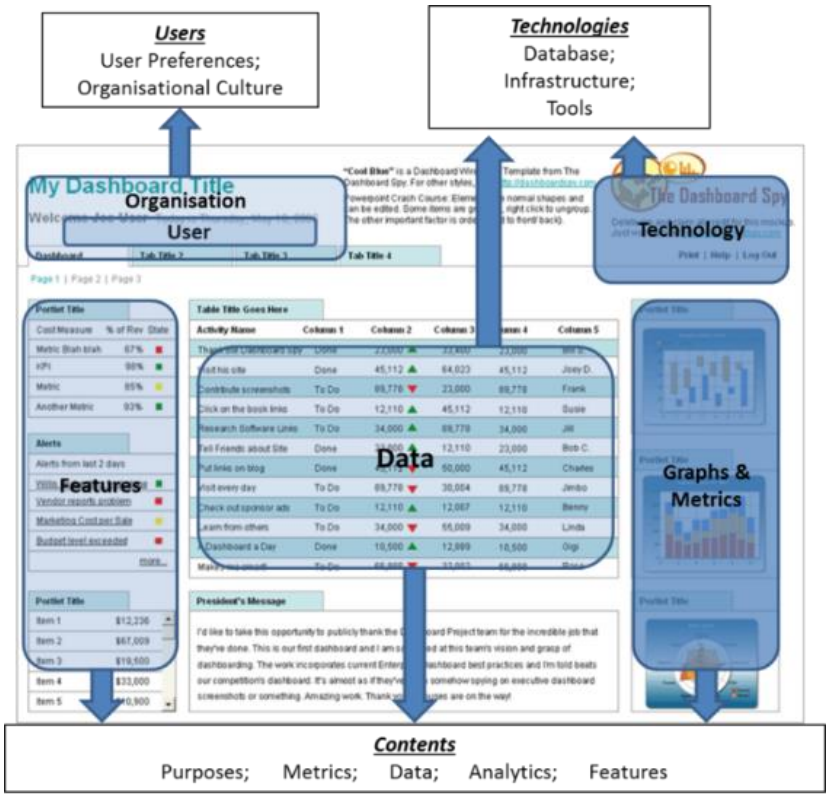


Figure 5.7 Key aspects of dashboard design in UniOne

Data and technologies

In UniOne's case, the emphasis has been on data preparation and not so much on features or technologies. As seen in Figure 5.3, UniOne does not have a complicated implementation model. The most significant part of the system configuration would be the server which stored data from various systems or databases throughout the organisation. The design team concurred that this process of gathering and preparing data before it can be used by Tableau is critical. It would indeed serve as a solid foundation of the dashboard design process and to support their aim of designing the dashboard for users in UniOne.

Typical Business Intelligence (BI) implementation architecture has a data warehouse as an intermediary server between data sources and front-end applications including dashboards (Chaudhuri, Dayal & Narasayya 2011). In contrast, UniOne does not have a physical data warehouse. Their main reasons were due to costs involved, time taken and resources needed to build a data storage warehouse.

Moreover, the design team is not exclusively dedicated to the dashboard project, because they have other work. UniOne is not like a financial institution, as argued by Uni-Mgr1, where they may need to access critical information ona daily basis to function well. Failure to do so can incur financial repercussions. Meanwhile, as a university, UniOne's core business is to deliver the highest quality education to the students. Performance is definitely measured regularly, yet not on a daily basis. Hence the priority would be on accuracy rather than timelines. Given these circumstances, the design team's decision to use a logical data warehouse seemed to have worked well for them.

Metrics

By definition, a dashboard contains "a relatively small collection of interconnected key performance metrics and underlying performance drivers that reflect both short- and long-term interests to be viewed in common throughout" the organisation (Pauwels et al. 2009, p. 177). Metrics in most businesses emphasise predominantly financial measures, while in the higher education field metrics can be easily quantified and usually relates to funding, student retention, graduation, and accreditation (Mitchell & Ryder 2013). Some other metric examples in the higher education field would be student engagement, allocation of student activities fees, course or training participations, and alumni donation rates (Matthews 2011). In UniOne, so far more than sixty important KPIs have been identified. They would then design appropriate metrics in Tableau for those KPIs accordingly. One of the challenges they have is for users to reach consensus regarding which metrics are appropriate for the dashboard.

Currently, they seemed to have a lot of dashboards available for different areas in UniOne. The design team has also observed an increase in user awareness of what the dashboard can provide in terms of information. At the same time, they have received more requests from users to design a dashboard for them. Uni-User1's suggestion to ask the 'why' questions would be helpful in narrowing user needs. This is supported by Verganti (2009), who argued that in order to innovate through design, we need to ask why users need it. Also, Uni-User1 argued that by doing so, it would ensure the usefulness of metrics. This is supported by Pankaj, Hyde and Rodger (2006, p. 1426) who argued that the "design of metrics" is crucial if dashboards are to be "perceived as useful".

It is a fairly reasonable starting point for the design team in UniOne to identify all the important KPIs for the organisation, before further refinement on metrics selection. They would need to work on selecting which KPIs to go for a specific dashboard for a specific group of users. It is a work in progress for them as acknowledged by research participants. In the end, a well-designed dashboard should not depend on the number of metrics provided, but whether or not it provides a complete picture of performance assessment of the organisation (Mitchell & Ryder 2013).

Analytics

UniOne wanted the dashboard to be useful for users in the long term: to grant users self-service access to information and empower them to perform their own analysis. The notion of 'self-service' is not new. It has been mentioned by Eckerson (2005) in articles sponsored by Business Object and Micro Strategy respectively. It refers to the idea that users can create a report by selecting metrics, configuring the output, and navigating around the tools themselves (Eckerson 2009).

These practitioner style articles were written based on the implementation of Business Intelligence circa 1990. They discussed the notion that self-service was not successful back then due to various reasons, one of them being the dependency on the IT department (Eckerson 2005). The analytics capability of the system had to be programmed by them in those days. Changes to business rules that built the analytics would have to go through the IT department. Arguably, it compromised the robustness of the system to support more dynamic business processes and decision making.

In UniOne's case, Uni-Mgr1 discussed the self-service notion not being limited to creating a report and navigating around the tool. Instead, it includes the ability for users to use Tableau to perform analysis, forecasting, what-if scenarios, and in finding the root cause of problems. Essentially, the dashboard should enable interaction with its users and needs to be actionable,

should the information suggest something out of the ordinary. To achieve that, it would depend on how user-friendly Tableau is, and on the willingness of users to learn and be independent in performing their own analysis. This is aligned with Eckerson (2009) where he suggested a dynamic interface to support interactions between users and the system plus an alert to notify users when a set threshold of metrics is reached.

From the interview with the design team, it seems that Tableau is easy to use from their point of view. While Uni-CFO seemed to be very confident in using this tool in terms of finding the right information to help analyse a problem, Uni-CFO thought the dashboard should be mobile-friendly so that users could get immediate feedback regarding their needs. Furthermore, Uni-User1 argued that users need intensive training to build confidence to perform their own analysis. This is supported by Pankaj, Hyde and Rodger (2006), who argue that user training ensures effective use of the dashboard. Although it is still at a fairly early stage, Uni-User2 believes they are on the right track in providing self-service access to information and to enable users to perform their own analysis.

Users and organisations

Undoubtedly some users would have reservations about using the dashboard, thinking it might be difficult and would take too much time to learn, as reported by Uni-User2. Despite the training and support for users, they need to make an effort and take the time to learn the dashboard. Getting buy-ins from users at the executive and management level would definitely help, as this would encourage increased use of the dashboard according to Uni-Mgr1. Additionally, the design team would focus on increasing awareness to new users on what the dashboard is able to provide and how it could benefit them.

Earlier in Chapter 2 section 2.2.1, dashboard users were characterised into executives, analysts, and workers based on their roles, information and decision-making characteristics, and the appropriate functionality of the dashboard (Anthony 1965; Eckerson 2006; Valacich & Schneider 2010). In UniOne, users like Uni-User1 and Uni-User2 can be categorised as “analysts” while Uni-CFO can be characterised as an “executive”. Overall, this categorisation reflects more on the level of detail or granularity of information displayed on the dashboard. In UniOne however, it is apparent they considered different kinds of user categorisation to address during the design process.

Table 5.2 presents a two-by-two matrix to summarise the type of dashboard users in UniOne. Firstly, it can be categorised based on the capability of users. Expert users are highly capable of using the dashboard in terms of extracting and understanding the information. While assisted

users need some degree of assistance to extract information, nonetheless they would still be able to make sense of the information.

Table 5.2 Types of dashboard users in UniOne

		Use capability	
		Assisted	Expert
Decision-Making Capacity	Interim users	Very rare, but executive and management assistants might be in this category. They prepare and extract information from the dashboard to be used by the bosses. To some degree, they may need help in navigating around the dashboard.	Just like Uni-User1 and Uni-User2, users under this category are very skilful in using the dashboard to get necessary information to support their work. But mainly they use information to be presented or published in another form for end users.
	End users	Users under this category get someone else to extract information from the dashboard for them. They use the information to support their decision making.	Uni-CFO is one of the users under this category. Technically users are very skilful in using the dashboard. At the same time they actively use the information to support their decision making.

Secondly, the type of user can also be categorised by user's decision-making capacity. End users, for example, use information on the dashboard to support decision making and business processes. Interim users may or may not make decisions based on information on the dashboard but would mainly provide the information to end users. They use the dashboard to extract information and do their work such as publish information into UniOne's internal wiki site or other places for all users. In some cases, they could possibly be adept in making sense of the data, trend analysis, and in helping end users understand the information.

Ideally, the dashboard should be designed to facilitate all users in the organisation. By understanding these different types of user, the design team should have a different approach or strategy to work with them to design a more useful dashboard. The design team also pointed out that the user culture in the organisation needs to be considered. Uni-Mgr1 argued that users were not going to get value from the dashboard unless their culture of decision making inside the organisation changes.

Organisational culture can be viewed as "an encompassing web of routines and patterns" (Oss & Hek 2011, p. 27), which explains why it is not an easy task for some users to acquire new habits in using a dashboard. Some people in UniOne, especially the more senior staff, had been able to make decisions that were not based on evidence, as reported by Uni-Mgr2. Uni-Dir concurred

that ageing workers contributed to this issue although Uni-Dir also thought that people in UniOne have started to use information to back their decisions.

The issue of user culture in the organisation is indeed a complex one. There are multiple facets contributing to the issue both from the users' and the design team's point of view. Based on design team accounts in UniOne, the top-down approach in the design process with executives and management buy-ins would come in handy to convince users and encourage more dashboard use.

To explain the relationship between design and use, Kelly and Matthews (2014) discuss the problems facing users and the relationship between problems and why users need the designed artifact. Because users need to make a significant effort to use the artifact, they may somehow view this as a problem instead of a solution. It is an important issue that the design team needs to consider so that users can see the benefits of the artifact, as it would impact long-term use (Kelly & Matthews 2014).

In UniOne's case, it needs strong empathy from the design team to understand how business processes work and why users need the dashboard to support their decision making. In the end, it would arguably help them design a more useful and beneficial dashboard. According to Kelly and Matthews (2014, p. 355), "vital contributions have come to design via an emphasis on use". Therefore, the design team needs to be aware of such issues and prepare a strategy to deal with it.

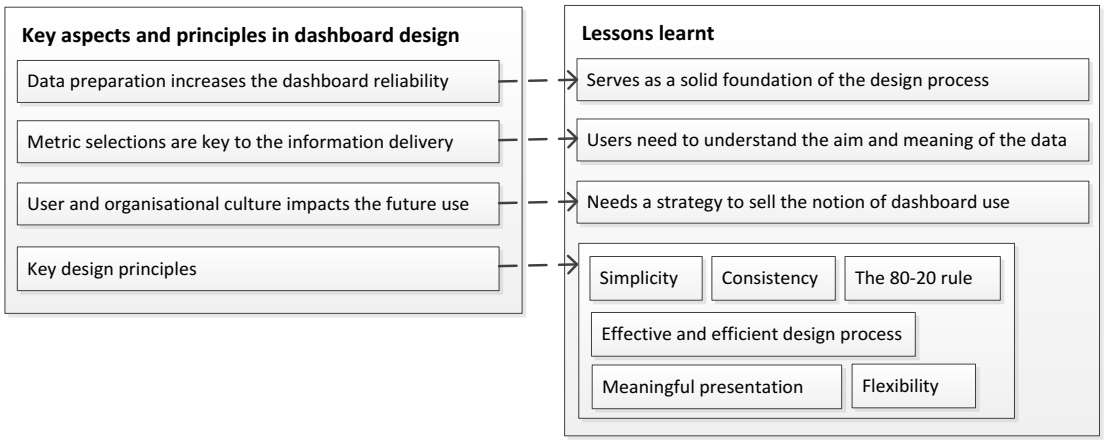


Figure 5.8 Takeaways from Theme 2

Figure 5.8 summarises key points as takeaways from the second theme. In the next theme, aspects taken up by UniOne to design a more user-centred dashboard will be discussed.

5.4.3 Theme 3: Designing a more user-centred dashboard

UniOne has been using the Tableau application to design and develop charts, diagrams, and metrics as components of their dashboards. Prior to that, they used Statistical Analysis Software (SAS) and Excel to generate charts or metrics to build reports for users. Nonetheless, they still require SAS along with Tableau to perform statistical analytics as part of their data preparation before being used on the dashboard.

Regarding this particular theme, advantages of Tableau, according to research participants in relation to how it has helped them with their work in providing valuable information for users will be discussed. As a result, it can be argued that with ease of creating dashboards, the design team can focus on user interests by proactively creating dashboard prototypes and by involving users to give feedback. This resonates with some design thinking characteristics discussed in Chapter 3 (refer to section 3.2).

In Chapter 3, it was discussed that design thinking strives innovation (Boland et al. 2007; Brown 2008). By definition, innovation signifies organisational efforts to improve the possibility of success of its businesses (business.gov.au 2014). For UniOne, they have quite a modest definition when it comes to innovation:

> *Saying it's something new, but if there's a kind of scale issue, even if it's a tiny incremental improvement, we probably wouldn't think of it as terribly innovative. But if it's some new way of presenting things, or some major new data domain or a really new type of report that people found to be very useful, you know, probably that can be called innovation. [Uni-Dir]*

Nonetheless, UniOne has arguably played their part in creating innovation. Literature suggests achieving innovation through the balance of technical feasibility, economic viability, and user desirability (Brown 2009; Wölbling et al. 2012). With feasibility and viability aspects becoming less of an issue, the design team in UniOne could dedicate more time to innovation with their dashboard design through collaboration with users. Their ultimate goal would be designing a self-service dashboard which supports users to make decisions based on the information presented, without the need to involve IT support in retrieving data from the database (Dover 2004).

5.4.3.1 Latest technologies provide advanced lead time in dashboard implementation

Earlier in Chapter 3, the notion of design thinking was discussed. Essentially, it is a holistic design approach that aims for innovation (Boland et al. 2007; Brown 2008), and using designer's

sensibility to satisfy what users desire based on technology feasibility while keeping the organisation viable (Brown 2008). In this sub-subsection, infrastructural and technological aspects when designing dashboards are discussed. From a design thinking perspective, an organisation is able to focus their resources on the desirability aspect when the feasibility and viability aspects have been resolved.

In UniOne, infrastructure and technology seemed to be less of a concern when the decision was made to use Tableau as the dashboard design and development tool. According to Uni-An1, the implementation was easily done with the help of the IT team in deploying or upgrading the server.

> *... with Tableau, that's the beauty of it. It's actually minimum fuss I'd say. ... we set up the server to hook on to it and it can take in multiple sources. ... It's all done very easily. It doesn't require a lot of setup or a lot of infrastructure to support it. [Uni-An1]*

Uni-User1 maintained that initially Tableau users might face difficulties navigating around the system. This signifies the importance of a transition period following dashboard implementation. Users would need intensive training and assistance to increase their confidence in navigating around and using the dashboard.

> *Well the reality check is ... Tableau isn't that intuitive. ... I know it's one of the better BI tools, but it's not that intuitive. Unless you've got a feel for that, you're not really sure of what you're doing. You click on a column, filter your data, but how you're meant to know that [sic]? Whereas a good program would give you a bit of a feel of what you're doing. [Uni-User1]*

Nonetheless, from the overall design process perspective, Tableau seemed to give the design team the edge to make implementation more straightforward. As a result, they needed less lead time in order for users to start using the dashboard. The lead time refers to the period between the dashboards project initiation and implementation.

Although the feasibility aspect of the whole dashboard design process has become less of an issue to UniOne, Uni-CFO pointed out that they should not take it for granted. They can easily spend more time on trying out new technologies or tools to improve the dashboard design process. In other words, they might compromise the whole project if they take more time than needed. As a result, it defeats the point that was discussed earlier about lead time. Hence, we need to be aware of such issues to balance the ease of implementation with the time taken to try and test dashboard design tools and technologies.

Quite often with this project, in the past, you get distracted for 12 months trying to select your tools, get the infrastructure setup, blah blah blah. Now you can effectively say "I'll try this one", run round the plan, get some dataset to go on, and away you go. But that's also a little bit dangerous 'cos you can waste time ... [Uni-CFO]

In addition, from a viability perspective, Uni-Dir mentioned they were supported by the organisation. Uni-Dir stated that Tableau licenses they procured were reasonably priced. Since they were supported by the organisation in terms of budget and resources, the feasibility and viability aspects of the dashboard design project were not considered as problematic. So, the design team can focus on designing the dashboard that displayed the most significant metrics aligned with the organisation's visions and goals.

5.4.3.2 A journey on the road to innovation

Infrastructural and technological aspects aside, the real hard work in dashboard design, according to Uni-Mgr2, was to figure out what users needed. Especially in presenting information on the dashboard, Uni-User2 stated that the design team should base it on how the users like to see it displayed.

So there is definitely a collaboration required to design a workbook. They can't go off ... and design something that has no input from somebody who wants the information for a particular purpose. [Uni-User2]

It could be challenging at times but Uni-Mgr2 suggested a way to explore user needs is through good communication and collaboration. It would not be helpful to think that users have no idea about what they actually need. Instead, the design team should figure it out by examining the purpose of information users are after. It is important to learn what users have in mind as "the key knowledge in design thinking is not the expertise of specialists but the knowledge of stakeholders that is supposed to be learned anew for every design process" (Lindberg et al. 2012, p. 231). Furthermore, Uni-User1 concurred that at some stage, the design team might need to *tease out the information* users need. By doing so, it could help the design team to design a more useful dashboard.

... quite often you'll hear people say "they don't really know what they want" ... And I don't know if it's actually true. I think that people, it's kind of like "I know I don't want that". ... having good communication with the end users about trying... the purpose of what they're using, to ensure that usefulness. [Uni-Mgr2]

At this point in time, the design team in UniOne carried a fairly big task in exploring user information needs, hoping to fill the gap by designing a dashboard for them. As they were still in the early stage of the dashboard design process, in some cases they had to approach users to show them what the dashboard could deliver in terms of information reporting and analysis. This sort of engagement is necessary according to Uni-Mgr1 and Uni-An2 to make users aware of the sort of information they can access, as well as convince them to use the dashboard in future. In the long term, UniOne wanted their users to utilise information as evidence to back up their decision making.

> *We've got a lot of data that isn't used; and we're trying to engage a lot more with the end users to see if we can fill the void of reporting that we think is needed; but you need the end users to engage and make use of ... make decisions on it [Uni-Mgr1]*

Arguably, all these efforts in engaging users and in building awareness on information and the dashboard's capabilities can be considered as a journey on the road to innovation. In essence, they were trying to create innovation through dashboard design. That is beyond merely designing the dashboard as an artefact, as it includes their efforts to change users' mindsets about data and educating them about benefits of data integration. Also, their intention of designing the dashboard was entrenched in the idea of giving users self-service access. In other words, the users should be able to analyse and investigate any phenomena in the organisation by utilising information from the dashboard.

The idea of providing self-service access for users albeit still in an early stage has been embraced by Uni-User2. Before the dashboard came into the picture, it was one of Uni-User2's responsibilities to prepare certain types of information for other people in the faculties.

> *... now we are making sure that the information is setup so that the faculties can themselves access it directly and get the information themselves, because it is rather time-consuming for me to do it. [Uni-User2]*

As it has been proven to reduce the amount of time Uni-User2 must spend on manual tasks, Uni-User2 could dedicate more time to making sure information was accurate and available. Uni-User2 would also be able to focus on collaborating with end users at the faculty level to work on necessary dashboard improvement in future.

5.4.3.3 Interdisciplinary communication is key in designing a more user-centred dashboard

Based on the middle part of the diagram in Chapter 5 (refer to Figure 5.6), it was stated that as the design team tried to reconcile the gap between the problem goals and the solution criteria, they would start exploring the problem area and framing the problem. At this stage, the solution concepts have to be in line with the problem frame. It was also mentioned that it is possible for designers to work back and forth between the frame and concepts in order to finally arrive at a dashboard that satisfies the solution criteria within acceptable time constraints.

Therefore, arguably communication becomes an important skill for members of the design team as they need to collaborate with and understand what users need on the dashboards. This resonates with Robey and Markus (1984) who suggested the importance of improving communication between users and designers. The analysts and other members of the design team in UniOne may not be formally trained as designers or software designers. But through empathy and collaboration in design thinking, they were able to assume the designer role. They developed "hybrid skills" (Keen 1981, p. 31) that enabled them to be more flexible and to have interdisciplinary communication skills that helped them move forward with the project of designing dashboards for UniOne users.

In Chapter 3 (section 3.2.3), it was discussed that design thinking is human centred, which is achievable through empathy and collaboration and that the role of users in design has shifted from consumption to participation (Brown 2009). Thus users should be involved as the design process is too significant to be left in the hands of designers alone. This is where 'hybrid skills' which mainly include interdisciplinary communication are needed.

> *... by not only after we communicate with them[sic] and see what help in their daily life, and their work, then we probably won't aware that what sort of report they focus that are more important to them. [Uni-An2]*

Therefore, Uni-An2 stressed the importance of communication with the users as it would facilitate understanding about how they go about their daily work. As a result, they would gain insight as to which information would be beneficial. Uni-User1 also concurred that it is important to understand each user group's needs. In some instances, the design team may also need to convince them if they believed users were not moving in the right direction, and to ensure they are on the same page regarding the design process.

When it comes to empathy in UniOne's case, Uni-User1 stated that the design team is very knowledgeable in data setup and presentation but not in a way users could understand easily. Uni-User1 stressed that designers need to understand how users comprehend the information presented on the dashboard. Therefore, Uni-User1 and Uni-User2 are taking up the role of being intermediaries and liaison between the design team and end users. They help with communication and filter user requests based on value and urgency. Through their involvement, they expect the collaboration between the design team and users will become more effective and result in a more useful dashboard. Uni-Mgr2 added that it is also crucial to understand why and how information can be considered useful by users. Thus through collaboration with users, the design team would be able to appreciate the issue from the users' point of view. Arguably, all these efforts would help them in selecting the most important metrics and presenting the information in a way that is easy for users to understand.

Collaboration can be supported by diversity in a team according to Uni-CFO. Furthermore, Uni-CFO suggested that collaboration also plays an important role in creating innovation.

> *So to me, if we're doing things the same way, we're definitely not going to get innovation. So, this is what I mean, the collaboration aspect and people coming in from different disciplines or different skillsets that help with innovation. ... There has to be a bit of a mixture to bring innovation. [Uni-CFO]*

Uni-CFO argued that *innovation would come from difference.* Diversity of opinions in a team could lead to rich discussions hence Uni-CFO proposed the design team comprise people with different skillsets and backgrounds.

5.4.3.4 Interpretation and analyses

Empathy and Collaboration

This theme discussed designing a more user-centred dashboard. In general, user-centred design involves users actively during the process of design (Knight 2011; Vredenburg et al. 2002) which aimed for a grounded understanding of user requirements (Vredenburg et al. 2002). Ahmed, McKnight and Oppenheim (2006) suggested an early prototyping approach to support user-centred design and for the prototype to be tested with real users. The process would naturally be iterative and accompanied by constant evaluation (Vredenburg et al. 2002). Based on a survey with experienced practitioners, Vredenburg et al. (2002) suggested a positive relationship between user-centred design and end product usability.

Design thinking is likewise user-centred and achievable through empathy and collaboration (Brown 2008; Wölbling et al. 2012). Nonetheless, the focus is not merely on users but more on achieving a balance of users, technologies, and organisations (Brown 2009). In UniOne's case, the design team seemed to have handled the technical and technological aspects well, which include database and infrastructure setup, as well as selecting a tool to design and implement the dashboard. Moreover, they were fully supported by the organisation in terms of resources. Therefore, their biggest current concern is to ensure the dashboard is designed based on user needs, and to reach the goals they were aiming for.

Arguably, the design team has collaborated with their users throughout the process of design and has felt the importance of thorough understanding about dashboard use. This is certainly in line with the notion of design thinking where collaboration and empathy play a vital role in creating innovation (Wölbling et al. 2012). However, it begs the question whether what users want and need is enough. It was unclear to the design team as to what ways and which level users should be involved. From the interviews, the design team seemed to have worked together and consulted with the users, but it does not appear that users have played a very active role in the design process.

The design team has also pointed out that the dashboard has to be useful. By having an in-depth understanding of how users make information work for them to support decision making and business processes, this is where empathy comes into the picture. At the same time, users and the design team need to be on the same page. With Uni-User1 and Uni-User2 helping out with the design process, they offer important insights to corroborate the design team's understanding of user needs. This undoubtedly would assist in future dashboard design. This is an important issue that should be discussed and considered at an early stage of the design process. This view is supported by Eckerson (2011) who argued that planning ahead is key to warranting future user adoption.

In terms of feasibility, the design team certainly has a high regard for Tableau as their tool of choice for dashboard use. They selected it after testing a few other tools and they used Tableau for two years before users accessed the dashboard. While it might be good for the design team, as Tableau has helped with data integration and dashboard design, users had a different view. As it turned out, Tableau is not as intuitive as was originally thought by the design team, according to the users. In the end, it could be a matter of users becoming familiar with Tableau over time with more hands-on training and assistance.

If the ultimate goal of designing the dashboard is for users to perform their own analysis, it may be worth considering whether users should be consulted, or involved earlier on in the process

when the design team was deciding whether to use the Tableau application. This could help the design team to even better understand user needs. However, this requires a serious commitment from users in terms of time and resources. Hence, it should be carefully thought through in terms of viability of the overall project. At the same time, it would be almost impossible for every user to be satisfied with the selected tool.

Essentially, the design team started small, with the finance team led by Uni-CFO as their first dashboard users. They subsequently spread awareness of the dashboard to bring more users on board. Taking all of these issues discussed earlier into consideration, together with the financial support and resources in UniOne, the design team is hopeful and anticipates that users will eventually overcome their problems. And they will continue to provide ongoing training and assistance through the help of Uni-User1 and Uni-User2 as intermediaries.

In IS design, intermediaries cover both human and non-human, for example, documents, technology artifacts, or formal procedures, may be viewed as boundary objects (Gasson 2006). Johnson and Duxbury (2010) classified the boundary-spanning role of expatriates into various roles mainly as relationship building, intelligence gathering, coordinating/negotiating, and intermediaries. Their main role would be to act as a broker to introduce and refer external entities(Johnson & Duxbury 2010).

In UniOne's case, the term intermediary was used by Uni-User1 to describe the role of Uni-User1 and Uni-User2 to help with communication between the design team and end users, to filter user requests based on the value and urgency, and to train end users in dashboard use. Based on Johnson and Duxbury (2010), Uni-User1 and Uni-User2 can be considered as boundary spanners for their role as relationship builders and coordinators/negotiators. Through their involvement, they expect the collaboration between the design team and users will be more effective and ultimately result in a more useful dashboard.

Overall, the design team in UniOne has used empathy and collaboration with their users to design a more user-centred dashboard. This would certainly help to ensure that the dashboard will be useful for the users as supported by Vredenburg et al. (2002). By collaborating with users, this is a way to "gain acceptance" as well (Ottersten & Balic 2007, p.39). Furthermore, Uni-Mgr2 has pointed out that the usefulness of the dashboard would impact future use. Therefore, a relationship between dashboard design and future use can be established.

Striving for Innovation

Another important characteristic of design thinking is striving for innovation (Brown 2008). Furthermore, Wölbling et al. (2012) emphasised the important role of collaboration and empathy in creating innovation. In UniOne's case, aided by the simplicity of Tableau, they could dedicate their resources to collaborate with users, to increase awareness on the extent of integrated data they have, and to design a useful dashboard. Also, justifying user needs supports innovation through design (Verganti 2009). However, it would be subjective and relatively difficult to say that UniOne has created innovation through their dashboard design, as the definition of innovation can vary greatly for each organisation. Nonetheless, based on their description of what constitutes innovation, it is fair to say that UniOne is on the road to innovation.

Uni-CFO also mentioned that innovation comes from difference. In UniOne's case, the design team consists of people with different training and qualifications. This is in line with what has been suggested by Wölbling et al. (2012). A small multidisciplinary team "with diverse backgrounds, expertise and experiences can foster team discussions and create a broader range of ideas and solutions than a team of people with similar expertise" (Wölbling et al. 2012, p. 129). Moreover, this multidisciplinary approach to user-centred design seems to have a close relationship with perceived effectiveness of design (Vredenburg et al. 2002). Thus all the more reason for UniOne to justify the importance of user involvement in dashboard design.

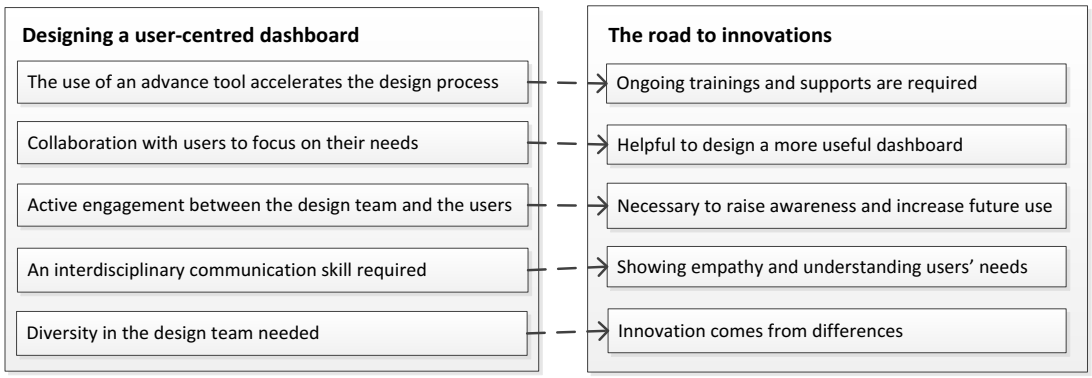


Figure 5.9 Takeaways from Theme 3

Figure 5.9 summarises key points as takeaways from the third theme. For the next theme, challenges thin UniOne has to deal with in order to realise their ideal dashboard design will be discussed.

5.4.4 Theme 4: Ways to deal with challenges in realising a desired dashboard design

Based on the top part of the diagram of design thinking dashboard development strategy model in Chapter 3 (or refer to Figure 5.6), there is a likely gap between problem goals and solution criteria. In terms of UniOne, they are yet to deliver an ideal dashboard. Reflecting on some characteristics of design thinking, they began with early prototyping and attempted to gather feedback from users. They also tapped into their past experience regarding what they were good at in terms of providing reports and information, and they have combined it with Tableau as a new tool/technology. In a way, they have figured out their problem goals. Nonetheless, they are still in the process of realising these problem goals and matching them with solution criteria.

In this theme, challenges in realising ideal dashboard design and ways of dealing with those challenges are discussed.

5.4.4.1 Challenges in realising desired dashboard design

In UniOne, there were apparent gaps between implementing plans and the reality, or between the problem goals and the solution criteria, to use the term in the conceptual framework. Based on interviews with research participants, some challenges faced during the process of designing the dashboard were discussed. The term "social inertia" is a plausible explanation for their challenges (Keen 1981, p. 24). Keen's idea on 'social inertia' relates to information systems and change in organisations. It is not easy to overcome inertia (Wisan 2002). Although we have attempted to work towards change, it has not happened yet. Keen (1981) argued that this could be due to many reasons including information being only a small part of the equation regarding decision-making, the complexity of the organisation, as well as data being used as political assets.

Uni-CFO believed that information is important when making decisions.

> *... well I'm not doing things by guesswork. ... So, by holding appropriate trend data we can see how we are going in relation to the past, whether we are going against our plans. [Uni-CFO]*

But it may not be true for all users in the organisation. As confirmed by Uni-Mgr2, some senior users in UniOne have been able to make decisions based on gut feelings and what has worked before. This is rather a simplistic view of decision making and as mentioned by Keen (1981, p. 24), "what has worked in the past is most likely to be repeated". This kind of organisational culture has made it hard to get a buy-in from some of the users. In the end, Uni-Mgr2 stated that the aim

was to demonstrate that the dashboard could deliver useful information to support their decision making.

> *We've been able to get away with kind of planning ... and measurement ... based on intuition for a really long time. Like people in senior management have been working ... for a long time, this always works for students. We just do that, oh if they are doing this, it's because of this. [Uni-Mgr2]*

Apart from that, following Keen (1981), due to the complexity of organisations, change was normally incremental and gradual over a long period of time. UniOne is indeed a complex organisation as confirmed by Uni-Mgr1. They have various stakeholders to convince when effecting change, especially the university council. Nonetheless, the design team were fully aware and have acknowledged the level of difficulties encountered with this task. With a top-down approach, Uni-Mgr1 hoped to break the old culture of decision making into fact-based decision making by getting an endorsement from users at the executive level. Ideally, when executive level users were convinced about the use of the dashboard, they could potentially encourage other users.

> *So I'm hoping in the future that we can draft, or put in a business plan, pass it through the CFO through the executive group, which gets endorsed, then passed on to the business areas and Deans; at least see something in writing and endorsed at a higher level. [Uni-Mgr1]*

Furthermore, Uni-Mgr1 raised another important point on why the dashboard design process is challenging. Uni-Mgr1 stated that as a university, UniOne has a different priority compared to other types of organisations, such as financial institutions, where having accurate and timely information is critical to support daily decision making and business processes. Shifting priorities happened often in UniOne, hence the dashboard design process may be delayed.

> *... our Tableau reports are not anywhere near where they should be, but then again we're not a bank or an organisation that has got strict identified areas of responsibility and accountability and so on. So even now in our area, our priorities shift on a daily basis and we have to deal with dropping work that we should be doing on Tableau and do something else that is regarded as more important to the university. So those are the things that get in our way and slow things down. [Uni-Mgr1, second interview]*

Last but not least, Keen (1981) also mentioned that in some organisations, data were being viewed as political assets. Uni-An2 discussed the issue of politics involved while gathering requirements

and during collecting data from different divisions in UniOne. In the end, it became an issue with data ownership and accountability. The design team needed to collaborate with data owners across the organisation and to negotiate with them to share their data as well. More importantly, they needed to explain the big picture with data integration as part of their efforts in designing a dashboard for users in UniOne.

> *It is difficult in a way that I think political reason. Because each area has its data reporting people. And they also have some sort of dataset that have been somewhere. … But sometimes I guess it involved whether people are happy to share or….yeah. Because I....You don't want to feel like you're taking over someone else's job. … if they don't tell me what kind of data they have, I won't know. [Uni-An2]*

Clearly Uni-An2 pointed out that there were other reporting people in other areas; the decision to share the data with the dashboard design team was entirely up to the data owners. Interestingly, however, Uni-User1 seemed to think the opposite.

> *… that's a good thing about data, they're really going to start to break down some of the politics. … it breaks down some of the barriers. It's less personal as you're talking about data as opposed to people … From the political perspective it takes the energy out of the politics. [Uni-User1]*

As Uni-User1 segregated data from people, Uni-User1 argued that the data was supposed to bring people from different departments in the organisation together through data integration. While Uni-An2 considered that the data is owned by a specific group in some areas within UniOne, Uni-Mgr1 argued that they are merely stakeholders of the data, thus they are accountable. It is the organisation that owns the data according to Uni-Mgr1. Unless they are all in agreement, this fairly convoluted situation undoubtedly adds to the explanation as to why the gaps in realising the ideal dashboard design still persisted.

5.4.4.3 Early prototyping as a collaboration tool in the dashboard design process

The design team in UniOne has been actively engaging their users by presenting them with a prototype of the dashboard. The idea is to show users what they can provide via the prototype and collaborate with them to design the dashboard. Although the prototype would normally be prepared by the design team, some users could initiate the collaboration by showing an example of dashboards or reports encountered from various sources to the design team. The types of prototypes used ranged from a low-fidelity such as sketches on papers or a screenshot of a system, to high-fidelity ones created on Tableau using the existing metrics.

For Uni-An2, prototyping helps to think about how they make it work to create the end result. The prototype facilitates visualising how the information will be presented on the dashboard. Apart from being a collaboration tool, the prototype assists users in understanding the experience. This notion was emphasised further by Uni-CFO regarding the importance of envisioning what the end result would look like. This signals a clear direction and way forward in terms of dashboard design.

As for the collaboration going further, the design team would inevitably encounter constraints on the dashboard design. Uni-Mgr2 conferred that these constraints had made them think about key aspects that contribute to dashboard design. In a way, constraints *distilled* problems, according to Uni-Mgr2. While it may sound very appealing to place various kinds of metrics or information on a single screen, constraints help refine the design requirements to come up with a more innovative solution. As a result, this arguably adds more evidence as to why prototyping should be done as early as possible, as far as the design process is concerned.

> *Constraint is actually forcing innovation in a way and that forces us to think about problems in new ways, so I think that's actually really good. I think having some constraints is valuable because it gets people to really think about they really want from this, well I can't do everything so what do I really want to know? [Uni-Mgr2]*

Most importantly, Uni-CFO believed that prototypes act as a starting point for collaboration with users. Understandably, the design team would need to have sufficient understanding about relevant business processes to identify the requirements and come up with the prototype. With that, they could invite user feedback and the design team could respond.

> *I don't believe the idea of the blue sky and asking them "what would you like?" which doesn't seem to get you anywhere. You go out and show them what's possible, and then take feedback and respond. ... as long as you have a reasonable understanding of the business, you should be able to come up with a prototype position before you go out and talk to people. [Uni-CFO]*

Apart from that, Uni-User1 suggests early prototyping gives both the design team and users a chance to reiterate on the design of the dashboard to ensure it is going to be useful. In line with Gabrysiak, Giese and Seibel (2011), it also assists them to envision how the dashboard might look. To help further with the envisioning process, Uni-User1 suggests the design team be aware and understand core business processes in order to select the right metrics to measure corresponding performance.

Generally, in UniOne, they tend to spend more time in analysing *the best way of doing something,* according to Uni-User1. So arguably, through prototyping and envisioning the end result of the dashboard, the design team could balance their time spent in analysing user requirements or in the problem space with time spent in the solution space.

> *...one of the problems is, a university is really good at sitting down and thinking about things and agonising over what's the best way of doing something. Sometimes you just need to come up with a model, "okay guys, like it or not, this is how we're going to organise it" and run with that. [Uni-User1]*

Early prototyping also helps them in assessing the usefulness of the dashboard earlier before it has been completely developed. In design thinking, we are learning by making, which can be achieved through creating the prototypes in early stages of the design process (Brown 2009), or making models as tools for thinking instead of merely representing ideas (Boland & Collopy 2004; Boland et al. 2007). Through early prototyping, the design team could *start the feedback loop* from the users, according to Uni-Mgr1.

By incorporating the feedback as they build the prototype, the design team and the users work together through iterations and making improvements accordingly. Whereas, if a dashboard design is based on merely a list of requirements, in the end the dashboard may not be entirely useful. As Uni-Mgr2 stated, what users *want* might change over time or might not necessarily be what they *need*.

5.4.4.4 Interpretations and analyses

Challenges

This theme discusses ways to deal with challenges in realising a desired dashboard design. First and foremost, challenges in realising dashboard design in UniOne are discussed. When it comes to making decisions, not all users in UniOne agreed that the use of information to support decision making is important. The main reason is the culture of decision making in the organisation. Based on the accounts of interviewees, a lot of users have worked in UniOne for a reasonably long time and trust their gut feelings to make decisions based on things that have worked previously.

With the recent Australian Government funding regulation changes and structural changes in UniOne, change is inevitable. Uni-Mgr1 reported that users need to be more accountable in decision making. Uni-Mgr2 also added they need more justification in spending the allocated budget. Hence, arguably, this is where information needs presented via the dashboard come into the picture. For users to get used to the idea of utilising information on the dashboard to support

decision making and business processes would be a real challenge. Especially when users felt that information is only a small part of the equation in decision making (Keen 1981).

As supported by Keen (1981), it is difficult to make any sort of changes in a complex organisation like UniOne. So it is a good strategy for the design team to start by spreading awareness about what the dashboard can provide to users who can benefit from the dashboard. Furthermore, the design team employed a top-down approach by getting buy-ins from executive and management users in the hope that they could encourage more users to use the dashboard. As confirmed by Uni-User1, users have started picking up the pace and feeling the need for information to support decision making, once they knew they could obtain such information. Uni-Mgr1 even suggested that some users would expect to have access to relevant information for them to be able to do their work properly.

Political Issues in Organisations

However, to provide users with proper information, the dashboard has to be linked to integrated databases across the organisation. This can be somewhat problematic when politics is involved as reported by Uni-An2. Keen (1981) discussed data that might be used as political assets. It is worth noting that in the early 1980s, the political playing field in organisations was different compared to the present. Information Systems (IS) implementation might involve a costly procurement of mainframes or servers. Although this does not apply to the current situation in UniOne, the fact that data is still being used as a bargaining chip substantiated that things have not changed so much in past decades when it comes to politics in organisations. In reality, IS design normally "crosses political and knowledge boundaries" within organisations (Gasson 2006, p. 27) and is considered "a political process in which various actors stand to gain or lose power as a result of design decisions" (Robey & Markus 1984, p. 5).

Keen (1981) has discussed this political issue regarding the implementation stage, while the interview with UniOne's design team would suggest that this matter appear early in the design process. The design team has to deal with it well before the dashboard is implemented. Arguably, multidisciplinary communication becomes an important skill (Keen 1981; Wölbling et al. 2012) for members of the design team, as they need to collaborate with and understand what users really need on dashboards (as discussed in Theme 3).

Keen (1981, p. 24) attributed all these challenges as "social inertia" which explains why IS related changes were difficult to make happen in organisations. Instead of the organisation being in an inert state, it should strive to be a more dynamic and robust organisation in order to make change possible and to be more innovative (Oss & Hek 2011). Dealing with the complexity of the

organisation, Uni-User1 has a slightly different stance and thought that the underlying problem was the people, thus data integration would in fact break the barrier between departments or areas.

Furthermore, as a university, UniOne has to embrace shifting priorities on a daily basis, according to Uni-User1. It is a different situation compared to financial institutions or big corporations where the departments are fully laid out and with a certain level of bureaucracy involved. The accountability in making decisions is critical and they may come with high risks involved or with financial repercussions. In comparison, a university is a collegial institution, and although departments and areas of responsibility were also laid out, the main responsibility and the core business of the organisation, as a whole, is to deliver high-quality education to its students.

This has placed more emphasis on what was discussed earlier in Theme 3, specifically the importance of communication, empathy, and collaboration between the design team and users. Although they had a textbook approach in designing the dashboard, in which the dashboard would have an aggregated form of information for executive users and a more detailed form for users at managerial and operational levels, the design team has been accommodating the changing needs of users in UniOne. This was demonstrated by the way they recognise different kinds of users as discussed earlier in Table 5.2. As a result, it would arguably help them to be flexible in working with users during the dashboard design process.

Early Prototyping

In addition, the design team provides users with the ongoing training and support. So their approach to design is holistic, which is in line with Owen (2006). They were not only focusing on eliciting requirements, but the big picture through long-term engagement with users. Moreover, the design team can use Tableau to design a working prototype instead of a mere mock-up of the dashboard user interface, to capture feedback and to facilitate user collaboration (Gabrysiak, Giese & Seibel 2011). Thus the design team can gain a strong empathy with users which helps them to improve dashboard design in relation to future iterations.

Ottersen and Balic (2007) argued that a strong empathy assists with a challenging situation when designing a system that requires user interaction such as a dashboard. Apart from focusing on users, the design team should also be able to visualise an idea for various prototypes (Owen 2006). Prototyping can help "build empathy for users" (Dow & Klemmer 2010, p. 112), facilitate learning (Lindberg, Meinel & Wagner 2011), and doing it early in the design process is one of the key characteristics of design thinking (Brown 2009). Arguably, the design team in UniOne can also envision the end result of the dashboard through prototyping.

Prototyping enables iterations and invites user feedback which can lead to a discovery of "unknown attributes, constraints, and opportunities" (Dow & Klemmer 2010, p. 112-113), or any potential use-case scenarios (Gabrysiak, Giese & Seibel 2011) that may have been missed at an earlier stage or while gathering requirements. Robey and Markus (1984) argued that early user involvement in the design process supports user acceptance and future use of the system. UniOne used an early prototyping approach to work with users and to perform further fine tuning, gathering feedback and improving dashboard design accordingly, based on Uni-An2's account. Through this process or journey, the users are informed of the progress of the dashboard design and can be engaged throughout the design process. As a result, it arguably warrants the future use of the dashboard.

Key Roles in the Design Team

While early prototyping seemed to benefit the design team and the users, justifications behind design decisions made might not be captured during iterations (Gabrysiak, Giese & Seibel 2011). In relation to such justification, Uni-User1 has pointed out that the design team needs a person to perform a data governance role to make sure that what has been planned is aligned with UniOne's strategic plans, and processed accordingly following the dashboard prototype iterations, in addition to addressing data quality issues (Wang, Wang & Alexander 2015). Even though the design team has collaborated effectively with users, they should take charge and drive the design process (Ottersten & Balic 2007).

Eckerson (2011) suggested an executive steering committee along with a project champion, project manager, business analysts, the 'KPI team', and the technical team for a dashboard project to be successful. In UniOne's case, Uni-Mgr1 holds the project champion role, is the 'go-to' person and in charge of the whole project (Ruuskanen 2012). The presence of a project champion is key in IS projects along with support from top management and efficient project management (Nah, Zuckweiler & Lau 2003).

Meanwhile, Uni-An1 and Uni-An2 are the technical analysts who know the ins and outs of data preparation, and integrate and transform the data into presentable information on the user interface. And as pointed out by Uni-User1 earlier, UniOne needs someone who takes on the governance role and arguably Uni-Mgr2 would be the most suitable. This person will be responsible for ensuring dashboard design is aligned with the organisation's strategic plans.

Lastly, Uni-CFO and Uni-Dir constitute the steering committee who help with getting buy-ins from executive users (Ruuskanen 2012), metrics definitions and standardisation, setting priorities, sustaining funding, getting approval for resources (Eckerson 2011). It is important to get buy-ins

from users while designing the dashboard as it can help win user acceptance and potentially increase the possibility of future dashboard use (Pauwels et al. 2009). Table 5.3 summarises the roles of UniOne's design team based on Eckerson (2011).

Table 5.3 Roles of UniOne's design team based on Eckerson (2011)

Roles	**UniOne's design team**
Project champion	Uni-Mgr1
Technical analysts	Uni-An1, Uni-An2
Governance	Uni-Mgr2
The steering committee	Uni-CFO, Uni-Dir

This evidently indicates the effort of the design team to build a strong, diverse team to collaborate with users and deal with challenging situations in the design process.

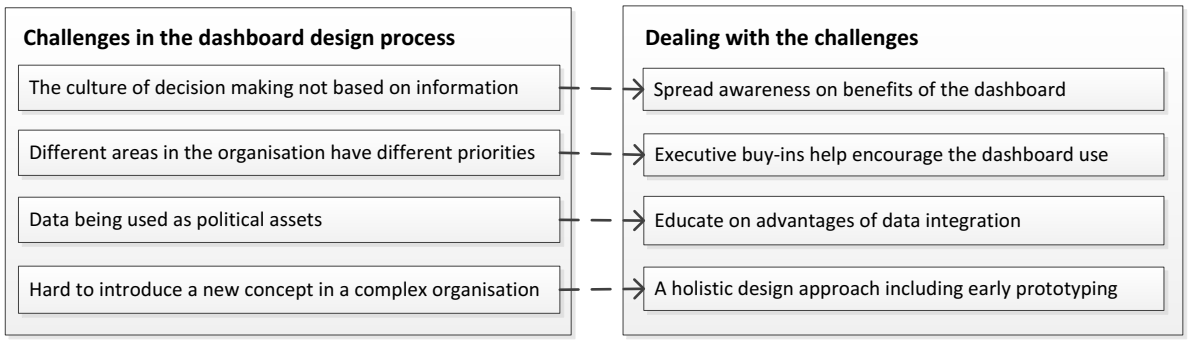


Figure 5.10 Takeaways from Theme 4

Figure 5.10 summarises key points as takeaways from the fourth theme. For the next theme,The notion of impact on dashboard design and use will be discussed in the next theme.

5.4.5 Theme 5: The notion of impact on dashboard design and use

The use of the dashboard has been valuable in supporting decision making and transparency in day-to-day work, according to Uni-User2. Uni-Mgr2 added that by using the dashboard, a sense of shared ownership is evident. Users would also be more involved in offering ideas or feedback for the improvement of the dashboard, as the design team encouraged more users to come on board. In relation to this point, there is an interesting theme that emerged on how the use of dashboards impacts the organisation.

Gallagher, Mason and Vandenbosch (2004) in the context of Enterprise Resource Planning (ERP) projects argued that ERP could lead to an initiative to improve current organisational processes

and systems. These projects require a deep understanding of current processes or systems that may impact the new system. Therefore, “a full set of the requirements is not possible a priori, but must be continually explored and developed over the course of the project” (Gallagher, Mason & Vandenbosch 2004, p. 1). This applies in UniOne’s case where there was no formal requirement gathering stage. Instead, the design team maintains a constant collaboration with users throughout the design process.

This theme is essentially related to the first research objective of this study which looks at the impact of the dashboard design process on existing organisational processes or systems. Based on the interviews, it is gathered that the notion of impacts could happen two ways. Firstly, the current organisational processes, systems, and/or cultures might influence the dashboard design. Hence various issues impacting the design of the dashboard will be discussed. Secondly, the use of the dashboard would impact current organisational processes, systems, and/or culture.

Essentially, the notion of impacts occurs from the use of dashboards, specifically from the information displayed. In UniOne’s case, it appears that the use of dashboards enables performance monitoring to increase accountability and transparency in the organisation. For example, the dashboard has helped UniOne to identify lower performing units so that they can come up with an action plan to improve the performance of the units accordingly. Furthermore, the use of information on the dashboard supports an evidence based decision making based on the accounts of some participants in UniOne.

5.4.5.1 Issues impacting dashboard design

Despite all efforts discussed earlier in designing a more user-centred dashboard, some issues impact the design of the dashboard. In some cases, users raised the idea of having particular metrics on the dashboard. According to Uni-Mgr2, the data required for such metrics might not always be available.

> *… this group come to us [because] they want a dashboard on these series of data. We've got three of them, they [all] want different stuff that I know we don't collect as an organisation.… So we’ll be setting up a formal process where we can then go to the next group "Alright, well we actually wanted to collect these data. Or should we be advising them to use something else?" [Uni-Mgr2]*

The main reason for the data being unavailable was that the data were not being collected by their current systems in the first place. To deal with this situation, they would need to negotiate with a number of relevant parties to work out the best solution.

Moreover, Uni-An1 mentioned they would identify the source system where the data were supposed to have originated. That way, they would then be able to inform the person or team in charge of such system on forthcoming changes. Depending on the urgency and priority of the request, some changes to the data structure or the current system would need to happen in order to accommodate change.

> *Perhaps the issue down the road is about how these data can be automated. ... It should be automated from the system where this information comes from. So that perhaps would be something that we have to consider and make sure we have a plan on how we might deal with updates for the data source. [Uni-An1]*

Uni-Mgr1 added that the design team should take into consideration whether the source systems could sustain data feed into the dashboard in a consistent manner. Essentially, the design team needs to work out an alternative solution should the source system could not feed the data timely and properly, for some reason. Without it, the dashboard would lose its essence as a platform to monitor progress towards the organisation's strategic goals.

> *All of the visions and plans have to be tied back to a set of information that is supplied in a consistent manner. And we have identified tableau BI as a tool to deliver a consistent set of information. How it lies in the background is important, because that gives you the quality of data and the results would be shown in the KPIs or the reports. [Uni-Mgr1, second interview]*

According to Uni-User1 the data would be available most of the time, albeit collected by many different areas in UniOne. It is only a matter of obtaining access to these disparate data sources and integrating them before being fed into the dashboard. However, Uni-Mgr2 added that they would have to be prepared that the design of the dashboard could be impacted due to the data being unavailable.

Another issue that would impact the design of the dashboard is a restructuring of the organisation. In UniOne, there have been some changes in terms of the structure of faculties and departments in recent times. Inevitably, it has prompted the design team to perform an impact analysis on for dashboard design and specifically data structures. According to Uni-Mgr1, there are many ways to display information in a report or in terms of metrics. But when the structure of the organisation changes, some information, especially information with comparisons between departments or functional groups, would not be relevant anymore. Therefore, some of the metric design and presentation of information would need to be changed to match the new organisational structures accordingly.

UniOne has recently implemented a new student management system which has replaced the old one. This has happened in parallel with dashboard design while it was in progress. Since the student management system is one of the dashboard data sources, there was an inevitable disruption to the dashboard design process, as stated by Uni-Mgr1. During the early transition period to the new student management system, Uni-User2 reported some teething issues, which resulted in incomplete and inconsistent data being fed into the dashboard. Due to this problem, Uni-User1 had to go back to using Excel to transform and process the extracted data into presentable information.

5.4.5.2 Use of dashboards enables performance monitoring and increases accountability in the organisation

Dashboards enable executive users to monitor the "health and wealth" of the organisation and drive "a culture of transparency and accountability" as they compare their progress against organisational goals (Dover 2004, p. 44). As a CFO, Uni-CFO monitored the health of the organisation in terms of finance and resources by using data presented in metrics and reports. Uni-CFO looked forward to the dashboard serving as a platform for them to be more proactive when encountering issues in the organisation.

> *'Cos our dashboard is going to say that these leading indicators are saying that students aren't happy or there's a high attrition rate that suddenly spikes in this course, why? It can't get any answer but they're the things that… if we can be responding to things while they're happening, rather than at the end of the year when you found out that everyone has gone missing from the program, that's where we need to get to. [Uni-CFO]*

Essentially, one of the capabilities of the dashboard is to assist users in spotting problems through the information displayed on the metrics. Uni-Mgr1 argued that the dashboard gives *full value of information delivery*. Through the metrics, users should be able to identify the problem and hopefully make a corrective action accordingly. This is particularly relevant in the higher education sector where some processes involve funding applications with government or external entities. Therefore, Uni-Mgr1 emphasised that it is important to spot the issue in a timely manner, otherwise they might possibly risk their funding opportunities. Additionally, Uni-CFO mentioned that with a drill-down feature on the dashboard, it enables them to further investigate further the root cause of the issue.

With increased competition in obtaining public funds from government, Uni-Mgr2 contended that accountability has become an important measure. The organisation needs to be more accountable

in terms of how they allocate funds across different areas over a period of time. At certain stages they performed an evaluation to ensure they were getting the output they expected from finance and resources. In this situation, the dashboard arguably provides a platform to monitor the accountability of the organisation through appropriate key performance indicators or metrics.

The dashboard has been valuable in monitoring the performance of units and courses in UniOne according to Uni-User1. In the past, there was a minimum check in place to monitor such performance; hence it was fairly difficult to judge the quality of units and courses delivered to students. In the context of the dashboard, Uni-User2 stated that it helps them identify the bottom performers, analyse the situations, and decide on a corrective course of action.

> *... we need to be able to identify top and bottom performing courses and units. It has to be made clear because that's where we need to drive continuous improvement, in those areas. So we look at this information all the time to drive how we're going to look at it[sic] ... It helps the faculty to identify areas for improvement. [Uni-User2]*

The same goes with employee performance. UniOne can promote performance awareness by introducing appropriate performance metrics on the dashboard for employees. According to Uni-Mgr1, by doing so, the staff would be able to see how they fared from the performance indicators. As a result, the dashboard would deliver information to users at every level in the organisation. Thus not only would it support the users in monitoring the performance of the organisation, but it would also allow them to access information related to the performance on a daily basis.

> *People are getting rewarded in a different way and I think the information delivery at all levels of an organisation is starting to show 'hey this is my job this is a metric that shows how well I've done. I've recruited x amount of students who're doing really well while they've graduated'. [Uni-Mgr1]*

As we are living in the information age, Uni-Mgr1 added that we can access various sorts of information more so than in the past. As users monitor feedback on their performance, they also identify areas that need more attention. In a way, Uni-Mgr1 suggested that it could empower users, particularly the younger generation who were more entrenched in receiving a lot of information, to improve their performance. Additionally, the information on the dashboard would be a reality check for some users, according to Uni-Mgr2.

> *A lot them kind of thought they were doing okay, it's like "nope, actually we're not doing that well". So I think it's actually a bit more than just ..., the intuition stuff, someone says and all the rumours and hearsay. [Uni-Mgr2]*

In the long term, with greater accountability and increased performance awareness, this arguably contributes to building a reputation for the organisation. In a way, metrics might not only represent performance in a specific area within the organisation, but holistically it also impacts the organisation. A good reputation would in turn bring in more students to study plus professional staff as well as academics to work at UniOne, according to Uni-Mgr1.

5.4.5.3 Use of information on the dashboard supports evidence based decision making in the organisation

At the time of interviews, the design team was approaching some key users in the organisation to promote awareness of the dashboard and to encourage the use of information to support their day-to-day tasks. Uni-Mgr2 argued that the information on the dashboard could influence users in making decisions and to make changes in the organisation. This is in line with Eckerson (2011), as mentioned earlier, who argued that dashboards can drive organisational change. Uni-Mgr2 pointed out that some users were not aware of the information displayed before them. That has prompted them to put forward an idea or even to make an action based on newly acquired information from the dashboard.

> *I would say there's a direct relationship there. So quite often some of these data would be a surprise. … So that people are going "really? That's really interesting. Maybe we can start a post graduate program in this area." … So I do think that it [the dashboard] influences … a lot of strategic directions. [Uni-Mgr2]*

Although it was not easy to establish a correlation between decisions made by users and information displayed on the dashboard, Uni-Dir believed there has been *a genuine attempt in the organisation to get all decision making evidence based*. Furthermore, Uni-User2 also stated that the dashboard has helped in making informed decisions in terms of identifying the bottom performing faculty or school.

Uni-Dir gave an example of determining the viability of a course in UniOne. This is management level decision making, as there were various aspects to be considered, such as the cost of delivering the course, the number of students enrolled in the course, and so on. At some point, they would need to justify whether or not to continue delivering the course. Having access to the information they need would certainly be helpful in making decisions at a later stage. As for strategic decisions, it is going to be even harder to establish if the decision making or changes in the organisation were done purely based on the information on the dashboard, as Uni-CFO pointed out.

But in terms of major choices for [UniOne], we wouldn't have driven them off any of this just yet. [Uni-CFO]

Having said that, Uni-Dir admitted that in order to make a strategic decision, they need evidence or information to back it up. Indeed, in such a situation, dashboards would fit nicely. Furthermore, Uni-Mg2 added that having a dashboard in UniOne enabled a reality check for some groups of users. According to Uni-Mg2, some users would have their own ideas how their group perform without being supported by facts or information. Dashboards could help with this situation by delivering information for users to develop real insights.

So it's nice to be able to go "Oh now look, we've done that analysis. It's in that dashboard. You can go and have a look at that. That's not true." I think while we've done it on some of those key myths about various things around ideas that people have about how that works. I reckon it's always been nice to have myth busting. [Uni-Mgr2]

Furthermore, Uni-Mgr1 believed that the dashboard is certainly making an impact on the organisation through data visualisation. The technology makes it easier for them to deliver information *through a variety of ways* to help users making decisions. Although the dashboard is not completely up yet for all of the users in the organisation, Uni-CFO feels confident in making decisions based on dashboard information.

I know how this information in put together… the indicators are there, and if I have any issues I would drill down into it further. Or I will send someone and tell him something is off the rails, so off you go and find out why, but yes, I use those things all the time. [Uni-CFO]

Furthermore, senior management in UniOne has been aiming for information transparency, according to Uni-Mgr1. Hence, in the long term, the design team aspires that the dashboard could empower the organisation in achieving such transparency. In a way, the users in UniOne should have access to information on how the organisation performed, and to compare it against other organisations in the industry across the country or internationally.

…transparency for me is the ultimate goal for everything that we do. I think all our data should be available to everyone; I don't think there should be any data that's unavailable to anyone, including staff performance stuff. [Uni-Mgr2]

Clearly, transparency should be balanced with privacy. Uni-Mgr1 argued that as long as the information is in aggregate form, there should not be a privacy issue. The access and ability to

drill down on some sensitive information on the dashboard should only be given to appropriate users.

A year on from the interview with the design team, it appears that users have largely embraced the idea of information transparency and having access to information through the dashboard, according to Uni-User1. Furthermore, Uni-User2 believed that the dashboard has in a way been *contributing to making changes* in the organisation by *providing information for decisions to be made* by decision makers.

However, Uni-User1 warned that with the dashboard currently available, the possibility of users suffering from information overload is on the increase.

> *Well they like that the data is available now. But the problem is we've almost like kids in a candy store, "gee we can get data on this, we can get data on that" so they want everything now without moderating the fact of understanding what's important. That's where we're at. Everyone all of sudden understands that data is really important, right? Now they want everything. It's just not going to happen. You really have to prioritise. [Uni-User1]*

Therefore, it is essential for the design team to facilitate and collaborate with users to prioritise their requirements based on importance, purpose and alignment with organisational strategic goals.

5.4.5.4 Interpretations and analyses

In this final theme, the notion of impact on dashboard design and use is discussed. Firstly, these issues will be conversed along with measures taken to minimise impacts. Secondly, the impact of dashboard use in terms of enabling performance monitoring and increasing accountability in UniOne will be analysed. Lastly, the analysis will be concluded with a discussion on the use of information on the dashboard in supporting evidence based decision making in the organisation.

Issues impacting the design of the dashboard in UniOne are summarised in Table 5.4. The interviews also suggest some measures or remedies taken by the design team to minimise impact, so the design process can move forward.

Table 5.4 Issues impacting dashboard design in UniOne

Issues	Remedies
Data unavailability	Assess the criticality of requirements and discuss with relevant parties on how to obtain the data. In some cases, creation of a new process or changes on source systems might be required in order to capture the data.

	Otherwise, users might be referred or advised to use similar existing KPIs or metrics on the dashboard.
Source system upgrades	Maintain a constant communication with the relevant team responsible for the source system upgrades or changes. Issues with the source systems as a result of their changes might give a domino effect to the dashboard. Hence, it needs to be managed to minimise risks and disruptions.
Data source sustainability	Maintain collaboration with other groups responsible for the source systems to make sure data can be supplied to the dashboard in a consistent manner. On top of that, a contingency plan should be made in case the source systems can no longer provide the data.
Organisational restructure	Perform impact analysis, assess areas needed to be changed, and implement the necessary changes accordingly. Users need to be informed to avoid miscommunication.

Generally, the issues impacting dashboard design were due to its heavy reliance on the source system. As described in Figure 5.3, the UniOne dashboard relies on external and internal data sourced from many different systems in the organisation. In fact, it is not uncommon to have such architecture, as usually dashboards follow the architecture of business intelligence (BI), where data is gathered and stored in a data warehouse before being used in front-end applications (Chaudhuri, Dayal & Narasayya 2011).

Although it is the nature of dashboards to get the data from other systems, the design team should take pre-emptive measures to ensure dashboard design does not become too reliant on dependent on source systems. Any changes or upgrades should not carry problems that affect their efforts in achieving the main aim of dashboard design. As mentioned by Uni-Mgr1, it might not be appropriate to demand or expect source systems to be working smoothly at all times. Hence, as previously mentioned, they should always be ready with a contingency plan. Uni-Mgr1 argued that understanding KPIs is important in this situation, so in case a source system is unable to feed the data, the design team can advise users to use similar metrics in order to monitor the required KPIs.

Holistic View of Dashboard Design

Uni-An1 suggested educating users about the data source and the benefit of data integration to help them understand the complexity of the design process. This definitely represents a holistic view of dashboard design and implementation. Furthermore, integration is a key characteristic of dashboards, according to Pauwels et al. (2009), that needs to be done in terms of data, business processes, and the user's point of view. Thus UniOne's design team has understood the notion correctly.

As discussed earlier in Theme 1 (refer to section 5.4.1), UniOne has aimed for the dashboard to be a platform to monitor performance of the organisation which includes their employees. Using the dashboard as a platform for monitoring performance has proven to be the most prevalent use, according to McKeen, Smith and Singh (2005), compared to using the dashboard as a tool to monitor projects or as a platform to identify new business opportunities. Treude and Storey (2010) added that the dashboard can be used for different purposes such as awareness, problem identification, or performance monitoring based on their respective roles in the organisation. Based on the interviews, apart from performance monitoring UniOne seems to need to spread awareness to more users about the extent of information the dashboard can provide.

Information Transparency

Furthermore, the dashboard is expected to enable the organisation in achieving transparency of information. As an example, Uni-User1 mentioned that the dashboard has helped them identify units and areas with low performance. As a result, they expect that accountability could be increased and plans for improvement can be made. While this seems to be valuable to UniOne, there should be a measure in place to evaluate whether accountability has indeed been achieved and to ensure information transparency via the dashboard has merit. In any case, interdisciplinary and cross-departmental nature of dashboards "should enable transparency and consensus building" in organisations (Pauwels et al. 2009, p. 180).

When it comes to information transparency, especially the performance of individuals, it inevitably creates a peer pressure environment, according to Treude and Storey (2010), which is not necessarily a bad thing as it creates healthy competition amongst employees. While Ruuskanen (2012, p.33) argued that the use of a dashboard "can expose internal problems", hence it creates resistance or inertia as discussed earlier in relation to Theme 4. Nevertheless, Treude and Storey (2010) suggested that performance information has existed in the organisation all along; however the dashboard has made it visible to users.

In general, it goes without saying that information transparency might not receive a positive reception from all users. Information transparency can be viewed by some users as loss of control (Pankaj, Hyde & Rodger 2006). McKeen, Smith and Singh (2005) discussed that organisations should be aware of the impacted staff or areas where organisations decided to use dashboards that aim for transparency. Especially with the drill-down feature, they advocate that it should be 'offered on a need-to-know basis' as this enables users to see detailed data "in their raw, un-sanitized form" (McKeen, Smith & Singh 2005, p. 1024). In this case, UniOne's design team has carefully assessed each user for appropriate access to information on the dashboard.

Another important issue in relation to the use of the dashboard for performance monitoring, selecting the right KPIs or metrics for measuring a certain performance impacts how the dashboard is being used, according to McKeen, Smith and Singh (2005). They offer the example of a call centre performance metric where an organisation measured the time callers had to wait before being answered. This was an inappropriate metric to use, as their employees have found a way to trick the system to meet the expected KPI by putting the callers on hold. It does not mean the callers were being attended and served. Also, it might suggest that performance monitoring might not be viewed as something positive by those being monitored. As Uni-Mgr1 argued, the monitoring should be done in a way to provide some sort of achievement or job satisfaction for employees through the selection of more appropriate metrics. It would be more rewarding for employees to know what they achieved when they look at the information on the dashboard.

Evidence-based Decision Making

Apart from being used as a monitoring tool, UniOne wants the dashboard to be used to support evidence based decision making. As an example given by Uni-Mgr2, one of the metrics on the dashboard has provided information on the allocation of Commonwealth funds. Thus users gained insight that some funds had not been allocated to students. As a result, they can make decisions based on the information to offer unallocated funds to courses which previously were only available for full fee paying students. This example demonstrates how the use of the dashboard is impacting both the organisation and students. The organisation can ensure government funds were allocated fully and effectively. The students can access the funds to enrol in courses which previously required them to pay upfront in full.

Evidently, UniOne's design team has approached key users in the organisation to promote awareness of the dashboard and to encourage the use of information to support their day-to-day tasks. But this is at a very early stage, as Uni-Mgr2 indicated that some users were not aware of the extent of information the dashboard can provide to support evidence based decision making. This re-emphasised what was discussed in Theme 3, specifically the importance of involving users earlier in the design process. Furthermore, it also helps in alleviating the inertia discussed in Theme 4. As Nah, Zuckweiler and Lau (2003) suggested, user involvement during the design and implementation of a new business process or a new system helps the users understand how the new system impacts their jobs. This can also be applied to UniOne with their dashboard design process.

Although the interviews suggest that information on the dashboard has helped them in making some decisions, it is worth noting that certainly there were other aspects influencing users in

making informed decisions other than information. Decisions can be made based on past repeated instances (Keen 1981) or intuitions (Martin 2009). Data and information on the dashboard can support decision making, but it does not warrant effective decision making as it would be heavily dependent on how the data is being used to help improve the situation (Marsh, Pane & Hamilton 2006). In some cases, information might only be used to rationalise decisions made in the past rather than being used in future (McKeen, Smith & Singh 2005). The direction UniOne has taken is moving towards using information on the dashboard to support future evidence based decision making.

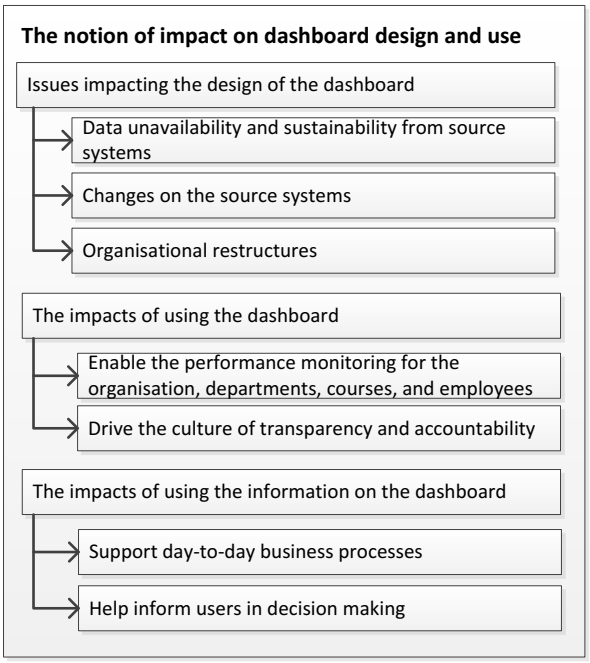


Figure 5.11 Takeaways from Theme 5

Figure 5.11 summarises key points as takeaways from Theme 5.

5.5 Summary

In this chapter, emerging insights from the first case study (UniOne) have been discussed. Regarding the first theme, the aim of designing a dashboard for each organisation was discussed. This included discussion on the aims and importance of dashboards for the organisation, and how dashboards help organisations utilise years' worth of accumulated data and other data collected from various sources, such as resource management, financial, and customer relationship management systems. Subsequently, key aspects and design principles in designing a dashboard were conversed in the second theme.

In the third theme, the issue of designing a more user-centred dashboard was discussed. Based on Brown (2009), the notion of design thinking suggested that innovation can be achieved through a balancing act of feasibility, viability and desirability. With the latest technologies and support tools to create a dashboard, feasibility and viability may become less of an issue. Therefore, it was argued that dashboard designers could focus more on user needs and therefore design a more useful dashboard. An emergent idea in this theme was how organisations are on the road to innovation by designing a more user-centred dashboard. This notion is in line with Wölbling et al. (2012, p.135) who suggests that design thinking enables engagement, empathy, and collaboration with users in understanding their requirements, thus "increases the chances of generating innovative ideas".

Evidently, designing a dashboard could come with challenges for some organisations. Based on design thinking as the conceptual framework, the fourth theme discussed ways to deal with those challenges, for instance, through early prototyping or by striking a balance of time spent on the problem and the solution. On the last theme, impacts of dashboard use on the organisations in terms of accountability in decision making and transparency of information was outlined. Discussion in Theme 5 emphasised that the design issue is indeed a critical one; hence it should not be underestimated.

A summary has been provided at the end of each theme discussion in the form of 'takeways' or key points. The next chapter will employ a similar structure to discuss the CareOne case study

Chapter 6: CareOne

6.1 Introduction

In this chapter, emerging insights from the second case study of my research are discussed. Chapter 5 discussed the first of two case studies. The structure of this chapter follows that of the previous chapter. First, background information on the organisation will be given, followed by relevant business processes and a general organisational structure of the departments. Second, some further information on research participants, particularly in relation to their job roles and responsibilities are described. Lastly, themes that have emerged as a result of my data analysis are discussed.

6.2 Background information

Established over a decade ago, CareOne is a not-for-profit organisation that delivers personalised aged care and disability services to older people and those with disabilities to live in their own homes and be more included in their communities. Although this organisation is based in Melbourne, Australia, CareOne operates in Melbourne, Sydney, and in various regional areas in Victoria and New South Wales, which in total employs more than 300 people. The organisation is mainly funded though government grants which have been allocated annually. When clients come to them requesting assistance, they are given a personalised service plan according to individual goals. The organisation has its own network built through partnerships with more than 200 commercial, government and non-government organisations. This network enables them to connect with and provide services to more than 10,000 clients each year. The services they provide can be as simple as helping an elderly client in mowing their lawn, or as complex as arranging a shared accessible house for clients with disabilities so they can live independently.

Figure 6.1 shows a simplified organisational structure covering the organisation's key departments. Three circled areas indicate areas of interest where interviews have been conducted. Further information on each research participant is discussed in the next section.

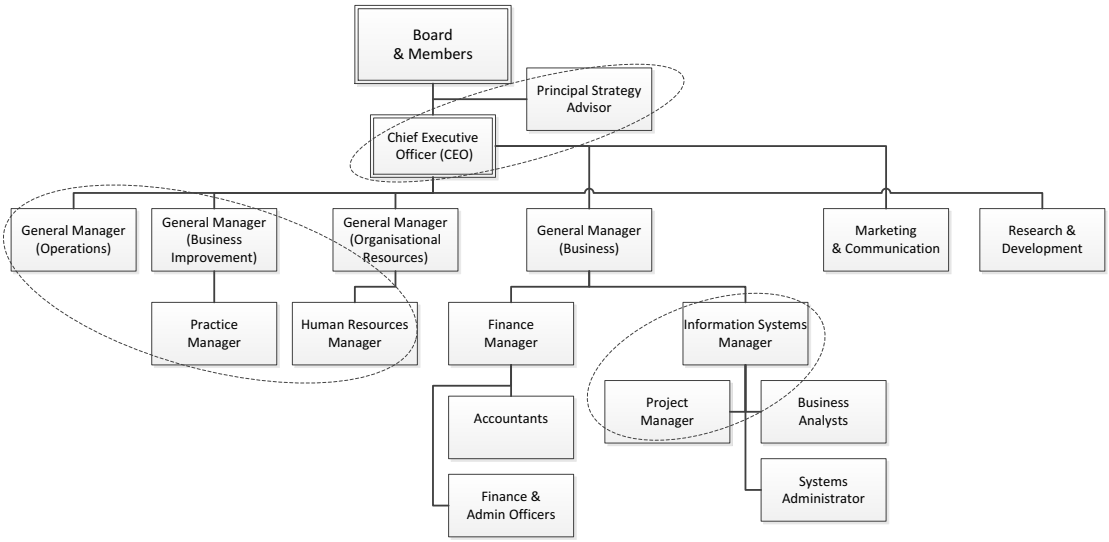


Figure 6.1 CareOne's organisational structure

Until this study was conducted, the organisation had had a fairly limited number of standalone information systems used to support day-to-day operations, for instance: carelink+ application for managing clients, a finance system, a payroll system, and a recruitment system. In 2012, the Human Resources (HR) department requested specifically for a HR system to be developed by the Information Systems (IS) department. In response to this request, Care-Mgr, one of the participants (see Table 6.1 for a full list of participants), suggested an integrated Enterprise Resource Systems (ERP) instead of a standalone system for each department. As a result, Care-Proj-Lead, who was a member of the HR team, was seconded to the IS department in 2013 to mainly gather requirements for the intended ERP system. Care-Proj-Lead has to analyse current business processes in the organisation to identify any potential improvements to the process to be made before the system is developed.

At the time of initial interviews (early to mid-2015), the aged-care industry has undergone a major change due to a new initiative by the Australian government called Consumer Directed Care (CDC) (myagedcare.gov.au 2015). Previously, Care-Mgr explained that government funding was distributed directly to various aged-care service providers through a bidding system in which CareOne participated. Subsequently, CareOne would deliver their services to their clients based on the allocated number of aged-care packages from the government. When CDC began in July 2015 government funding was distributed directly to clients, giving them the option to choose their preferred provider to deliver care services.

Thus CareOne's current business processes and information systems are CDC compliant. The organisation also prepared for the National Disability Insurance Scheme (NDIS) launched in 2016 (Buckmaster 2012; Ireland 2013). These two main recent government initiatives have added a

sense of urgency to the earlier initiative to develop the ERP system. As the scope of the project has become bigger and more significant, Care-Proj-Lead was appointed as the project manager to work with business stakeholders to make necessary process changes and to implement the ERP system eventually.

While analysing current business processes, Care-Proj-Lead has come across ways to improve the organisation's reporting and to initiate a key performance indicator (KPI) monitoring process through performance dashboards. The current process of gathering data to generate performance reports has not been very effective or efficient. It was a laborious exercise and could take days for them to source a piece of information for the reports. When the reports were finally prepared, participants reported that the information might not be that useful and some users would not even need it. The Chief Executive Officer (CEO) agreed that the reporting process needed to be improved to ensure the right information was delivered to the right person in a timely manner.

Furthermore, the project also entails the initiative to design dashboards for the purpose of monitoring the performance of employees, departments, and the organisation. To support this initiative, they need to identify key performance indicators to be monitored. CareOne planned to use Balanced Score Cards (BSC) developed by Kaplan and Norton (1996) to help with the KPI identification for the organisation, its departments, and employees. This was discussed at an initial meeting with the CEO in April 2015. The detailed timeline of the interviews is described in Figure 6.2. Care-Proj-Lead prepared a project brief following this meeting to disseminate awareness of the project to potential dashboard users. At the same time, Care-Proj-Lead also organised a survey for key users to determine the order of importance of a number of KPIs identified using BSC.

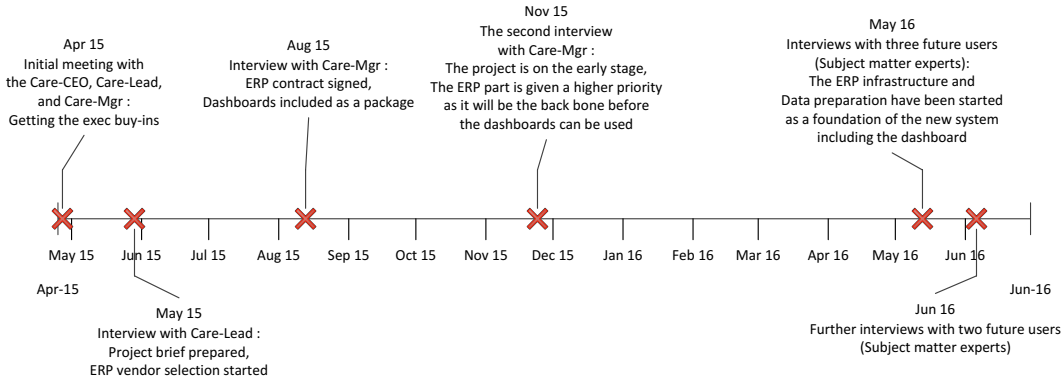


Figure 6.2 Interview timeline with research participants in CareOne

Three months after the initial meeting in April 2015, CareOne signed a contract with a Melbourne-based vendor, a technology company called TechAus[3], to implement the ERP system. The process of selecting the vendor was a rigorous one involving key executive and management users from the finance and human resources department. The new ERP system will also be integrated with CareOne's existing client service management system called carelink+. Along with this ERP project, dashboards would be included as a package. Figure 6.3 delineates a simplified implementation diagram of the project. This illustrates how the design of the dashboards will be aligned with the main organisational strategy. Integrated data gathered by the ERP systems will be used on the dashboard for the purpose of performance monitoring and to support users in making informed business decisions.

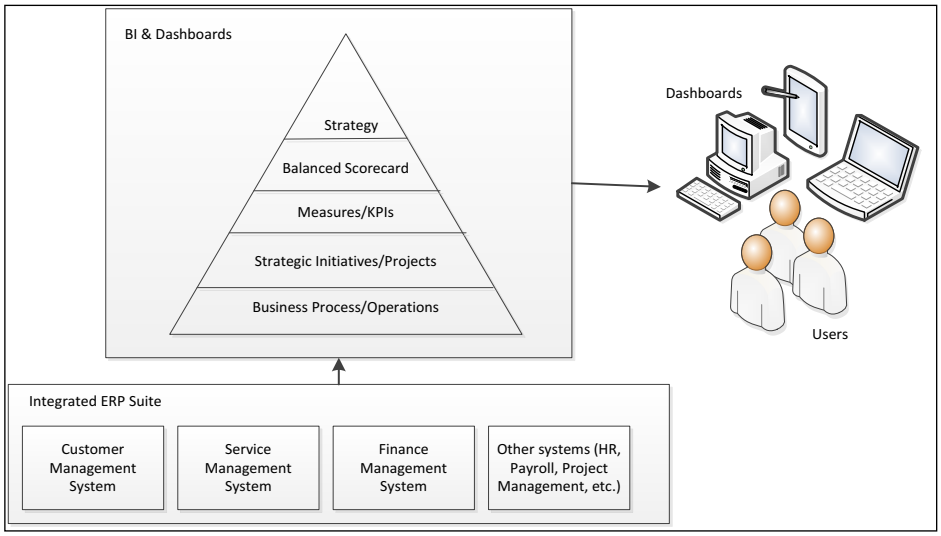


Figure 6.3 Implementation diagram of UniOne's dashboard

For this study, the interviews were conducted with key personnel responsible for the ERP and dashboard project. Thereafter, they would be referred to as the design team, and the ERP and dashboard project would be referred to as the project. The design team was led by Care-Proj-Lead and supported by Care-Mgr to provide project assurance. The core team members were the subject matter experts from finance, payroll, HR, and stakeholder management departments. The subject matter experts, as the name suggests, were experts in each department who would define requirements of the system. They were also responsible for liaising with fellow users in their department to keep them informed of progress on the project.

Additionally, the design team was supported by members of the IS team. The business analysts were responsible in data conversion and transformation, and in managing the user acceptance

[3] The name of the technology company was changed to de-identify CareOne.

testing. The IT supports were responsible in overlooking how the new system runs on the network. Lastly, the carelink+ supports take care of the interfacing between carelink+ application and the ERP system. It is worth noting that only Care-Proj-Lead was assigned to the project on a full-time basis; the rest of the team members were not exclusively assigned to the project as they had to attend to other current systems and/or other tasks.

6.3 Information on research participants

Relevant information on each participant and their job roles in relation to the project is summarised in Table 6.1.

Table 6.1 Interview participants in CareOne

Participant	Job title	Role description
Care-CEO	CEO	Care-CEO supports and promotes the project to the project governance board, prospective users, and other stakeholders to make sure that everyone in the organisation is on board with the change initiative.
Care-Mgr	Information Systems (IS) Manager	Care-Mgr's project role is to provide assurance. Care-Mgr identifies and manages risks, oversees the project, ensures and provides assurance to the project governance board and other stakeholders that the project can be delivered in time according to the planned budget and the desired quality.
Care-Proj-Lead	Project Manager	Care-Proj-Lead was seconded to the IS team from the HR department. Care-Proj-Lead leads the project on a full-time basis, manages relationships between users, the design team, and the software vendor, and works very closely with Care-Mgr in managing the project.
Care-User-Strat	Principal Strategy Advisor	Care-User-Strat is a member of the governance board of the project. Care-User-Strat is very data savvy and will be an expert user of the dashboard as well as a user advocate to fine tune dashboard use and to align it with user roles in the organisation.
Care-User-GMOps	General Manager (Operations)	Care-User-GMOps will be one of the users of the dashboard. Care-User-GMOps has always used information from various sources in the organisation to inform Care-User-GMOps's decision making. The dashboard would make it easier for Care-User-GMOps and other users to access integrated information to support business processes and decision makings.
Care-User-GMBiz	General Manager (Business Improvement)	Care-User-GMBiz will be one of the users of the dashboard. Similar to Care-User-GMOps, Care-User-GMBiz considers business decision making should be supported by necessary information. Care-User-GMBiz emphasises that in selecting key metrics for the dashboard, business drivers and outcomes should be considered apart from financial indicators. This is to enable

		the users to have a balanced view of the organisation through the dashboard.
Care-User-HR	Human Resource Manager	Care-User-HR will be one of the users of the dashboard. Care-User-HR has been involved in the project since the initiation as the project was started as a HR system improvement. The HR department has nominated one of the team members to be a subject matter expert in the design team. The subject matter expert will keep Care-User-HR updated as the project progresses and ensures that the HR team's requirements have been taken care of.
Care-User-Prac	Practice Manager	Care-User-Prac will be one of the users of the dashboard. Care-User-Prac believes in process changes, improvements, and innovation. Care-User-Prac expects the dashboard to provide information for all users in the organisation so the users would not have to use anecdotal evidence to support business decision making. Care-User-Prac also anticipates the dashboard to enable the organisation to monitor its performances to ensure the organisation achieves its goals in making social impacts on the community.

6.4 Themes emerging from the research

As explained in Chapters 4 and 5, five themes have been identified and developed as a result of the second cycle of coding, in which the date is summarised based on "categories or themes, causes or explanations, relationships among people, and theoretical constructs" (Miles, Huberman & Saldaña 2014, p. 87). A similar structure is used in this chapter to discuss CareOne's case study.

6.4.1 Theme 1: The aims of designing a dashboard for an organisation

In this theme, the aims of designing and developing dashboards are outlined from the point of view of the CEO, members of the design team, and key users. Based on the interviews, dashboards are viewed as a platform to monitor progress towards the organisation's strategic goals. The monitoring task is achievable through the use of key performance indicators (KPIs) or metrics defined and selected. Prior to starting the dashboard design process, the design team and key users have been in discussion to define KPIs suitable for them to measure performance of each department and overall performance to achieve the organisation's strategic goals. Apart from monitoring purposes, the CEO concurred that the dashboard can be used to empower and inform business decision making. Furthermore, the dashboard can be used to support, facilitate, and enable business improvements in the organisation.

6.4.1.1 Dashboards as a platform to monitor progress towards the organisation's strategic goals

The participants in CareOne agreed that one of the purposes of the dashboard is to monitor the performance and health of the organisation. According to Care-User-GMBiz, the dashboard is expected to be 'one source of truth' which promotes information awareness for all users in the organisation and facilitates efficient information extraction. Care-User-GMOps added that the dashboard should utilise data collected by existing systems and from various external sources in order for it to deliver comprehensive information and be valuable to users. Subsequently, it will make the process of sourcing information more efficient, as the users only need to use a single platform.

In order for the dashboard to monitor the performance and health of the organisation, the design of the dashboard has to be aligned with the organisation's strategic goals. In a way, metrics or KPIs used to measure organisational performance must be defined based on the strategic goals. As described by Care-User-Strat, as an organisation, CareOne's performance is measured by whether or not it is making social impacts on the community. Care-User-Prac added that overall organisational strategic goals would subsequently need to be translated into practical goals at departmental and operational levels.

> *I think we need the program to help the organisation align and deliver its – on its mission and its purpose and its values, and for us to be able to continue doing that in the future with significant changes in the community sector and increased competition, a project like this, and the implementation can only assist us in our work by getting proper data, good data, knowing where our inefficiencies are, and so we can fix them and so that way, we can be more competitive. [Care-User-GMOps]*

Although the dashboard design process is still in its early inception, Care-User-Strat stressed the importance of measuring the right metrics and putting the organisational strategic goals in perspective. At the moment, Care-Proj-Lead stated there has been a disconnect between the organisation's strategic plan with employee performance measures. Therefore, the dashboard project should give the design team and key users an opportunity to get it right. According to Care-User-Strat, performance should be measured by outcomes not outputs. Provided the dashboard is designed well and consistent with CareOne's strategic goals, it should provide its users with a view of staff, departmental, and overall organisational performance.

With regards to the performance of the organisation, Care-User-GMBiz clarified that the design team should not focus exclusively on financial measures. Even though it is crucial for a not-for-profit organisation like CareOne to remain sustainable, Care-User-GMBiz suggested they should not lose perspective in terms of their strategic goals. Hence the financial measures used on the dashboard should be balanced with other measures to give users insight from various perspectives. Eventually, CareOne should look into whether or not they have made social impacts on the community, as emphasised by Care-User-Prac.

> *What we are trying to prove is, if you get a package from CareOne, you are more likely to stay at home longer, not moving into a nursing home or an institution. So they are kind of the little bits and pieces that would evolve around… How would we know people are better off by getting a service from CareOne? [Care-User-Prac]*

In terms of dashboard design, the design team aimed for all users to have access to a single display of insightful information. The users at executive level would see the most aggregated level of information, while management level users would be able to drill-down the information on the dashboard, and operational level users would be able to see the most detailed information.

6.4.1.2 Dashboards enable the use of integrated data to inform decision making

In CareOne, the dashboard is delivered as part of the ERP project. Originally initiated as an upgrade to their outdated HR system, Care-Mgr as the IS manager suggested CareOne build an ERP system. The system acts as a backbone in the organisation supporting daily business processes in delivering services to their clients. Subsequently, the ERP system will collect data across the organisation from various business processes in all departments. The integrated databases would be a valuable data source to be used on the dashboard, and include the data accumulated by their existing legacy systems and client service management system.

Care-Mgr pointed out that the organisation has been collecting data over the years but has not used it to inform decision making and to support business processes. Other participants including Care-User-GMBiz agreed.

> *We do great stuff in this organisation, but one thing we don't do great is the use of data. And we have lots of data, but it's scattered through a million systems. And like it or not, we haven't known how to get it out on time which is a challenge. [Care-User-GMBiz]*

Current legacy systems in CareOne provide limited information and require users to perform manual checking of different parts of the organisation in order to get information, according to Care-User-GMOps. The ERP and dashboard project would help CareOne build an infrastructure to make use of their existing data and to streamline the process of collecting new data for an integrated database. Care-Proj-Lead added that the dashboard is expected to offer consistency in reporting in comparison to CareOne's current inefficient and "*dreadful"* reporting system. Care-CEO also concurred their current reports did not deliver useful or meaningful information with regards to organisational performance and anticipated that the dashboard would perform better in delivering information.

Furthermore, Care-CEO advocated that users in CareOne need to start looking at the data to inform if the organisation is running at full capacity and efficiently. Ideally, users should have access to information on the dashboard on a daily basis, according to Care-Mgr.

> *This is my vision, and it could be taken as naïve. But my vision is that if you go in the morning, you switch on your computer and you see… [Care-Mgr]*

Care-User-GMOps added that the dashboard is not only an improvement on current systems but also could help with future planning by identifying inefficiencies in processes which in turn supports the organisation to be more competitive. In any case, the dashboard is expected to support decision making and to ultimately achieve organisational strategic goals.

> *So it's really using that data to target who we need to partner with that will then enable people to be more included at a community level. [Care-User-Prac]*

Apart from that, Care-User-Strat believed the use of information should enable users to be proactive instead of reactive to adverse situations. Especially with changes occurring in the industry, including but not limited to funding regulation changes by the government or increased pressure from competition. According to Care-Proj-Lead, many competitors have adapted their business processes to the new government changes and therefore CareOne should do so to remain competitive.

> *We're going to bring about huge change in business processes. If we don't there's no point. We're spending a lot of money on this. We're not doing it for fun, we're doing it to make us a much more efficient and effective organisation. Because if we don't, we won't survive. [Care-Mgr]*

So, as suggested by Care-User-GMBiz, every business decision making should be supported by relevant information. The dashboard will enable users to source information from a single, integrated, and consistent platform.

6.4.1.3 Dashboards support and facilitate business process improvements

When the project was initiated as an upgrade to CareOne's HR system, one of the user requirements, according to Care-Proj-Lead, is to have more streamlined and efficient reporting processes, not limited to improving how the reports were produced, but include the collecting the data to report generation. The old process involved manual paper-based processes and were labour intensive, according to Care-User-HR.

> *Oh my goodness, it's a long, arduous process. Most of it is on spreadsheets, hard copy. Data has to be manually fed – input is manual. The analysing is manual. If we want to get data, it's a manual process as well. [Care-User-HR]*

CareOne's information needs are quite complex including obtaining information for the purpose of government, compliance, and board reporting. Information is also needed for internal reporting on the organisation's performance to eventually measure the social impact the organisation has made on the community. With the new ERP and dashboard, Care-User-HR expected some automation of processes in collecting data for the purpose of generating reports and in supporting business processes.

Care-Proj-Lead mentioned that prior to project commencement, key business processes were analysed in order to identify inefficiencies and redundancies. Subsequently, those processes needed to be improved along with the project. This was supported by Care-User-Strat.

> *This isn't an IT program. This is an organisational change program. IT is just an enabler. [Care-User-Strat]*

Care-User-Strat also mentioned that it is important to take the business process changes into consideration when designing the new system. This is to enable these changes to be implemented with the new system. As a result, users should not be able to find a *workaround* in order to avoid using the new system.

The design team and key users agreed that improving business processes was necessary. Care-CEO specifically emphasised *environmental* changes in the sector, which were mainly due to the new CDC (Customer Director Care) funding scheme, which added a sense of urgency in revamping key business processes. For the same reason, their clients could decide to take their

business to CareOne's competitors. Hence, Care-User-GMOps process improvement would be inevitable to remain up to date and competitive in the sector. As Care-User-Strat has mentioned, the new ERP system and dashboard implementation would go hand in hand with and facilitate business process changes.

6.4.1.4 Interpretations and analyses

In CareOne, the dashboard and ERP are viewed as an integrated project which will be delivered along with process changes and alignment. Prior to starting the project, CareOne did not have an integrated enterprise system. Their information systems were mainly stand-alone such as payroll, finance, and the HR system. As previously mentioned, CareOne has a client management system, carelink+, which is the most prominent system in the organisation. Although there is no integration between carelink+ and the other systems in CareOne, most of the data used for their reports were sourced from it.

Essentially, the much needed ERP acts as a backbone system to collect data for finance, payroll, and HR departments and also integrates data with the carelink+ system. This data along with historical data will then be used in dashboards. The dashboard is expected to present meaningful and actionable information which indicates whether the organisation is running at full capacity. This strategy to implement dashboards along with an ERP system is in fact not uncommon, as the ERP will facilitate integration of various aspects in organisations (Pankaj, Hyde & Rodger 2006).

As mentioned in section 6.2, the project was originally initiated as an upgrade to the HR system. The recent government changes (NDIS and CDC) however have added a sense of urgency to kickstart the project. These triggers have driven CareOne to have better visibility of the health of the organisation, as emphasised by Care-User-Strat and stated by Houghton et al. (2004), which is one of the benefits attributed to dashboard use. As a not-for-profit organisation, they need to make use of insightful information to help with decision making which in turn helps the organisation to remain viable and to survive in a very competitive and changing environment.

Furthermore, the participants expected the dashboard to be a platform to monitor performance and the health of the organisation. As highlighted by Care-User-GMBiz, the dashboard is expected to be 'one source of truth' or a single place where users can source information. Essentially, it means that all users should be "looking at the same thing", which is the information displayed on the dashboard (Pankaj, Hyde & Rodger 2006, p. 1427). In a way, all users should see a consistent set of metrics to be used throughout the organisation and this notion is in line with Clark, Abela and Ambler (2006). As explained in Chapter 5, the idea is not dissimilar to the term 'single source of truth' from the data warehousing literature (Baltzan, Lynch & Blakey 2013;

Bose 2006; Lawyer & Chowdhury 2004). The term represents the data warehouse as an organisation-wide data repository, hence more consistent information can be disseminated across the organisation (Baltzan, Lynch & Blakey 2013; Bose 2006; Lawyer & Chowdhury 2004).

The design team has followed best practice suggested by Eckerson (2006), as discussed in Chapter 2, where a dashboard can be designed following a framework called Monitor, Analyse, Drill to detail or MAD (Figure 6.4). The form of a pyramid in the diagram intuitively indicates an appropriate proportion of the number of users and metrics on each level in an organisation.

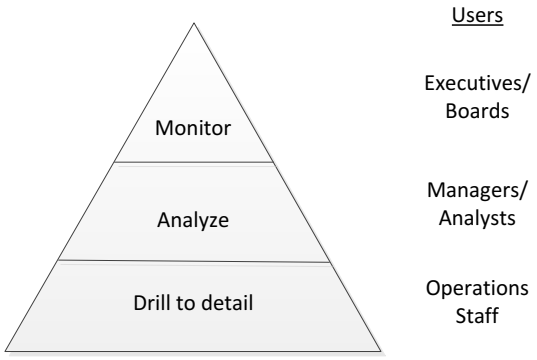


Figure 6.4 MAD framework (Eckerson 2006)

Moreover, the design team and key users stressed that dashboard design should be aligned with organisational strategic goals. This view is supported by Pankaj, Hyde and Rodger (2006) who pointed out the importance of relationships between dashboard design and organisational strategic goals. When users fail to see those relationships, they might not be compelled to use the dashboard, as they do not see it adding value or being relevant to current business processes (Pankaj, Hyde & Rodger 2006). Ideally, users should have self-service access to information which would enable more efficient inquiry, as mentioned by Houghton et al. (2004).

CareOne could refine their current business processes to align with the ERP and dashboard project. According to Care-Mgr, it is partly due to a limited budget and resources, so they cannot afford to customise the new system to match current business processes. Furthermore, according to Care-Proj-Lead, key users expressed their frustration with regards to the current process in obtaining information for the purpose of regular reporting. As Care-User-HR and Care-User-GMOps concurred, there have been some inefficient and ineffective processes that can be ironed out and improved along with this project.

Hence, Care-Mgr suggested some process improvement based on best practice in the sector. Additionally, Care-User-Strat mentioned that process changes have to be implemented together with the dashboard. As a result, users would use the dashboard as part of the newly improved

business processes. Arguably, the dashboard can be considered as a catalyst or enabler for organisational business process changes, as supported by Houghton et al. (2004). Houghton et al. (2004) used the Western Digital company as an example. With dashboard use, their daily five-hour production meeting can be shortened to less than two hours.

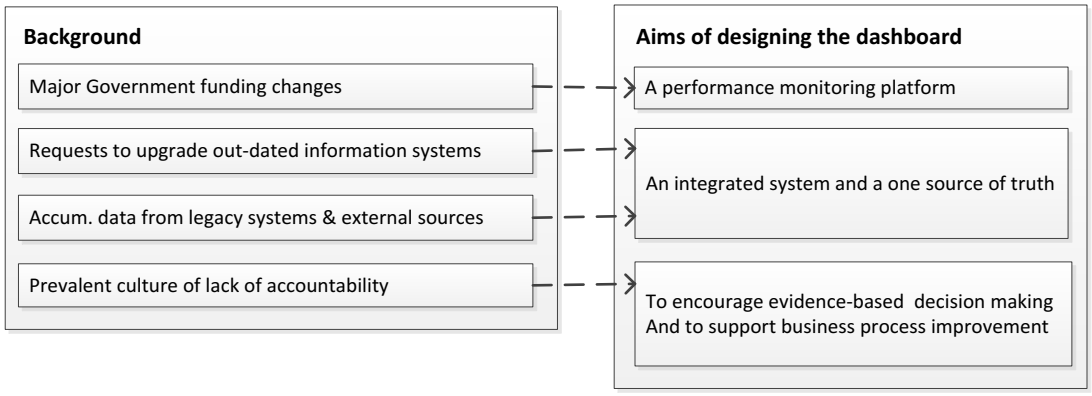


Figure 6.5 Takeaways from Theme 1

Figure 6.5 summarises key points as takeaways from the first theme. In theme 2 which follows, key aspects and principles in dashboard design are explored.

6.4.2 Theme 2: Key aspects and principles in dashboard design

For this theme, key aspects and principles in dashboard design are discussed. These relate closely to the dashboard components mentioned in Table 2.4 in Chapter 2. The discussion goes beyond the graphical user interface (GUI) aspect of design. Nonetheless this should not undermine its importance. In terms of the technological aspect of the dashboard, CareOne appointed TechAus to handle the development and implementation of the ERP and the dashboard. The design team would collaborate with key users and subject matter experts to define user requirements and to ensure the project was aligned with organisational strategic goals.

All key dashboard design elements mentioned in Table 2.4 in Chapter 2 were discussed by the research participants. However, more emphasis was placed on issues surrounding data quality and integrity as a foundation of dashboard design, and how analytics help users to make business decisions. The participants highlighted the importance of metrics definition in which the design team planned to use the renowned BSC as a guideline. Lastly, knowing the lack of accountability culture in decision making in CareOne, key users anticipated with the dashboard in place, users would be more accountable in taking actions when organisational performance falls below targets.

6.4.2.1 Data quality and integrity ensures reliability

Care-User-Strat believed it is critical for CareOne to have a dashboard, as it will provide a visual and simplified representation of data for users to access.

> *It's going to be a period in time, so you can actually look and then you can actually look to see how it's moved. You've got a nice indicator. You can see how you travelled against it. It's visual and it's simple. If it's thought through, if you're measuring the right things. [Care-User-Strat]*

Evidently, all participants agreed that the reliability of the dashboard will be dependent on the quality of data used by the dashboard. Firstly, the data needs to be relevant and current (up-to-date). As Care-User-GMOps mentioned, it will set the dashboard apart from regular monthly reporting systems as it provides more frequent, current, and actionable information to support decision making. Furthermore, Care-User-GMBiz added that data across the organisation needs to be integrated, thus consistency is maintained.

Undoubtedly, Care-Proj-Lead concurred that the design team needs to clean the data before being used on the dashboard. Having multiple stand-alone legacy systems might leave the design team with data quality and integrity issues (Valacich & Schneider 2010). The issue can be as simple as having inconsistent lower case/capital case in the 'Name' field for instance, or it could be a case of duplicated data. Although it might sound simple, Care-User-GMOps thought it was really important to obtain accurate information to inform users in making business decisions.

> *If we can get that information done efficiently without manual data replication from mistakes and get instant reports, it's amazing. … It's a real issue because on many levels, we can't give our clients the right information about what they've spent and what is owed to them. Our case managers find it hard to make decisions about saying yes or no to different products, because the information may not be right. Just having correct information, I think, is going to be really important. [Care-User-GMOps]*

It is clear that all participants considered data key. Hence providing a solid database infrastructure is an important foundation of the project, according to Care-User-Strat, which would be handled by the design team and the IT department. It will also include integration with legacy systems including Carelink+. As a result, the dashboard will be able to get data from various sources in CareOne.

Furthermore, it is also important for the design team to understand the context of data and/or information used on the dashboard. When collaborating with key users or subject matter experts, the design team needs to recognise the meaning and context of the metrics requested by users. Subsequently, the design team would be able to identify whether data sources were available and if the requirements can be addressed accordingly.

> *So that's why we are looking at this, the indicators, and dashboard reporting… Where do we get this information? And what does that look like? It's really important. Because even if there's a correlation, some of it would be relevant, some of it won't. [Care-User-Prac]*

Nonetheless, some key data have not been collected by any of the current systems in CareOne which will be addressed by the new ERP system. Essentially, the design team would need to properly identify the data needed according to user requirements (i.e. what metrics users need to monitor individual/departmental/organisational performance). The new system will support daily business processes and collect data for the dashboard.

> *What do we need? We do need to be able to monitor it [performance] and the use of external agencies. Whether or not that's the best indicator, we actually, in some teams we used, in my view, far too many. And across the organisation. We have far too many. …. To put it bluntly and obviously we're going to need a major project to pull that back. The question is what data needs to be collected ongoing to really monitor[sic]. [Care-CEO]*

6.4.2.2 Choosing the right metrics

When it comes to defining and selecting metrics or KPIs to be used on the dashboard, Care-CEO agreed that it is an important yet not straightforward process. The metrics need to be aligned with CareOne's strategic goals and should be designed with built-in flexibility for users to adjust thresholds or targets for each metric. The number of selected key metrics to be used on the dashboard should be kept to a manageable number, according to Care-Proj-Lead. Care-User-GMBiz added that the dashboard should provide alerts to users when a certain value of metrics falls below the set threshold. Furthermore, users should be able to drill-down the information to investigate further and take action accordingly. The level of granularity of information that users can access will be dependent on user roles. The notion is similar to the three dashboard user roles discussed in Chapter 2. Table 6.2 details characteristics of dashboard users.

Table 6.2 Characteristics of dashboard users (Anthony 1965; Eckerson 2006; Valacich & Schneider 2010)

User Characteristics	Roles	Information Characteristics	Decision Making Characteristics	Dashboard Functionality
Executives/Boards	Strategic	Aggregated, summarised	Unstructured, irregular	Monitor
Analysts/Managers	Management	Function specific	Semi-structured	Analyse
Workers/Operations	Operational	Task specific	repetitive, structured	Detailed

Other than using KPIs as metrics on the dashboard, Care-CEO suggested the design team might look into leading indicators which could be useful to flag potential problems. Meanwhile, Care-User-Strat recommended that metrics selected should measure quantifiable outcomes. But most importantly, the design team needs to make sure that users are measuring the right things. As Care-User-Prac mentioned, it is important for users to know the context and meaning of each metric, hence they know what it is measuring and why each metric is selected.

According to Care-User-Strat, the organisation has been measuring the wrong metrics all along. Performance of the organisation was measured by outputs instead of outcomes. Care-User-Strat believed that as an organisation, CareOne already had a set of metrics to be used in measuring the organisational performances. The dashboard is expected to enable them to actually use the metrics to monitor the health of the organisation.

> *Well, we know what the KPIs are. We haven't got the systems in place to measure them. So we've got to do the foundation work and once that's done, well then, we can start to collect the data that will lead to the measurement against KPIs that we're seeking. [Care-User-Strat]*

Care-User-Prac suggested the use of a publicly available well-known model to help users define and select metrics or indicators for their dashboard. For instance, for the customer service metrics, CareOne can use the Community Indicators Victoria (CIV) framework as a benchmark or guideline (McCaughey 2016). The indicators are categorised into five major domains. They include: healthy, safe and inclusive communities; dynamic, resilient local economies; sustainably built and natural environments; culturally rich and vibrant communities; and democratic and engaged communities (McCaughey 2016). Care-Proj-Lead and Care-Mgr suggested Balanced Scorecards (BSC) as a guideline for users to set up or select metrics applicable to their business processes. BSC advise four different perspectives, namely financial, customers, internal business processes, and learning and growth (Kaplan & Norton 1996) to identify metrics used to track organisational strategic goals.

Moreover, Care-User-GMBiz emphasises that in selecting key metrics for the dashboard, business drivers and outcomes should be considered separately from financial indicators. This is to enable users to have a balanced view of the organisation through the dashboard.

> *There's other stuff like this that is equally important because then we are performing well financially. It doesn't actually mean we're delivering anything that we say we are going to deliver, so I think that's the balance between financial and risk management stuff and then the other stuff is more focused on outcomes. [Care-User-GMBiz]*

6.4.2.3 Users and culture in the organisation

Based on the interviews with key users in CareOne, it is evident that they are data savvy and understand the importance of evidence based decision making, the use of metrics for performance measuring, and the use of information systems to support business processes. During the early stages of the project, key users have been involved in selecting the vendor to be hired to implement the ERP system and dashboard. By involving them, Care-Mgr anticipated that it would increase use and acceptance rates when the system is finally implemented. The key users felt optimistic about the project although Care-User-Strat thought some users probably would not know it exists. Potentially, this is because the design team has been focusing on their collaboration with key users and subject matter experts during the early stages of the project.

With regard to user expectations, generally the expectations are fairly high.

> *Expectations are high, you know. It's been – we've invested a lot of money into it, so we need to – the expectations are high. [Care-User-BizOps]*

Although, Care-User-HR expressed being unsure and quite overwhelmed in terms of what to expect from the dashboard. Care-Mgr concurred that some users had experienced difficulties in articulating their requirements. They tend to get fixated in discussions and take a long time to make decisions, according to Care-Mgr.

> *We like to get in a room and talk talk talk… Alright, I'm like corporate, so I'll say here's the agenda, here's the decisions we have to make. … I've got three consultants that we're paying for and I need their decisions. [Care-Mgr]*

Nonetheless, the design team has constantly worked together with the subject matter experts in defining the requirement. It is crucial for the design team to be upfront about scope, resources, and project budget to manage user expectations.

In terms of decision making, users in CareOne tend to be more reactive instead of proactive, according to Care-Proj-Lead. Instead, seeing a trend or a pattern based on historical data and pre-empting before things become problematic, there is a tendency in CareOne to make intuitive decisions to address problematic situations.

> *We go down that 'I've got a bad feeling in my gut that something is going to happen', to 'oh my god it's happened' road, and then we look at doing something about it. So it's purely because we don't have the appropriate amount of information at our fingertips to make those decisions before those bad things happened. We are very reactive. [Care-Proj-Lead]*

Being a not-for-profit organisation, most of the staff or potential users of dashboards in CareOne have a social work background. According to Care-Mgr and Care-Proj-Lead, this can prove to be challenging, to convince them about the new concept of using the new system and the dashboard to support business processes and decision making. Furthermore, Care-User-HR added there is a culture of lack of accountability in task owning and decision making in CareOne. According to Care-User-Prac, CareOne has not been using the right metrics to measure the overall performance of the organisation which has resulted in people not being held accountable, or they only become accountable for wrong metrics. Eckerson (2011) mentioned that unless people are held accountable for actions or decisions made, it is going to be challenging to change their habits and culture in the organisation.

6.4.2.4 Key design principles support the design process

When it comes to the presentation of data in dashboards, the participants agreed that it should be simple and consistent. According to Care-CEO, the simplicity should be reflected in the way information is being visualised so information overload can be avoided. Care-Proj-Lead added that the use of terms, colour codes, or any form of dashboard visualisation on the dashboard should be consistent and the meaning should be explained.

Furthermore, Care-Mgr anticipated the design team would use a template provided by TechAus as a starting point, and a foundation for further improvement. Essentially Care-Mgr's idea is to use something 'tried and tested' in their dashboard design process, as the dashboard is something relatively new for CareOne. Similarly, Care-Mgr stated that the design team would be using Kaplan and Norton (1996)'s Balanced Scorecards (BSC) to help users identify key metrics for the dashboard.

I tend to think given that our starting point, we don't aim for the moon. Let's just take one step at a time with something that's well tried and tested like the balanced scorecard. [Care-Mgr]

At first, Care-Proj-Lead's idea was to use BSC as a guide to start exploring which metrics were suitable to monitor the performance of the organisation and for each department. The idea is supported by Airinei and Homocianu (2006) and Lawson, Stratton and Hatch (2007) whereby scorecards and dashboards are partners in performance measurement and monitoring. Although as the project progressed further, time constraints and changing priorities have stemmed the idea, so it has to be scrapped. Nonetheless, it is possible for an organisation to start designing a dashboard based on their scorecard's experience and to modify it according to their needs (Pauwels et al. 2009).

Another key principle in designing a dashboard is to make sure that it has meaningful and actionable data along with analytic features such as forecasting, trends, and comparative analyses.

I think consistent dashboard reporting shows this over time, what people are doing, I think is really powerful, as well as the story alongside it, because data is just data, and unless there is some analyses to say what the hell the data is telling us, and what are we going to do about it… do more of or do less of or totally change it, then the data is useless. [Care-User-Prac]

Analytics are needed to *empower* users in the organisation to use historical data and competitive information to inform decision making, according to Care-CEO. Care-User-Strat stated that analytics can indeed be powerful and provide an example of how it can be used in deciding a location to open a new branch. In Care-User-Strat's example, Care-User-Strat used CareOne's historical data in which locations where most staff were recruited can be determined. External data was also used as a comparison to subsequently assist further analyses in determining the new branch location, where they can run an office effectively and where services are needed.

I got data from Macquarie University,[which] looked at employment vulnerability, so all of these indicators point to high levels of relative poverty. … So those communities where there are low levels of employment, of skills and education, impoverished communities and low levels of employment … they've also got a high level of ageing and a similar prevalence of disability. They are the communities in which we should be working first to develop our resource. … Having a dashboard that would draw this data out, so if we decided we wanted to look into say –the south

east suburbs, … we will extract data based on these and a number of other headings, and it would tell us, Frankston. [Care-User-Strat]

6.4.2.5 Interpretations and analyses

The design team has been building a robust project foundation by preparing and integrating data from various sources, as well as cleaning up inconsistent data. Ideally, the dashboard should display different granularity of information depending on user roles and provide an analytics feature. However, with a limited budget and resources, it was key for the design team to manage user expectations by being upfront about the scope of dashboard design. Most importantly, the design team was required to guide users to select relevant key performance indicators (KPIs) or metrics to be used on the dashboard.

Data and technologies

It is clear that all participants considered that data is key to delivering a useful dashboard. Having comparable data will provide context or meaning to information presented on the dashboard. Other than that, Care-User-GMOps added that with reliable and actionable data, it would set the dashboard apart from their regular monthly reports. Evidently, they needed integrated data from various sources in the organisation and from external sources to be used for on the dashboard. Hence Care-Mgr argued that CareOne needs a good ERP system to collect data from various departments. This particular issue will be discussed further in Theme 3.

In terms of technologies, the participants did not raise significant concerns. Essentially, CareOne has selected a vendor called TechAus to help them with the development and implementation of the project. IT support would ensure the new system can be implemented and integrated well in their current IT infrastructure. Therefore, the design team could concentrate on gathering user requirements and collaborate with users in the design process.

Metrics

In CareOne, there seems to be great emphasis on the issue of metric selection. The design team used the BSC to help users identify key metrics relevant to them. Indeed, the scorecards can assist in transforming the organisation's "vision and mission statements" into specific, assessable goals and enable users to monitor organisational performance in terms of achieving those goals (Wisan 2002, p. 132). It may not direct the design team and users to select specific metrics to monitor, but at the very least it moves them in the right direction by examining organisational performance

through those four perspectives (Wisan 2002). Arguably, this exercise should help users identify important metrics to select for their dashboard at a later stage.

Although organisations often mistakenly use dashboards and scorecards interchangeably (Lawson, Stratton & Hatch 2007), CareOne knows the difference between them. As Care-Mgr stated, the scorecards would be used for guidance or as a framework to inform the selection of key metrics. This view is supported by Airinei and Homocianu (2006, p. 329) who stated that "using the Balance Scorecard framework is a good place to start" before designing a dashboard. Essentially, it allows the organisation to align key processes and to transform their strategic plans into "operational objectives, measures, targets, and initiatives" (Airinei & Homocianu 2006, p. 329).

Furthermore, Resnick (2003) suggests that dashboards can be designed based on quadrants of a BSC. In a way, the scorecard acts as a platform for the organisation to have initial ideas on how dashboards can be designed. In any case, it is not a bad strategy for an organisation to implement a scorecard system before designing a dashboard, as it would indicate how strategic plans are communicated and get the organisation accustomed to a culture of accountability (Lawson, Stratton & Hatch 2007). In CareOne's case, as stated by Care-User-Strat, the users seemed to have an understanding of their relevant performance metrics. Therefore it is only a matter of selecting the key ones to be used on the dashboard.

Analytics

In CareOne, the dashboard is expected to have analytics as one of its features. According to Care-CEO, analytics would provide additional context and meaning to the information being presented. This is materialised in the form of predictive, trend, and comparative analytics. Care-User-Prac added that with analytics, it should help users in analysing and making sense of information on the dashboard. Care-User-Strat provided an example of how analytics can be used in supporting decision making. Care-User-Strat used historical data to determine locations where most staff had been recruited. Furthermore, external data was also used as a comparison to assist further analyses in determining the new branch location, where they can run an office effectively and where services are needed.

By designing dashboards with analytics and forecasting capabilities, users will not only be presented with information, but the ability to analyse and perform a what-if analysis with the information (Nagy et al. 2009). Indeed, analytics helps in reducing the size and complexity of data and works best with visualisation (Wang, Wang & Alexander 2015). With that, users can subsequently make an informed decision when needed. In the long term, this could potentially

increase the quality of decision-making activities in the organisation. However, it is worth knowing that benefits of analytics might be dependent on how 'expert' the users are. Users with high analytical skills, like Care-User-Strat for instance, are needed. Apart from that, a high level of understanding of critical business processes goes hand in hand.

Users and the organisation

In CareOne, key users seem to have good understanding about the importance of the dashboard design process. Generally, user's expectations are high, as the project is viewed as costly but valuable for the purpose of monitoring and supporting decision making. However, there seems to be a dissonance between the apparent user's attitude towards the project and reality. According to Care-Mgr, some users would *nod their heads and agree because the CEO is in the room and they walk out and do something totally different*. Care-User-HR concurred that in CareOne there is a culture of lack of accountability in task owning and decision making across the organisation.

Organisational culture can be viewed as "an encompassing web of routines and patterns" (Oss & Hek 2011, p. 27), which explains why it is not an easy task for some users to break into a new habit. Designing a dashboard requires a serious commitment from stakeholders at various levels to ensure the dashboard is perceived to be useful (Wisan 2002). It is a challenge the design team must face. This issue will be discussed further in Theme 4.

One way to deal with this issue is to actively involve users in the design process, so it gives them a sense of belonging. Also, by involving users, Care-Mgr anticipated that it would increase use and the acceptance rate when the system is finally implemented. Through user participation, it would provide the design team with all the necessary information to ensure the end result would be high quality. But at the same time, it is important to give them the ability to influence design decisions so they can value their participation (Markus & Mao 2004).

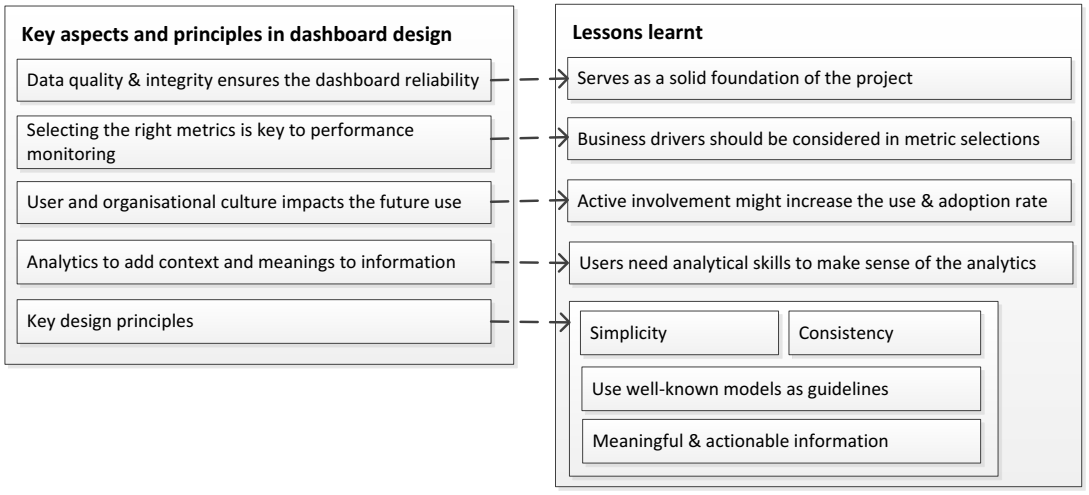


Figure 6.6 Takeaways from Theme 2

Figure 6.6 summarises key points as takeaways from the second theme. For the next theme, aspects taken by CareOne to design a more user-centred dashboard will be discussed.

6.4.3 Theme 3: Designing a more user-centred dashboard

For this theme, the participants discussed activities undertaken prior to the design process. The design team had been building a robust foundation by preparing and integrating data from various sources, as well as cleaning inconsistent data. Ideally, the dashboard should display different granularity of information depending on user roles and provide an analytics feature for users. However, with a limited budget and resources, it was key for the design team to manage user expectations by being upfront about the scope of the dashboard design. Most importantly, the design team was required to guide the users to select relevant key performance indicators (KPIs) or metrics to be used on the dashboard.

Furthermore, the focus on user needs and co-evolution of problems and solutions were discussed. The design team started collaborating with subject matter experts who represented users from various departments in the organisation. By doing so, this facilitates the design team in understanding user requirements. Also, by involving users early on in the design process, it supports acceptance and future use of the system as suggested by Robey and Markus (1984). Essentially, CareOne adopts a holistic approach by viewing the project as a business process change instead of a mere technological overhaul which demonstrates the essence of design thinking. Besides getting sponsorship support from the executive management and the project governance board, the design team also ensures the design of the dashboard is aligned with the organisation's strategic goals.

6.4.3.1 Groundwork activities in preparation for the design process

About a year prior to project commencement, Care-Proj-Lead has been analysing CareOne's key business processes to explore ways to improve inefficiencies from the perspective of information systems. While most finance processes seemed to be fine, according to Care-Proj-Lead, Care-Proj-Lead has been working with the marketing and HR department to map current inefficient reporting processes. Subsequently, Care-Proj-Lead has made suggestions for more effective and efficient processes. Essentially, this business process analysis is an important exercise to prepare for the start of the project. After all, as discussed in Theme 1, the new ERP system and dashboard implementation would work together to facilitate change.

At the start of the project, Care-Mgr admitted that the design team were *stepping a little bit into the unknown.* Hence the design team and stakeholders approached the dashboard design process and regard it as something totally new because CareOne has never had a project of this scale before.

> *That's the thing. So although we've signed on the dotted line and have all these meetings and all the rest of it, it can only go so far … We've seen as much as we can, we've invested a lot of time. We seemed to have ticked all the boxes. But we're never really sure exactly what we're going to get, what it's going to look like. So who knows … [Care-Mgr]*

Essentially, that is in line with Boland and Collopy (2004) who suggested designers start anew on each design task and always strive for something new and innovative. At the same time, designers should respect any special conditions or constraints, but they should not feel limited by them. Instead, they should have the ability to exploit contrasting ideas and constraints to create new solutions (Brown 2009). Care-Proj-Lead and Care-Mgr agreed that constraints can motivate the design team in analysing the design problems and exploring the solution criteria concurrently.

> *I think the constraints will be good for us. They will make us focus and they will make us move quicker than we are used to in [CareOne]. [Care-Mgr]*

Another way to assess the opposing constraints is to strike a balance between desirability, viability, and feasibility (Brown 2009). In terms of viability, CareOne has obtained financial approval and buy-ins from their executives to support the project. Regarding feasibility, the design team and key users have selected TechAus as the vendor to implement the ERP system and the dashboard. CareOne's IT support can work together with TechAus to make sure the new system can be implemented in their current infrastructure. In a way, the design team can now concentrate

on ensuring the design of the dashboard suits user requirements and aligns with organisational strategic goals.

At the time of interviews, the design team had started collaborating with users from the Finance and Accounting department. More foundational work was done on finance and accounting modules as they are the essence of the ERP system according to Care-User-Strat and Care-Mgr. Additionally, as mentioned in Theme 2, Care-Proj-Lead and Care-Mgr suggested the use of BSC as a guideline for users to set up or select metrics applicable to their business processes.

> *We've got to get the backend right first because without the backend, you can't measure anything. [Care-User-Strat]*

While the users from the Finance and Accounting department were working to build their chart of accounts, the dashboard templates from the ERP suite were used as a baseline for further refinement and improvement. This is a good strategy, according to Verbert et al. (2014), as a starting point for dashboard design. Furthermore, perceived usefulness can be checked with users after using the dashboard for a certain period of time (Verbert et al. 2014).

A few months after the project had started, the design team was still undertaking groundwork and data preparation for the implementation of the ERP system and the dashboard.

> *We're bogged down at the moment with foundational stuff. And the reality of the project is… it takes a while for the reality to sink in. At the start of the project we all have the fantastic dream of what it's all gonna look like. But when the reality sets in, once again it's human nature, we start to lure those dreams [sic] a little bit … It's a meeting between dreams and reality. [Care-Mgr]*

This highlights the importance of groundwork activities and how design problems and solution concepts can be explored together. Apart from that, the design team and users should remain mindful of their overall design constraints, which should be embraced to manage the project and deliver results as planned. Challenges faced by the design team will be discussed later in Theme 4.

6.4.3.2 Focusing on user needs supports a journey on the road to innovation

Design thinking is human centred, which is achievable through empathy and collaboration (Brown 2009). Being human centred means knowing who the users are, thus anticipating their interests in the design process to create an artifact that is useful, fairly easy to interact with, and

relevant (Cavoukian & Weiss 2012). According to Care-Mgr, the design team is working very closely with users to make sure they are actively involved on the dashboard design process.

> *It's very important to get to know each user. ... We'll press people's buttons and some resistance will come up that we didn't expect. But then we've taken them on the journey already. ... So we know we're taking people along. [Care-Mgr]*

Care-Proj-Lead added that it might be worthwhile for the design team to *speak the same 'language' with users*, in a way to understand their needs and to treat each user differently based on their preferences. In CareOne's case, a group of users had been involved in a failed project before; therefore it is important for the design team to reassure and advocate for them. The design team needs to keep users informed and allow key users to be actively involved in the process, according to Care-User-GMOps. In general, user-centred design involves users actively participating in the design process (Knight 2011; Vredenburg et al. 2002) which aims to understand user requirements (Vredenburg et al. 2002).

In terms of collaboration, the design team has conducted application training and presentations together with TechAus and key users. At the same time, the design team has gathered user requirements for the new system and the dashboard. User feedback was obtained via surveys after each training session or presentation. However, some users felt that the collaboration between the design team and users could be improved. Care-User-GMOps thought that the design team needed to fully understand the relevant business processes in order to comprehend user requirements.

> *To some degree, they won't know what some of the impacts would be on the regions without actually knowing what the processes are in the regions, and I don't think that question has been asked yet. Having said that, the efficiencies of the program will lend itself to running [the program] in a particular way. So ... the devil is in the detail as to how much influence there could be anyway. [Care-User-GMOps]*

Nevertheless, Care-User-GMBiz completely understood that the current focus is on groundwork and data preparation in the finance and accounting modules. Care-User-HR agreed that collaboration and user engagement can be improved to ensure user needs are being accommodated. Care-User-HR admitted that the design team had made an effort to do so, but the users might have been too busy with 'business as usual' to get involved in the design process. Essentially, the design team should not lose focus and they take care of users in other departments as well.

When it comes to empathy, Care-Mgr thought it is all about *genuinely listening to people*.

But also knowing your limits when you have reached the level of what you can do to accommodate them. There would be a limit. [Care-Mgr]

Care-User-Strat believed that users have been given the opportunity to participate in the design team.

It's been very deliberate in the way thus far that's been developed and people, the needs of people to engage are being considered. [Care-User-Strat]

Essentially, the focus will always be on the users. The design team's role is to help users reframe problems and work out proper solutions accordingly.

If you have a problem, you can come to us and we would work together to come up with the solution… It's not our decision, the people who're going to be using the solution, it's up to them. [Care-Proj-Lead]

Additionally, there is another important issue on the dashboard design process. The use of the dashboard needs to be considered early on in the design process. As Care-User-Strat emphasised, the way the dashboard is designed should be aligned with business processes. Therefore, the users would need to use the dashboard as part of business processes.

If people don't know about something, they don't know what they don't know, and I have seen endless systems in business that have been developed. They've spent millions and millions and millions and millions of dollars. They don't get used. [Care-User-Strat]

This view is supported by Eckerson and Hammond (2011) who indicated designers would need to understand how users work along with their culture of work within the department or area in order to design the right dashboard for the right users. As a result, it will significantly increase the rate of uptake and adoption of the dashboard at a later stage (Eckerson & Hammond 2011) as users understand the benefits of the dashboard (Treude & Storey 2010).

Furthermore, design thinking is about creating innovation (Boland et al. 2007; Brown 2008). As discussed in Chapter 3, innovation can be defined as efforts made by an organisation to improve the possibility of success in business which includes but is not limited to changing processes to be more effective, productive, and to deliver better product or services (business.gov.au 2014). According to Care-Proj-Lead, CareOne's dashboard project can be considered as innovative and will help the organisation to grow. In a way, information empowers the organisation to be more innovative in delivering services to clients.

However, Care-Mgr has a different view with regards to the notion of innovation in their dashboard project. The dashboard is hardly an innovation as most of their competitors have already created dashboards. Indeed, innovation is notably hard to achieve due to the unexpected and disruptive nature that change brings to organisations (Wölbling et al. 2012). Care-Mgr noted that the uptake of information from the dashboard would help CareOne to survive and remain sustainable *in a very competitive and changing marketplace*.

> *Once we have survived, we get to be innovative [Care-Mgr]*

Care-User-Prac also added that CareOne always looks for ways to innovate business processes. In a way, innovation is viewed as part of the business processes, not merely a result of such process.

> *We're looking at innovative or different ways of doing things… For instance, how is this assistive technology or digital inclusion actually offering us a different way to do things, an efficient way… So then we can start experimenting and then roll it out to business as usual. [Care-User-Prac]*

6.4.3.3 Co-evolution of problem and solution spaces in the dashboard design process

As mentioned earlier in section 6.2 CareOne's design team is led by Care-Proj-Lead and supported by Care-Mgr as its project assurance. The core team members are the subject matter experts from finance, payroll, HR, and stakeholder management departments. They are responsible in defining requirements of the system. Having subject matter experts as part of the design team is indeed crucial for the design team to gain domain expertise in understanding meanings of data (Wang, Wang & Alexander 2015). They also act as liaisons responsible in keeping their fellow users in their department informed on the progress of the project. The design team is also supported by business analysts, IT support, and carelink+ support.

With this structure, the design team is essentially multidisciplinary and consists of people from non-IT backgrounds. This is supported by Houghton et al. (2004) who suggested that multidisciplinary team collaboration in dashboard design helps with effective communication with users. Care-User-Strat is currently comfortable with the level of involvement or collaboration with the design team and felt they have communicated well with users and stakeholders. Also, Care-User-GMOps concurred that the design team has helped both users and the stakeholders in understanding the design process and its impacts on their respective roles in the organisation.

> *We work really closely with the [design team], really closely. We have to. Because the system has come out of there. … So absolutely, we would have to collaborate with every part of the organisation to do this. And IT is a key department because the data would come in, a lot of the data would be generated from our systems. [Care-User-Prac]*

Apart from embracing multidisciplinary collaboration, the notion of design thinking supports the balance between problem analysis and solution exploration (Martin 2009). Designers should not spend more time analysing design problems, but design thinking promotes co-evolution of problem and solution spaces (Cross 2011). As such, design thinking supports designers to generate ideas and to create various possible solutions to design problems (Brown 2009).

In CareOne's case, the design team would try to envision what the dashboard would look like while collaborating with users, according to Care-Mgr.

> *It's about getting them out of their comfort zone and to go 'right let's use your system, it's up on the wall. … It's a bird's eye view. We're now looking at it. Where could we make things easier for you? Where could we reduce the time'? Getting people into that mindset. Working on the problems I think has been very valuable for my systems project because they've now gone up and down other things that are completely unrelated, which is upgrades, templates, and forms … They just evolved naturally out of it. I haven't told them to do that. But it's just something that came out of that. Working on the problems I think it's going to make getting to the solution a lot easier. [Care-Proj-Lead]*

Meanwhile, Care-Proj-Lead seemed to think the design team has spent more time on analysing problems although solution options were also discussed. Care-Proj-Lead's explanation articulates activities carried out in the solution space while describing the process of analysing problems. Hence there is a plausible co-evolution between problem and solution spaces. The design team will help users reframe problems and run through solution options, which essentially is one of the characteristics (Cross 2011).

6.4.3.4 Interpretations and analyses

This theme discussed designing a more user-centred dashboard. As mentioned in Chapter 5, user-centred design involves users actively during the process of design (Knight 2011; Vredenburg et al. 2002), which aimed for a strong understanding of user requirements (Vredenburg et al. 2002). Ahmed, McKnight and Oppenheim (2006) suggested early prototyping to support user-centred

design and for the prototype to be tested with real users. The process would naturally be iterative and accompanied by a constant evaluation which can increase the end product's usefulness and usability (Vredenburg et al. 2002).

Design thinking is likewise user-centred, which is achievable through empathy and collaboration (Brown 2008; Wölbling et al. 2012). Besides focusing on users, design thinking strives to achieve a balance regarding users, technologies, and organisations (Brown 2009). In CareOne's case, the technological aspect of the project does not seem to be an issue as they have hired an external vendor, TechAus, to handle the matter. Furthermore, the design team has received support from Care-CEO and the executive board. Their biggest current concern tends to be user aspects to ensure the dashboard is designed based on user needs, to be useful, and to reach the goals they were aiming for. There are other constraints that also need to be addressed in the design process.

In terms of empathy and collaboration, the design team seemed to have made a significant effort in working closely with users. In design thinking, the key knowledge is supposed to be "learned anew for every design process" from users and stakeholders instead of specialists' expertise (Lindberg et al. 2012, p. 231). As Care-Proj-Lead mentioned, it is important for the design team to 'speak' using the 'language' that users understand. That is, to ensure the design team understood the requirements, and how users conduct their business processes on a daily basis.

Notably, some key users have expressed their dissatisfaction at the level of collaboration between the design team and users. These key users were essentially the subject matter experts from various departments in the organisation (Finance, Human Resources, Marketing, etc.) all of which played an important role in the project. Arguably, it will be hard for the design team to keep everyone in the organisation happy. They certainly have to prioritise requirements as well. This is where project governance comes into the picture; they would help the design team to set the project priority right and ensure users are well informed of progress. Essentially, the existence of the project governance board has demonstrated that CareOne follows best practice in project management. With a complex project like theirs, the design team needs to ensure they manage risks well, thus project governance is "a critical element" (Project Management Institute 2013, p. 33).

Furthermore, the collaboration with subject matter experts as part of the design team is aligned with the notion of design thinking which embraces multidisciplinary collaboration in order to create innovation as its main goal (Meinel & Leifer 2011). This is also supported by Pankaj, Hyde and Rodger (2006) who specifically discussed, in relation to dashboard design, that the design team should not be limited to technical personnel. Table 6.3 summarised CareOne's design team

members along with their roles adapted from Eckerson (2011). Eckerson (2011) suggested a design team should have an executive steering committee along with a project champion, a project manager, business analysts, the 'KPI team', and technical team to ensure the success of the dashboard project.

In CareOne's case, Care-Proj-Lead is the project champion, whose role is as the 'go-to' person and the person in charge of the whole project (Ruuskanen 2012). Having a project champion has been viewed as one of the critical factors in Enterprise Resource Planning (ERP) projects along with support from top management and efficient project management (Nah, Zuckweiler & Lau 2003). Meanwhile, TechAus would be responsible in handling technical aspects of the project. The governance role is mainly held by Care-User-Strat, while Care-Mgr is responsible for project assurance. This role ensures the design of the dashboard is aligned with the organisation's strategic plans. Care-CEO is a member of the project steering committee who supports and promotes the project to the project governance board, prospective users, and other stakeholders to ensure that everyone is on board with the change initiative. Lastly, Care-User-GMOps, Care-User-GMBiz, Care-User-HR, and Care-User-Prac are the subject matter experts for the project.

Table 6.3 Roles of CareOne's design team members adapted from Eckerson (2011)

Roles	**CareOne's design team**
Project champion	Care-Proj-Lead
Technical analyst	TechAus
Project governance & assurance	Care-Mgr, Care-User-Strat
The steering committee	Care-CEO
Subject matter experts	Care-User-GMOps, Care-User-GMBiz, Care-User-HR, Care-User-Prac

At the time of interviews, the design team had started working on the finance and accounting modules of their ERP as a foundation for the rest of the system. Furthermore, Care-Proj-Lead has helped users in identifying inefficient processes to be improved along with the use of the new system. Care-Mgr also suggested the use of BSC to help users identify and select key metrics to be used on the dashboard. Indeed, it is quite common for an organisation to have gone through an exercise of constructing their KPIs using the BSC before designing and implementing dashboards (Pankaj, Hyde & Rodger 2006).

The design team is well aware of their design constraints. As an example, their limited budget dictates the extent of customisation they can get in the new system. Subsequently, for a similar

reason, the design team might start using standard dashboard templates to improve the design as the project progresses. The design team can use the template as a starting point or as a prototype to help build ideas. This is supported by Brown (2009) who stated that designers build ideas and learn by making or creating prototypes early on in the design process (Brown 2009). Constraints are essential to avoid fixating on a certain idea too soon and to ensure new ideas keep flowing (Boland & Collopy 2004; Boland et al. 2007).

Essentially, Care-Proj-Lead and Care-Mgr agreed that constraints can motivate the design team in analysing design problems and exploring solutions. This is aligned with the model discussed in Chapter 3, especially the top part of the diagram. Figure 6.7 is used as part of the conceptual framework for this study. There is a likely gap between problem goals and the solution criteria. The problem goals in this context signify the designers' innovative idea on how the dashboard will be designed. Whereas the solution criteria suggest what is required by and acceptable to users, that includes some constraints as well. As designers attempt to reconcile the gap, they would start exploring the problem area and framing the problem.

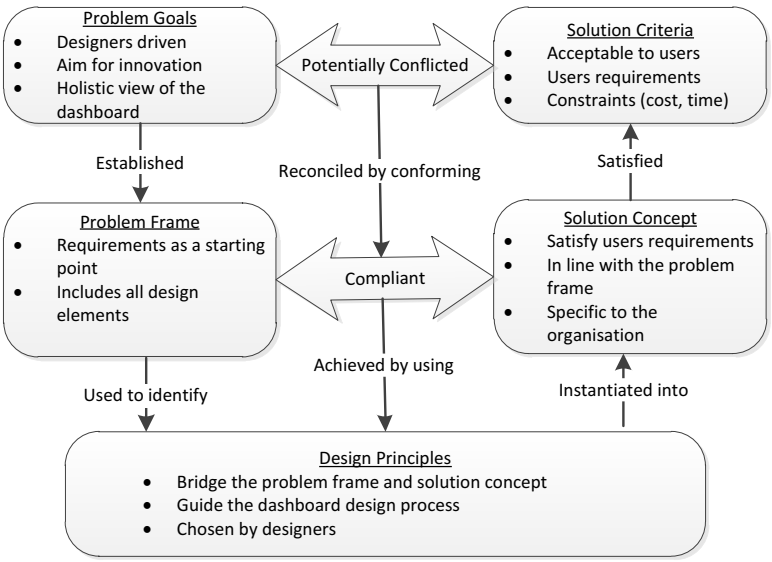


Figure 6.7 Design thinking dashboard development strategy model adapted from Cross (2011)

Based on the middle part of the diagram in the above figure, as the design team tried to reconcile the gap between problem goals and solution criteria, they started exploring the problem area and framing the problem. At this stage, the solution concepts have to be in line with the problem frame. It was also mentioned that it is possible for designers to work back and forth between the problem frame and solution concepts in order to finally arrive at a dashboard that satisfies the solution criteria within acceptable time constraints.

In CareOne's case, the design team helps users reframe problems and work out proper solutions together. According to Care-Proj-Lead, it seems that the design team favoured analysing problems to building solutions. But when Care-Proj-Lead discussed the problem analysis (see section 6.4.3.3), Care-Proj-Lead's explanation has indicated an articulation of activities that were done in the solution space. Supposedly, there is a co-evolution of problems and solutions. It is indeed difficult to talk about one without the other. In a way, structuring a problem is considered as "a process of taming instead of defining a problem". It should not be considered as deriving solutions directly from the problems, but it is more like "framing problems and solutions interdependently in frequent iterations" (Lindberg et al. 2012, pp. 230-231).

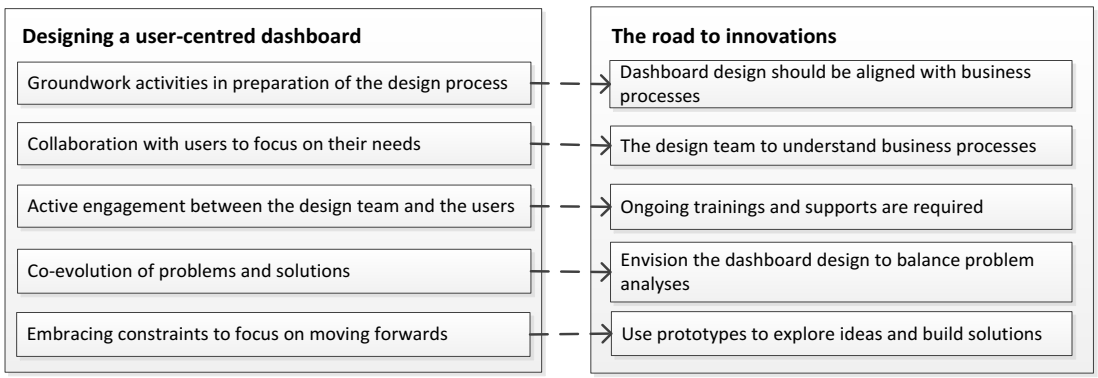


Figure 6.8 Takeaways from Theme 3

Figure 6.8 summarises key points as takeaways from the third theme. For the next theme, challenges that CareOne has to deal with in order to realise their ideal dashboard design will be discussed.

6.4.4 Theme 4: Ways to deal with challenges in realising a desired dashboard design

Even though CareOne is in the early stages of the design process, the design team has encountered some challenges and constraints. On this theme, the challenges in realising CareOne's ideal dashboard design and ways to deal with those challenges were discussed.

6.4.4.1 Challenges in realising the desired dashboard design

The main challenge comes from resistance and anxiety from users. These users werepredominantly social workers and/or had been working in the field for decades.

> *Because it goes against them having a social work background. Everyone is entitled to have the same level of support and enjoyment in their life, have access to*

employment and health care and that sort of stuff. So changing that mindset to "we have to think about the dollar", because if we're not making money we can't remain commercially viable. [Care-Proj-Lead]

The apparent gaps exist between the need for CareOne to stay financially sustainable as an organisation and the fact that social workers had been delivering services and helping their clients in the same way over the years. Care-User-Prac attributed this phenomenon to a common fear of change felt by a certain group of people, especially those who had been working in the industry for a long time. Care-Mgr, as one of CareOne's managerial staff who had come from a commercial background, simply could not understand how CareOne survived without having a proper information system to support business processes and decision making. Care-User-Prac agreed that changes must happen and CareOne needs more than anecdotal evidence to support the running of the business. Care-User-Prac understands there would be anxieties around every change in the organisation. So it is important to anticipate that and accept that it would be a part of the change process.

Like any system design and development project, the dashboard design process has its constraints. For CareOne, the technological constraints include integration of the new systems with the existing client service management system (carelink+). In terms of resources, Care-Mgr stated they are *time and cash limited*. But the more interesting constraint, according to Care-Mgr, is the people and the nature of a not-for-profit organisation. They undoubtedly felt the changes were happening too quickly with some business processes all needing to change at once. Nonetheless, Care-Mgr supposed that constraints would help the design team to focus on the task at hand and move on with the design process.

I think the constraints will be good for us. They will make us focus and they will make us move quicker than we [are]used to in [CareOne]. But they will throw up challenges because we are not used to moving that quickly so I am expecting [sic]. [Care-Mgr]

Furthermore, Care-User-GMOps added that resistance might stem from job insecurities, and that the new system would make some job positions redundant.

Is there still a job for me if I don't have to do this anymore? But it could be that the region might do a particular process in one way and they can't see any other way of doing it. [Care-User-GMOps]

Apart from that, some would feel the fear of being monitored through performance metrics on the dashboard. As Care-User-HR explained, there is a lack of accountability in task owning and in taking responsibility for decision making. Although Care-User-Prac agreed with Care-User-HR, Care-User-Prac also thought that the anxieties, job insecurities, and the fear of being monitored were not merely caused by the addition of the new dashboard, but also stemmed from the overall reform happening across Australia in the aged care and disability sector.

There also seemed to be office politics could potentially affect the progress of the design process. According to Care-User-HR, the design team has been planning this project for over two years and the new system has not been delivered. Care-Mgr mentioned that at some point that the supervisor had caused delays. This put Care-Mgr in a difficult position regarding necessary action, thus this highlights the importance of a project governance board to oversee progress. Apart from that, some users felt sceptical about implementing a new system due to a bad experience in the past, which highlights the importance of constant engagement between the design team and users.

> *We had our other system deployment that took two years, it wasn't fully deployed it was only a part of the system that was switched on. And no one was given any training. It was basically "Here's the system, have fun!" and the consultants walked away; the finance team are quite sceptical about doing another software implementation, as you can appreciate. [Care-Proj-Lead]*

The term "social inertia" is a plausible explanation for their challenges (Keen 1981, p. 24). Keen's 'social inertia' is related to information systems and changes in organisations. It is not easy to overcome inertia (Wisan 2002). Although they have tried their best, changes have not happened. Keen (1981) argued that it could be due to many reasons such as information being only a small part of the equation regarding decision-making activities, the complexity of the organisation, and associated political issues. When it comes to the idea of using data to support decision making, Care-User-GMBiz believed it has a lot to do with users being in their comfort zones. Therefore, it has been very challenging for the design team to get users to come on board with this notion.

> *I think because we've operated for a long time without focusing on that [data] as the basis for decision making, then it becomes really hard to look at it from the other perspective. But we're big enough now that we can't afford not to. [Care-User-GMBiz]*

6.4.4.3 Early prototyping as a collaboration tool in the dashboard design process

Despite the challenges discussed earlier, the design team has anticipated both positive and negative responses from users. The design team was prepared for this and has ensured that users were given an opportunity to participate and be involved in the design process.

> *It's like any interaction between human beings when, you know, there will be some who are early adopters and … there some who won't. There'll be some who will just – will leave 'cause they say, "I can't do that," and they walk away … There will be others who will love it and – yeah – a whole range of people. [Care-User-Strat]*

In particular, Care-Mgr believed that executive buy-ins needed to be obtained early on in the process to ensure the vision of the project is congruent with organisational strategic visions and goals. Care-Proj-Lead also agreed with this top-down approach and suggested that once executive buy-ins have been obtained, the project would receive full support and be promoted to the rest of the users in the organisation.

Although the top-down approach is good, Care-User-Strat thought but it may not be a fail-safe solution to overcome the challenges facing the design team. The users can always work around the system and revert to the old ways of conducting business processes without the use of the dashboard. One way to deal with this challenging situation is to embed the use of information from the dashboard in business processes. Most importantly, users have to be informed of these changes and be involved in the design process from the beginning. As a result, at some point the users would have to be able *to work within a more efficient and effective system and not work outside it and in spite of it* according to Care-User-Strat.

> *From what I can see, it's on track and people are going with it because if it was an imposition, people wouldn't use it. Because, you know, it would be very easy to sit and say, "Here is the dashboard. Here are the systems. Use it!" And people would not. [This]happens all the time in business – people work their way around the systems, whereas this one is embedded in the systems. And that's sustainable. People won't work around it. They would be embedded in it. They'll be working with it. [Care-User-Strat]*

One way to involve users in the design process and gather their feedback is through early prototyping. Thus designers can visualise an idea into a various array of prototypes (Owen 2006). Prototyping can help "build empathy for users" (Dow & Klemmer 2010, p. 112), facilitate learning (Lindberg, Meinel & Wagner 2011), and doing it early in the design process is key

(Brown 2009). It enables iterations and invites feedback from users which can lead to a discovery of "unknown attributes, constraints, and opportunities" (Dow & Klemmer 2010, pp. 112-113), or any potential use-case scenarios (Gabrysiak, Giese & Seibel 2011) that may have been missed in the earlier stage or while gathering requirements.

According to Care-User-GMOps, prototyping might give users clarity about what the dashboard can do, hence they know what to expect.

> *It's not until someone sees it [prototype] … It's not until someone gets to play with it and see it to know how effective it is or how to make it more effective… There's a little bit of anxiety about what some of the changes might mean because people don't have enough of the information yet to know what it will look like. [Care-User-GMOps]*

Care-User-GMBiz reinforced that early prototyping would help in eliciting requirements as articulating what users want in a dashboard can be difficult. Care-User-HR concurred that the prototypes have helped in understanding what the dashboard can provide. Care-User-HR emphasised that the design team has to ensure that dashboard design can actually be realised and delivered based on the prototypes.

With all the effort the design team has put in, including getting executive buy-ins, incorporating business process changes, constant engagement with users, and using early prototyping as a collaboration tool, Care-User-Prac has finally seen a positive change in user attitude and acceptance towards the dashboard design process.

> *I think people have started to realise that it isn't just another great idea that is going to disappear in a year's time. This stuff is here to stay and we're building in things that are going to hold us all [sic]. [Care-User-Prac]*

6.4.4.4 Interpretations and analyses

Like most technological design and development projects, some challenges are faced by the design team. The main one comes from resistance and anxiety from the users whom predominantly were social workers and/or had been working in the field for decades. The resistance was fundamentally due to the fact that the social workers had been delivering services and helping their clients in the same way over the years. Some users have expressed their anxieties over their job security when the system is up and running. The new system would notably automate a large part of CareOne's business processes which have been conducted manually.

Furthermore, such resistance is about some users not liking their performance to be monitored through the dashboard. This concurs with Pankaj, Hyde and Rodger (2006) who attributed these challenges to political and cultural issues in the organisation. The new dashboard may induce "the fear of a big brother" attitude in some users as their performance is being monitored and "a loss of autonomy at lower levels" at regional/distributed offices, even before the project has started (Pankaj, Hyde & Rodger 2006, p. 1427). It is worth noting that in CareOne's case, Care-Mgr implied that this issue was apparent not only at lower levels but also management level users. It is important that the design team is prepared and fosters "a positive attitude" by explaining the benefits of the dashboards "as early in the project as possible" (Pankaj, Hyde & Rodger 2006, p. 1427).

Another way to deal with the challenges, according to Care-Mgr, is to obtain buy-ins from the executive level users in CareOne so that the project would be fully supported and promoted to the rest of the users in the organisation. Care-User-Strat felt a bit wary about this top-down approach. This approach has to be followed through to include the use of information in the dashboard. As a result, arguably users cannot avoid the new system and go back to the old business processes, which defeat the purpose of having the dashboard in the first place. Understandably, users have to be informed of these changes and to be involved in the design process from the beginning of the process.

Arguably the relationship between the design and use of the dashboard needs to be thought of early in the process to circumvent low adoption rates after its implementation (Pankaj, Hyde & Rodger 2006). User involvement and participation in the design and development process can result in an active sense of belonging, leading them to adopt the new system and use it at a later stage (Barki & Hartwick 1994). Most importantly, users must essentially have the ability to influence decisions regarding the project (Markus & Mao 2004). In CareOne's case, key users have been consulted from the beginning of the project, including during the vendor selection process. Otherwise, participation would be viewed as "a sham and is as likely to leave user participants feeling cynical and manipulated" (Markus & Mao 2004, p. 516).

Generally, as part of ensuring dashboard adoption and to drive positive change, a resistance should be expected and accepted as part of the process (Eckerson 2011). The design team should take this opportunity to gain feedback from users about their concerns, which could help improve the design of the dashboard (Eckerson 2011). CareOne's design team has maintained active engagement and collaboration with users to communicate the changes and to guide them along the way. Despite all these challenges, business process changes along with the new dashboard design have become a long awaited tool to help CareOne survive and remain sustainable due to

external pressures from government funding regulation changes and ever increasing competition from service delivery organisations.

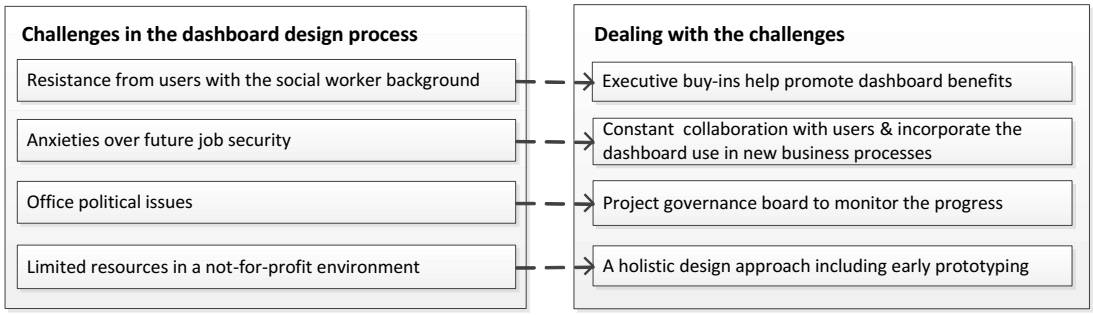


Figure 6.9 Takeaways from Theme 4

Figure 6.9 summarises key points as takeaways from the fourth theme. For the next theme, the notion of impact on dashboard design and use will be discussed.

6.4.5 Theme 5: The notion of impact on dashboard design and use

This theme is related to the first research question which looks at the notion of impacts between current organisational processes and the dashboard design process. Since CareOne was still in the early stages of the design process, the discussion will be on the participants' perspectives and expectations of how both dashboard design and use impact the organisation. For the same reason, the overall discussion for this theme will not be as elaborate as the other themes.

6.4.5.1 Issues impacting dashboard design

As discussed in Theme 1, CareOne is refining inefficient business processes to meet the requirements of the new ERP system and dashboard use. In Theme 3, constraints facing the design team were discussed. Due to time and financial constraints, CareOne cannot afford much customisation of the new system, following their current business processes. Therefore, according to Care-Mgr, they will need to make process change based on best practice in the sector to make their processes more efficient and effective. Care-Mgr added, the process change initiative had been conveyed to business process owners before the ERP and dashboard project were considered.

Care-Mgr mentioned however that the aged care and disability service industry has undergone major change, especially in relation to two government programs (NDIS and CDC). Therefore it is vital that CareOne ensures the design of the new system and dashboard support supports NDIS and CDC.

There's a few things going on there. Obviously because the political environment is changing, …. How we perform, our services are going to change a bit, now that we're going to be in a consumer based environment as opposed to the government giving you a package. The reporting requirements are going to change. All that sort of thing, like auditing requirements. That will change too. [Care-Proj-Lead]

Most importantly, the design process is ongoing and would always need to be improved based on the current situation in the industry, taking government changes into consideration. It will take time for users to realise the benefits of the dashboard, according to Care-User-Strat. Furthermore, users need sufficient time to understand the effectiveness of the dashboard and areas that need improvement. Therefore, users could propose changes to improve dashboard design.

I don't think it will ever be done. Because I think it will be an iterative process. There would be further refinements to the process, so it will be an ongoing quality system evolution that will start to take effect in the next few months, I would think, or probably the first quarter of the next financial year. I would think that people will start looking at reports and using reports to make more informed decision making. [Care-User-Strat]

6.4.5.2 Use of dashboards enables performance monitoring and increases accountability in the organisation

According to Care-Mgr, ideally the dashboard should be used daily in CareOne. Care-User-HR mentioned daily use aims to monitor KPIs, identify risks and to provide alerts in areas needing attention. Similarly, Care-User-GMOps supported daily use, so the dashboard can be used not only for the organisation's health check, but to source most information needed to support business processes.

I think it would at least be a view day, at least. Ideally, you'd have it open. … I imagine it being open on one, but having the right information that a very quick glance can give you, you know, 80 percent of the information that you might need. I know it won't be able to give you everything, but that – get as much information as you can from it and where there's a hotspot that's identified, and get onto it there and then [Care-User-GMOps]

Essentially, making social impacts is the reason for the existence of the organisation and also the long-term strategic goal in CareOne. Care-User-Strat and Care-User-GMBiz added that since dashboard design is aligned with organisational strategy, information on the dashboard should

help users achieve that goal. At the same time, Care-User-Prac concurred that the dashboard should be able to eventually measure the social impacts CareOne has made through services delivered to their clients.

Moreover, performance monitoring is needed as there is a lack of accountability in CareOne, according to Care-User-HR, as explained in Theme 4. That is one of the reasons why Care-User-HR expected the dashboard to offer transparency of information for all users to support accountability in owning tasks and decision making. The design team and key users were well aware that it might trigger a fear of being monitored amongst some user groups. Information transparency on individual performance creates peer pressure (Treude & Storey 2010) which can result in resistance dashboard use, as discussed earlier in Theme 4.

> *I think it's going to be a bit of a shock to a few of them, because it will highlight whether or not they are reaching their KPIs. It will highlight that quite clearly, but I suppose then what happens after that, if they're business critical, that's when the accountability and responsibilities come into it, but I think we have a culture here where … there's just no follow up with – when things go wrong, there's no – there doesn't seem to be consequences or accountability at the highest level for not achieving goals, which makes it really hard, whereas I'd like to think that some of these reporting metrics that I can provide to the CEO will determine what [the CEO] sees as business critical and are important to the health of the organisation and you know, so that it gives [the CEO] some – a starting place for strategies to create, … This is what we're going to do, you're going to do this, you're going to do this. This is your responsibility. Why haven't you met this target? [Care-User-HR]*

Care-User-GMBiz also emphasised that information on the dashboard should enable users to be more accountable, especially when their performance falls below what they have aimed for. Meanwhile, for Care-CEO, it is very important to monitor and figure out if services were being used at full capacity. The key metric in this case is the vacancy of packages. The dashboard should inform users if vacancy rates are high, so they can make a corrective action to address the situation.

> *In terms of questions such as: Are we actually filling up places? Are we delivering? What's the vacancy rates? It doesn't really tell us that. It's a beginning, a step towards that. But that kind of information, we do need to monitor and the managers need to monitor it. And with the system that it can be easily accessible rather than keeping it all on a spreadsheet and converting it to Word. [Care-CEO]*

6.4.5.3 Use of information on the dashboard supports evidence based decision making in the organisation

As discussed in Theme 1, Care-User-Strat mentioned that the ERP and dashboard project is not viewed as merely an IT project but can be viewed as an opportunity to improve inefficient business processes. Care-Proj-Lead concurred and added that CareOne is growing as an organisation following the latest CDC changes by government. The new system and dashboard will provide a solid foundation for the organisation to use information to support future business processes and decision making.

> *So it's transformational change on a major scale. We're not only looking at implementing a new system or a new business process. We're looking at growing the organisation ... so we're trying to get our foundation right. Which is a big change to the organisation in itself. Because we're moving from a manually intensive activity to a more streamlined and technological area. [Care-Proj-Lead]*

Care-User-GMBiz expected that the use of information on the dashboard can support business decision making. Subsequently, outcomes should be observed to ensure the organisation is making social impacts in the long term. It is critical that what they are doing will impact the community eventually, as it is one of their strategic goals or reason for existence as an organisation.

Apart from that, Care-User-GMOps and Care-User-Prac emphasised the importance of informed or evidence based decision making. The culture of decision making in CareOne is mostly based on hearsay and anecdotal evidence. Thus decisions are made with limited use of reliable information, and users tend to be reactive instead of proactive, according to Care-Proj-Lead. Care-User-Strat added that most of the time decisions were driven by the urgency of the situation.

Furthermore, Care-User-GMBiz argued that as the organisation is growing, the old ways of conducting business and making decisions might not be acceptable anymore.

> *There's so much happening for this organisation at the moment, and we're growing really rapidly. And what we could get away with ten years ago is no longer okay, because we've got so much bigger and there's so many more people, so that not being able to have a solid sort of foundation for making decisions is quite problematic, because I think particularly for managers, being able to actually see data and evidence that helps them make that call rather than using their own intuition on most things. [Care-User-GMBiz]*

At the end of the day, having reliable information would help the organisation to survive and remain commercially viable as a competitive and evolving industry, according to Care-Mgr and Care-Proj-Lead. Care-User-Ops concurred that the dashboard is expected to provide relevant information for users to be informed.

> *It can only be for the better because I'll be more informed, so even if the answer means 'it's a no', at least it's informed. And we've made the right decision based on the information we had rather than saying 'yes' and it should have been a 'no'. So … I see it as an enabling tool, not as a hindrance. [Care-User-GMOps]*

6.4.5.4 Interpretations and analyses

An emergent idea on this theme highlights the fact that CareOne adopts a holistic approach by viewing the project as a business process change instead of a mere technological overhaul, which demonstrates the essence of design thinking. Essentially, a design problem is approached as a whole, taking other systems or processes impacted by it into account (Cross 2011). This explains how CareOne took the opportunity to identify inefficient business processes and to work on improvements as part of the design process of the new ERP and the dashboard. Such change can be made by integrating one process into another process, possibly eliminating inefficiencies (Nagy et al. 2009).

This notion is also supported by Gallagher, Mason and Vandenbosch (2004) who argued that an ERP project could lead to an initiative to improve current organisational processes and systems. Similarly, as mentioned earlier, Eckerson (2011) suggested dashboards can drive organisational change. In a way, designing dashboards could impact or trigger change in various activities or processes in organisations. This is likely to be the case in CareOne. Care-User-Strat mentioned that the project is not perceived as merely an IT project, but can also be seen as an opportunity to improve inefficient business processes. Furthermore, with changes in recent government funding regulations, Care-Proj-Lead concurred that the new system and the dashboard would provide a solid foundation for the organisation to use information to support business processes and decision making.

Evidently, to manage this kind of project requires a deep understanding of the current processes or systems that may impact the dashboard. Therefore, "a full set of requirements is not possible a priori, but must be continually explored and developed over the course of the project" (Gallagher, Mason & Vandenbosch 2004, p. 1). This confirms Care-User-Strat and Care-Mgr's argument that the design process is ongoing and there will always be room for improvement based on the current situation in the industry and taking government changes into consideration. Given there is

sufficient time for users to use and adopt the dashboard, they could subsequently propose changes to improve the design for future iterations.

In terms of performance monitoring, Care-User-GMBiz expected that information on the dashboard should enable users to be more accountable, especially when their performance does not meet the organisation's targets. Other participants agreed there is a culture of lack of accountability in CareOne due to minimal performance monitoring, or incorrect use of KPIs to measure performance. As discussed in Chapter 2, dashboards can stimulate cultural change in an organisation to become more performance oriented (Dover 2004). Information associated with performance measures can be displayed on the dashboard through pre-defined metrics.

Having said that, Nagy et al. (2009) mentioned that it is challenging to demonstrate the causal relationship between performance improvements in an organisation and dashboard use. It was argued that dashboards do not directly impose change but rather facilitate the organisation in improving their performance through "knowledge discovery" (Nagy et al. 2009, p.1903). The information on dashboards would help users in the organisation monitor the organisation's performance, spot problems, and identify the root cause. Subsequently, users could make changes or improvement plans in relation to the problems.

Essentially, dashboards enable users in the organisation to fix problems more promptly and increase the accountability of decision makers (Nagy et al. 2009). That is what CareOne expected from the dashboard. As Care-User-HR mentioned, the dashboard should offer transparency so all users would be more accountable. In addition, Care-CEO stated that the dashboard should inform users if a corrective action should be made to address a concern. In the long term, CareOne expected that the dashboard should provide information to enable users to be proactive in dealing with the ever changing market and increasing competition.

Certainly, users in CareOne expected the dashboard to provide useful information to support business decision making. As discussed in Chapter 2, having access to information for people in organisations to inform and support their decision making is only the first step (Gurbaxani & Whang 1991). By designing dashboards with analytics and forecasting capabilities, users will be given the next step, which is the ability to analyse or even perform a what-if analysis (Nagy et al. 2009). As discussed in Theme 2, Care-User-Prac noted how analytics can help users in analysing and making sense of information on the dashboard. Analytics helps in reducing the size and complexity of data and works best with visualisation (Wang, Wang & Alexander 2015). Users can subsequently make informed decisions.

Furthermore, participants emphasised that the dashboard should provide reliable information for users. Nonetheless, while the dashboard might provide reliable information, it "cannot replace critical thinking" thus it cannot warrant absolute decisions or actions (Wang, Wang & Alexander 2015, p. 33). As Care-User-GMOps mentioned, the dashboard would be an enabling tool. It assists and empowers users in decision making rather than automating decisions on the user's behalf (Verbert et al. 2013). Therefore, providing an information system, such as dashboards, to support decision making will not impact decision making performance (Yigitbasioglu & Velcu 2012b).

Figure 6.10 Takeaways from Theme 5

Figure 6.10 summarises key points as takeaways from the last theme.

6.5 Summary

In this chapter, insights from the second case study at CareOne have been discussed. On the first theme, the aim of designing a dashboard for each organisation was discussed. This included discussion on the aims and importance of dashboards for the organisation, and how the dashboard would be implemented as part of their ERP project. The dashboard and the ERP were viewed as an integrated project. The much needed ERP system acts as a backbone to support the collection of data for finance, payroll, and HR departments and will be integrated with the existing client management system (carelink+). This data along with the data which has been collected over the years will be used on the dashboard. The dashboard is expected to present meaningful and actionable information which indicates whether the organisation is running at full capacity.

Subsequently on the second theme, key aspects and design principles in designing a dashboard were conversed.

On the third theme, the issue of designing a more user-centred dashboard was discussed. The design team has been building a solid foundation for the project by preparing and integrating data from various sources, as well as cleaning inconsistent data. Key for the design team is to manage user expectations by being upfront about the scope of dashboard design. The design team has also collaborated with subject matter experts who represent users from various departments in the organisation, and this helps them understand user requirements. Also, by involving users early on in the design process, acceptance and future use of the system is achieved, as suggested by Robey and Markus (1984).

Evidently, designing a dashboard for organisations comes with challenges. In CareOne, the main challenge comes from resistance and anxiety from the users, who were predominantly social workers and/or had been working in the field for decades. The resistance was fundamentally due to the fact that social workers had been delivering services and helping their clients in the same way for many years. To alleviate these challenges, the design team maintained an active engagement and collaboration with users to communicate change and to guide them. Despite all these challenges, the business process changes along with the new system design have enabled CareOne to survive and remain sustainable in the face of external pressures from government funding regulation changes and ever increasing competition.

On the last theme, impacts of dashboard use in terms of accountability in decision making and transparency of information are discussed. An emergent idea highlighted the fact that CareOne adopts a holistic approach by viewing the project as a business process change instead of a mere technological overhaul, which demonstrates the essence of design thinking. Besides getting sponsors from the executive management and project governance board, the design team also ensured the design of the dashboard was aligned with the organisation's strategic goals.

Overall, CareOne is still in the early stages of the design process. There are a lot of uncertainties in regard to the actual design of the dashboard and how the use of the dashboard will impact the organisation. Nonetheless, the design team and key users have collaborated and discussed their expectations early in the process. Furthermore, the fact that they have considered the issue of use and adoption of the dashboard early in the design process suggests they understand the big picture. The design team and key users remain conscious that this is a costly investment for a not-for-profit organisation, and they should therefore keep things in perspective and revisit users' expectations as the project progresses.

A summary has been provided at the end of each theme in the form of ‘Takeways’ (key points). The next chapter presents cross-case analysis.

Chapter 7: Cross-Case Analysis

7.1 Introduction

In this chapter, cross-case analysis of UniOne and CareOne case studies is conducted. Key similarities and differences between cases are outlined. Subsequently, in-depth exploration of comparison between cases will be further discussed and categorised by themes. The themes used in this chapter are the same as those from the previous case study chapters (Chapters 5 and 6).

7.2 Key similarities and differences between cases

As discussed in Chapter 4, there are two main reasons for cross-case analysis (Miles, Huberman and Saldaña (2014). Firstly, increase the transferability of research findings to other contexts. This is to make sure that the study is not "wholly idiosyncratic" (Miles, Huberman & Saldaña 2014, p. 101). Secondly, increase understanding of the insights by examining similarities and differences between multiple cases (Miles, Huberman & Saldaña 2014). As a useful starting point, Harding (2013) suggests a summary of key similarities and differences between cases.

UniOne and CareOne share some similarities in relation to their characteristics as an organisation and how dashboards are being used. Firstly, both are located in non-financial industry sectors, as a higher education provider for UniOne and a not-for-profit aged care and disability service provider for CareOne. Their shared primary goal is not so much on generating profits for their stakeholders, but delivering services and remaining sustainable in running their businesses. With their annual budget and government funding, they need to be accountable and justify how and what they spend the money on.

Secondly, in terms of the use of dashboards, it is not mission critical as they can certainly still run the business without them. However, potentially dashboards can provide strategic and critical support in running the business more efficiently by having information to monitor the performance of the organisation and to support business decision making. Lastly, UniOne and CareOne want their dashboards to be '*one source of truth'* for all users who seek out information and use a textbook pyramid approach, in which dashboards have aggregated information for executive users and more detailed information for users at management and operational levels.

At the time of interviews, UniOne and CareOne were at different stages of the dashboard design process. While UniOne had at least designed a dashboard for users and received user feedback on

further improvements, CareOne was in the early stages of the design process. CareOne's holistic approach to the design process views the overall ERP and dashboard project as a business process change instead of a mere technological overhaul. In comparison, UniOne's dashboard project started from overwhelming requests for information/reports, calling for a single platform for users to access information. Nonetheless, they both agreed that the dashboard design project is ongoing with no foreseeable end. It is envisaged that both projects will continue to improve based on user needs, environmental changes (government and competitors), and alignment with organisational strategic goals.

Table 7.1 summarises similarities and differences between cases.

Table 7.1 Key similarities and differences between UniOne and CareOne

Elements	**UniOne**	**CareOne**
Industry	Non-financial	Non-financial
Type of businesses	Higher education provider	Aged-care & Disability Service provider
Facing government funding changes	Yes	Yes
Triggers for the design process	Increased ad hoc requests for reports Organisational restructuring Government funding cuts call for accountability in spending.	Upgrades to existing IS Government funding regulation changes call for business process improvements.
The use of dashboards	Not mission critical	Not mission critical
Aims of dashboards	As a single information platform for monitoring & supporting decision making.	As a single information platform for monitoring & supporting decision making. To increase accountability in the organisation.
Stages of the dashboard design process	Has completed the design process and is undergoing further iterations (evaluation & improvement).	Early stages, data preparation, user collaboration.
The dashboard project	A standalone project using Tableau as a design and implementation tool.	As part of an ERP project employing an external vendor to assist the design, development, and implementation of the project.

In subsequent sections, in-depth comparative discussion will be further discoursed and categorised by themes similar to those in Chapters 5 and 6.

7.3 Theme 1: The aims of designing a dashboard for an organisation

According to Eckerson (2011), an organisation normally has a clear and urgent need for a dashboard before starting the design and development process. One of the reasons is restructuring of the organisation. Executives who reorganise groups and divisions to improve productivity or competitiveness need to explain their rationale and monitor the effectiveness of such a move (Eckerson 2011). It is indeed the case for UniOne, as the organisation was undergoing a major restructuring when they started the dashboard initiative. UniOne needed an accurate source of information to support business decision making and monitor organisational performance.

Although it started with a modest goal to upgrade their existing information systems, CareOne also faced external pressures which prompted the organisation to start their ERP and dashboard project. Government funding regulation changes triggered a more pressing need for the dashboard project. Furthermore, most competitors had already adopted these changes into their business processes. CareOne therefore felt increased pressure to take action to remain competitive in the industry sector. Similarly, government funding regulation changes also prompted UniOne to justify their spending. In a way, such financial pressure has driven both CareOne and UniOne to effectively manage their respective funding allocation and subsequently remain sustainable in the long term. Using the dashboard would help them to monitor organisational performance in finance and in other departments.

Besides monitoring, UniOne's dashboard users extracted information for further analysis. Likewise, CareOne expected their dashboard to be a platform where all users could access information as part of their daily business processes. In a way, both organisations need their dashboard to be the one source of truth to support real-time informed business decision making (Houghton et al. 2004). However, Few (2007) argued that the main purpose of the dashboard is merely for monitoring, not analysis. Few (2007) contended that the term 'dashboards' has been used inaccurately to describe any type of screen-based display which contains a multiple number of charts regardless of its purpose. Based on Few's (2007) description, UniOne's dashboard is described as "Faceted Analytical Displays" (p. 1). This view is considerably limiting and contradicts other dashboard definitions discussed in Chapter 2 (refer to section 2.2). Also, as discussed in subsection 2.2.2 (Purpose of dashboards), the literature suggests the dashboard goes beyond monitoring.

It is important for organisations to describe and clarify the aims and purposes of the dashboard at the start of the design process. According to Few (2006), while dashboards can be popular, some organisations might be just following a trend. In this case, it might be difficult for the design team

to find a fit between user requirements and the data and features that can be made available on the dashboard (Yigitbasioglu & Velcu 2012b). This is because the exact purpose of the dashboard cannot be identified at the beginning of the design process "due to fashion and fad motives" (Yigitbasioglu & Velcu 2012b, p. 52). Nonetheless, both UniOne and CareOne have a clear idea of what their aims are, so it is only a matter of translating and operationalising them in dashboard design.

Having their purposes clarified and defined, both UniOne and CareOne see the importance of groundwork in preparation for the dashboard design process. UniOne emphasised data preparation to ensure good quality data for the dashboard. Whereas CareOne emphasised their groundwork in system integration and in building user trust, collaboration, awareness, and interest regarding the dashboard project. A slight difference between the two organisations is mainly that UniOne had reached a more mature stage in the design process compared to UniOne at the time of interviews. UniOne's design team has used Tableau as their design tool for at least two years. In CareOne's case, the design initiative is considered a totally new project in the organisation. Therefore, it is crucial for the design team to ensure the project is aligned with CareOne's strategic goals and for key users to come on board with the initiative.

In terms of design strategy, CareOne and UniOne both adopted a top-down approach in which executive buy-ins were obtained at the beginning of the design process. Not only does this suggest that the dashboard initiative is fully supported by executive users, it expects executive users to promote and spread awareness among users of the purpose and benefits of the dashboard to the organisation. At the same time, CareOne is wary of the fact that executive buy-ins may not be the only key to the success of the design process. Hence in addition to gaining executive buy-ins, CareOne believes the use of the dashboard needs to be incorporated and embedded in business processes.

Taking a different stance, Pankaj, Hyde and Rodger (2006) argued that the bottom-up approach is preferable, which means the design initiative should be directed at management and operational levels than rolled out at executive level. In a way, this proactive approach would spread awareness of the dashboard throughout the organisation and help with cultural considerations in using the dashboard as part of the business process. Pankaj, Hyde and Rodger (2006) also mentioned that while executive buy-ins were helpful in terms of sponsoring the project, it would not automatically mean that executive users would use dashboards. Furthermore, users may not appear to show resistance due to the executive directive, but it is possible that those at management level would be unreceptive. That is because the concept of information transparency

with dashboard use may be viewed as "loss of control" by certain groups of users (Pankaj, Hyde & Rodger 2006, p. 1429).

Cross-case analysis of Theme 1 is summarised in Table 7.2. The table also shows an emerging category which appeared only in CareOne's case study.

Table 7.2 Cross-case analysis for Theme 1

Categories	**UniOne**	**CareOne**
Dashboards help the organisation utilise years' worth of accumulated data	UniOne has existing student management, HR, finance and other systems running prior to the dashboard design process. The dashboard is designed to help users utilise historical data to inform decision making.	CareOne has not had an established Enterprise Resource System (ERP) in place. The dashboard project is initiated as part of the ERP system implementation.
Dashboards enable the use of integrated data to inform decision making	The dashboard enabled the use of integrated data from various systems in UniOne and data from external sources. Subsequently, users were able to use information on the dashboard to support decision making as opposed to basing decisions on purely intuition and/or what had worked in the past.	The dashboard is expected to use integrated data from the ERP system, the client management system (carelink+), and publicly available information to support business processes and decision making.
Dashboards as a platform to monitor progress towards organisation's strategic goals	One of the purpose of dashboards is to enable users to monitor the health of the organisation and drive a culture of transparency and accountability as they compare their progress against the organisational goals. Ultimately, the dashboard would provide a self-service access to information to enable the users to monitor organisational performance.	As an organisation, CareOne's performance is measured by social impacts made in the community. In order for the dashboard to monitor this performance, the design of the dashboard has to be aligned with the organisation's strategic goals. Metrics or KPIs used to measure organisational performance have to be defined based on the strategic goals.
Dashboards support and enable business process improvements [Emerging Category]	There was a very limited discussion with regards to this category.	In CareOne, prior to starting the project, key business processes were analysed in order to identify inefficiencies and redundancies. Subsequently, those inefficient and redundant processes would be improved along with the project. The new processes should incorporate the use of dashboard. This is to enable the changes to be implemented together with the new system.

Figure 7.1 summarises key takeaway points for Theme 1 which include theoretical and practical importance.

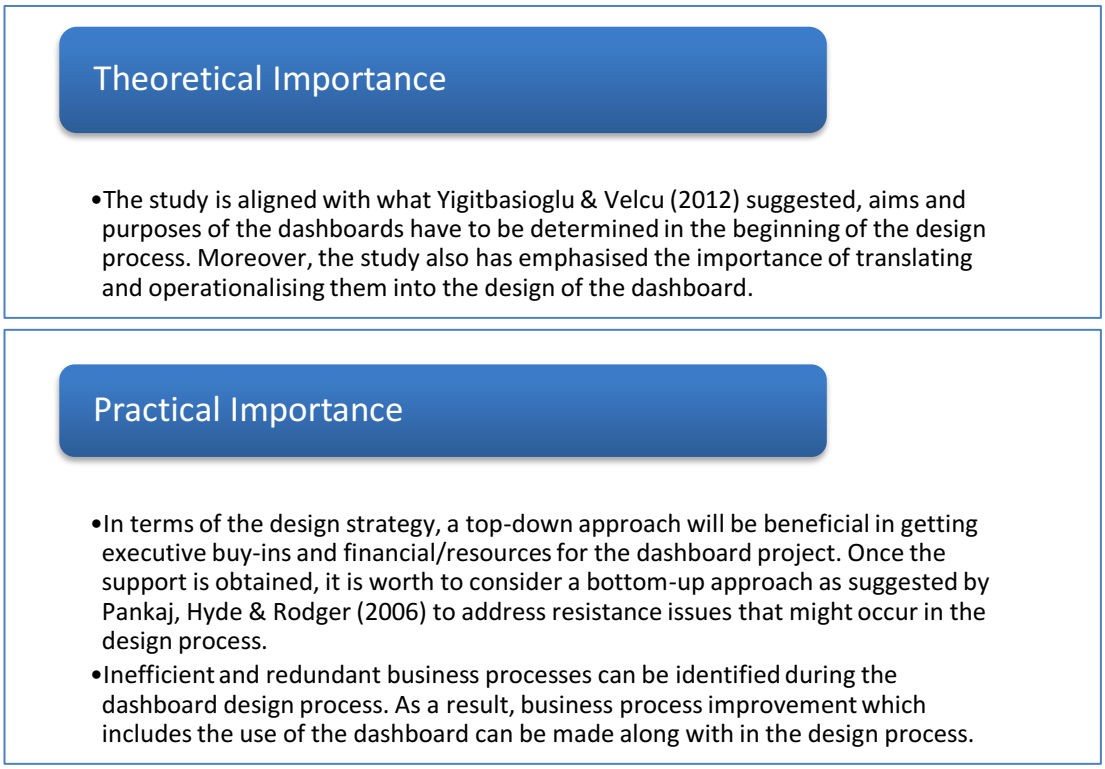


Figure 7.1 Takeaways from Theme 1

7.4 Theme 2: Key aspects and principles of dashboard design

In Chapter 2, some aspects to be considered in order for the dashboards to be valuable to users was discussed such as dashboard types and design, presentation styles of the information, and types of users (Dowding et al. 2015). Regardless of dashboard types or metrics used, components of a dashboard typically could be categorised into three main categories (Users, Technologies, and Contents) as described in Figure 7.2. Users entail not only those who use the dashboard but also the organisation they belong to. Technologies on which the dashboard was built, include but are not limited to database technology, infrastructure, and design and development tools. Contents include other dashboard components such as the data being displayed, features, graphs and metrics.

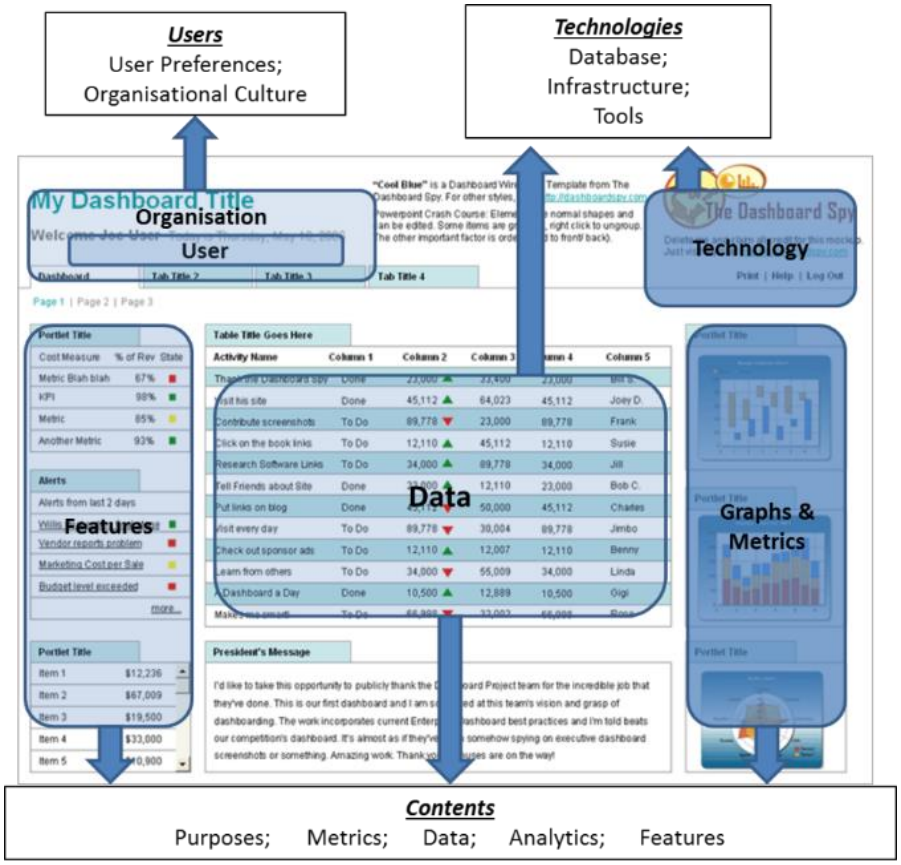


Figure 7.2 Key elements in dashboards

The background dashboard taken from http://dashboardspy.com/dashboard-screenshot-wireframe-coolblue-template.html

Based on case study, UniOne and CareOne have similar perspectives in terms of importance of data quality and integrity in ensuring the reliability of dashboards. A solid database infrastructure is an important foundation for dashboard implementation. In UniOne's case, a logical data warehouse was used for pooling, integrating, and standardising data from various sources in the organisation before the data is linked to the dashboard. Howevere, there was inconsistency and duplicated data due to multiple stand-alone legacy systems in CareOne. It is quite common to encounter poor quality data in dashboard design (Houghton et al. 2004). Furthermore, CareOne had an issue with data availability because some key data had not been collected. However, these issues will be addressed eventually with their new ERP system.

Clearly, UniOne and CareOne agreed that data utilised on the dashboard should be relevant and up-to-date (current). The meaning and context of the data should be clarified so users can understand accurate information to support decision making. In UniOne's case, validity and reliability of the data used on the dashboard was considered. Just because the data is available does not mean that it must be used. As an example, data used for student satisfaction metrics

might be collected via surveys. If the survey response rate was low, the metrics used to measure student satisfaction rate might potentially display misleading information. Overall, a balance between data currency, consistency, and integrity of the data should be achieved, as it would impact the reliability of the dashboard.

In terms of overall design, both UniOne and CareOne followed the pyramid or the textbook approach as discussed in the literature review in Chapter 2. Eckerson (2006) depicted this pyramid in a framework called MAD (monitor, analyse, drill to detail) framework (see Figure 7.3).

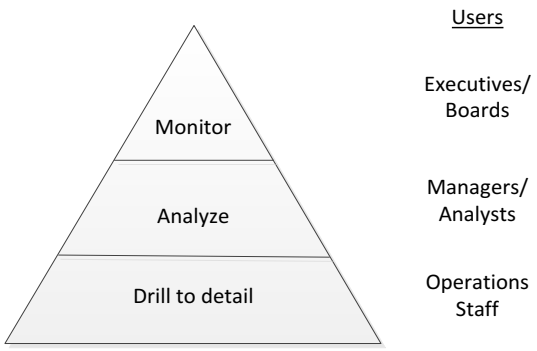


Figure 7.3 Pyramid structure in dashboard design adapted from Eckerson (2006)

The pyramid form intuitively shows an appropriate proportion of users and metrics at each level in an organisation. Essentially, all users at executive, management, and operational levels have the same set of metrics in their dashboard. Executive users would get the most aggregated information. Management users would be able to drill down to get more detailed information. Whilst, operational users would be able to drill to obtain detail to get appropriate information. UniOne suggests that the drill-down feature could help users in analysing and investigating the root cause of issues indicated on the dashboard. For instance, when a certain metric shows the performance falls below a pre-set threshold. CareOne added the drill-down feature also enables users to take action when necessary. This notion is supported by Yigitbasioglu and Velcu (2012b) who suggested the drill-down feature comes in handy in assisting critical analyses.

While the pyramid or textbook approach seems to be ideal, there could be potential fallout in defining and selecting key metrics. In terms of the number of metrics designed and prepared by UniOne, there were more than sixty metrics to choose from. This could indicate that agreement is hard to reach by multiple users at all three different levels. In fact it is quite common for an organisation to track too many metrics, while facing difficulties in getting insights from them (Lawson, Stratton & Hatch 2007). Although CareOne has not reached this stage yet, they are well

aware of this matter and suggested selected key metrics should be kept to a manageable number. As suggested by Mitchell and Ryder (2013), it is best to use a limited number of well-defined metrics. Having too many metrics in a dashboard can distract users (Wisan 2002). Hence Wisan (2002) suggests that metrics should be prioritised based on their "ease of use, importance, and clarity" (p. 132).

Subsequently, CareOne implied that metrics should include leading indicators which might flag potential problems before they happen. UniOne also suggested the use of leading indicators in metrics to help users perform a predictive analysis of the business. But, when it comes to leading indicators, business processes must be well understood by the design team. Especially in UniOne's case, where they have a vast number of datasets, it is important that the design team collaborates with users to identify those indicators. With predictive analysis, the information could potentially inform where the business is heading, or at the very least users can make action plans based on those indicators.

CareOne emphasised that both the design team and users need to ensure that metrics selected are the right ones to measure the performance of the organisation. Otherwise, the whole notion of having a dashboard for performance monitoring would be pointless. Furthermore, both UniOne and CareOne suggested that reasons for what each metric is really measuring and why each metric is selected should always be examined. While it might be a good thing to follow best practice, in the end, the real challenge is deciding what metrics are the most important and for whom.

When it comes to users and organisational culture, UniOne seemed to have a number of user groups that operate in 'silos'. In a way, they have their own data analysts who produce reports for themselves. Clearly, this presented a real issue for the design team in UniOne, and this will be discussed further in Theme 4. With the dashboard, all users benefit from having access to integrated data sourced internally and externally. A few participants in UniOne suggested some users might have a fear of change or new technology when the dashboard was introduced. Some users were notably not technologically savvy, with the younger cohort of users being more accepting of the dashboard.

Meanwhile, key users in CareOne were particularly data savvy. They understand the importance of evidence based decision making, supported by information from the dashboard. However, some users felt quite unsure and overwhelmed as to what to expect of the dashboard and had difficulties in articulating their requirements. Furthermore, as a not-for-profit organisation, most staff are social workers, who according to participants, might show resistance with the idea of

using the dashboard to support business processes and decision making. Seemingly, they prioritise helping clients rather than focusing on financial sustainability of the organisation.

Apart from focusing on the data and users, dashboard design principles influence the effectiveness of dashboard design (Yu & ZhiYong 2013). Both UniOne and CareOne concurred that the design should be kept simple to avoid 'information overload'. Essentially, each element on the dashboard must serve a purpose. The dashboard should present useful, meaningful and actionable information which can be achieved through analytics. This study concurred that historical data will provide useful insights for trend analyses, while comparative data will add value by giving a meaningful comparison of performance with other similar organisations as discussed in Lawson, Stratton & Hatch (2007) as well as Wisan (2002).

Another design principle adopted by CareOne is a well-known model to guide them in the design process. CareOne is using the Balanced Scorecard (BSC) to guide and inform users in defining and selecting key metrics. This view is supported by Airinei and Homocianu (2006, p. 329) who stated that "using the Balanced Scorecard framework is a good place to start" before designing a dashboard. In UniOne's case, they adopted the 80-20 rule as a guide to determine the metrics to select. The 80-20 rule, one of the vast number of universal design principles, states that 80% of impacts come from 20% sources (Lidwell, Holden & Butler 2003). Ideally, most information needed by users would be sourced from about 20% of the metrics on the dashboard.

Cross-case analysis of Theme 2 is summarised in Table 7.3.

Table 7.3 Cross-case analysis for Theme 2

Categories	UniOne	CareOne

Data quality and integrity ensure the reliability of the dashboards	Data from various sources need to be pooled, integrated, standardised before linked to the dashboard. There has to be a balance between currency, consistency, and integrity of the data. Furthermore, validity and reliability of the data used on the dashboard need to be warranted to avoid giving misleading information to users.	Data from existing multiple stand-alone legacy systems have caused inconsistency and duplicates. Hence, a solid database infrastructure would be an important foundation for the dashboard. Apart from that, there might be an issue with data availability, some key data has not been collected at all. This would be addressed with the new ERP system eventually.
Choosing the right metrics enables a delivery of the right information to the right people	Metrics selected should be meaningful and useful. Users must understand why the metrics were selected. The real challenge is deciding the most important and useful metrics to be used by the right users. With around sixty metrics already designed and prepared for users in UniOne, it is proven to be difficult to adopt the best practice, in which all users see the same set of metrics with different level of details.	The most important thing in metric selection for CareOne is making sure the right metrics are selected to measure the organisational performance. Choosing the wrong metrics would result the use of dashboard pointless. Also, the use of leading indicators should be considered to flag potential problems before happening. Lastly, the number of selected metrics should be kept manageable.
Users and the culture in the organisation play an important role in dashboards use	Majority of the users were not aware of the benefits of having integrated data through the dashboard. It might be partly due to the ageing workforce issue as the younger staff was more acceptable to the notion of accessing information through the dashboard.	Although key users were data savvy and understood the importance of evidence based decision makings, there is a culture of lack of accountability in the organisation when it comes to task owning and decision making.
Key design principles support the process of designing a dashboard	The 80-20 rule was used as a guide to determine the metrics to select. The data visualisation on the dashboard should be kept simple to avoid analysis paralysis. Every element on the dashboard must serve a purpose, be meaningful and be useful for users.	The Balanced Scorecards were used as a guideline to select and define key metrics in CareOne. The dashboard should display meaningful and actionable information which can be achieved through analytics. Comparative and predictive analytics would help in making sense of information.

Figure 7.4 summarises key takeaway points for Theme 2 which include theoretical and practical importance.

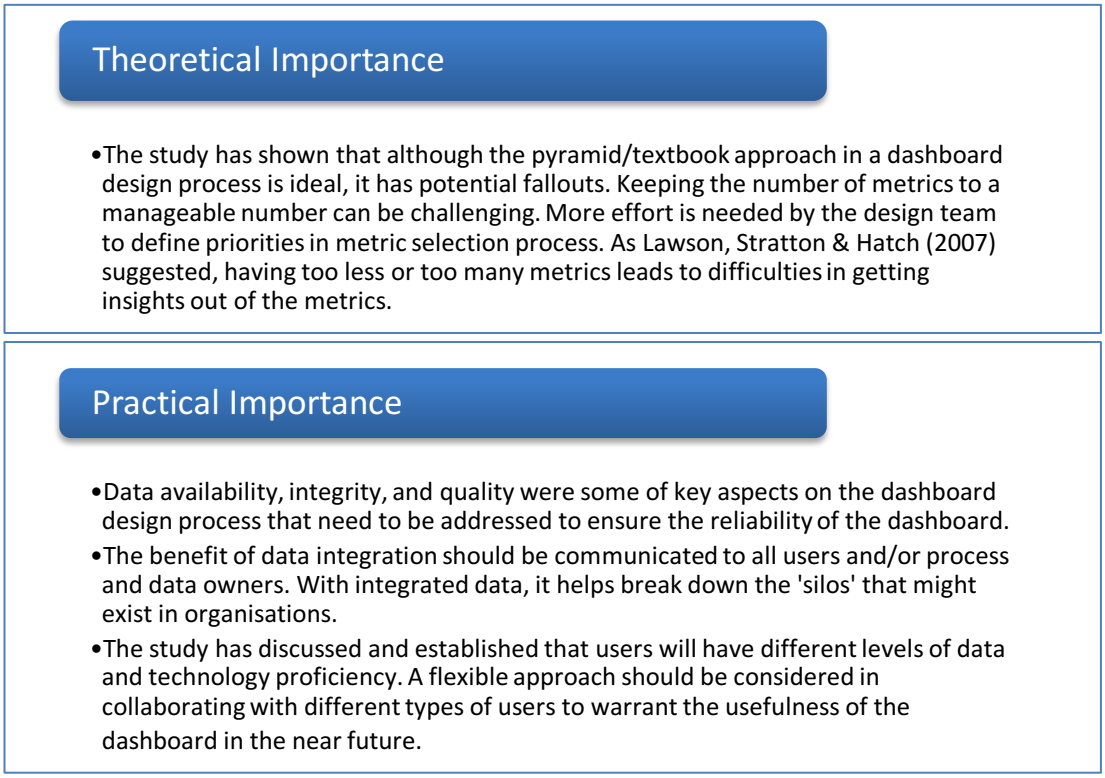


Figure 7.4 Takeaways from Theme 2

7.5 Theme 3: Designing a more user-centred dashboard design

Over the years, engineers in the information systems field have taken on the role of designers, even though they were not formally trained in design (Lindberg et al. 2012). This has resulted in a greater emphasis on technical aspects and subsequently has left out "social complexity" of software design (Lindberg et al. 2012, p. 230). This study indicates in both cases that the design team is a cross-functional team and each person has their own main job responsibility. Designing the dashboard is merely a part of their work portfolio, with the exception of Care-Proj-Lead in CareOne where Care-Proj-Lead is assigned full-time to lead the project.

In UniOne, the design team was mainly formed as part of the finance department, specifically the planning and performance group. They have other jobs to do in which the dashboard was needed to support their job and provide better information for all users in the organisation. In CareOne, the design team was separately formed by the IT department, with the IT manager as the project sponsor. As mentioned, Care-Proj-Lead is leading the project full-time. Essentially, the design team was formed on an ad hoc basis which consists of subject matter experts from various departments in the organisation (Finance, Human Resources, Marketing, etc.). In both cases, the

design team has built a robust foundation for the project by preparing and integrating data from various sources, as well as cleaning inconsistent data.

Design thinking is human centred, which is achievable through empathy and collaboration (Brown 2009). Being human centred means knowing who the users are, thus anticipating their interests in the design process to create an artifact that is useful, fairly easy to interact with, and user relevant (Cavoukian & Weiss 2012). UniOne demonstrated their efforts on 'empathising' with users through understanding how they go about their work. Whilst for CareOne, the design team should endeavour to 'speak' using the 'language' that users understand. This is to ensure the design team understood the requirements, and how users conduct their business processes on a daily basis.

users in the way they gather user requirements, spreading awareness about the advantages of the dashboard and the use of information to support decision making, as well as conducting training sessions to help users understand how to use the dashboard effectively. According to Care-Mgr, the design team is working closely with users to make sure they are actively involved in the dashboard design process. As discussed in Chapter 2, when users participate in design and development activities, it creates a sense of ownership, giving them a higher rate of adoption and use of the system (Barki & Hartwick 1994). Through user participation, it also creates a "psychological buy-in" towards the system, which can lead to better design and collaboration between users and system designers (Markus & Mao 2004, p. 515).

The study has also shown a prevalence of design team members with a multidisciplinary background. UniOne's design team members were reasonably diverse in terms of their backgrounds. With a mix of finance, accounting, technology, and statistical backgrounds, they strive to work together to promote evidence based decision making by providing information through the dashboard. Although there was limited discussion on this matter in CareOne's case, their design team consists of subject matter experts from various departments in the organisation (Finance, Human Resources, Marketing, etc.). This aligns with the notion of design thinking which embraces multidisciplinary collaboration in order to create innovation as its main goal (Meinel & Leifer 2011). This is also supported by Pankaj, Hyde and Rodger (2006) who discussed specifically in dashboard design, that the design team should not be limited to technical personnel.

In this theme, there are two new categories emerging from the second case study in CareOne. The first category is *groundwork activities in preparation for the design process* and the second category is *co-evolution of problem and solution spaces in the dashboard design process*. UniOne's case study was revisited and analysed to see if these two categories were applicable. In relation to preparatory groundwork in relation to the design process, the activities in UniOne

seemed to be around data preparation. At the time of interviews, UniOne had reached a more mature stage in the design process as opposed to CareOne. In CareOne's case, the majority of the preparation work performed by the design team was identifying inefficient business processes. The design team has been working with key users from various departments aiming to streamline and improve inefficient business processes from the perspective of IS. Such improvement would later be implemented as part of ERP and the dashboard project.

The second emerging category, as mentioned above, is *co-evolution of problem and solution spaces on the dashboard design process*. In Chapter 3, it was discussed that the notion of design thinking supports a balance between problem analysis and solution exploration (Martin 2009). Designers do not focus merely on analysing design problems, but design thinking promotes co-evolution of problem and solution spaces (Cross 2011). As such, design thinking supports designers to generate ideas and to create various possible solutions for design problems (Brown 2009).

In both case studies, the design team viewed the design process as a problem solving task, in which user requirements and constraints were regarded as 'problems' to be analysed. But, at the same time interviews suggested the design team should discuss and examine solution options through prototyping or by envisioning the design of the dashboard. It is highly unlikely that the design team could discuss 'problems' without 'solutions'. In a way, the design team assisted the users in reframing problems (i.e. requirements and/or constraints) and running through solution options which are essentially characteristics of design thinking (Cross 2011).

Cross-case analysis of Theme 3 is summarised in Table 7.4.

Table 7.4 Cross-case analysis from Theme 3

Categories	**UniOne**	**CareOne**
An interdisciplinary communication skill in a user-centred dashboards design	The design team come from the finance planning and performance department. Their different backgrounds in terms of trainings and qualifications varied from statistics, accounting, finance, to information technology (IT).	There was a limited discussion in this category in CareOne's case study. However, it is worth noting that while the design team was formed by the IT department, they have subject matter experts from other departments to join the design team.
Focusing on user needs supports a journey on the road to innovations	The design team needs to tease out the information to help users articulate their requirements. This could help the design team to design a more useful dashboard.	The design team has to speak the same 'language' with users, in a way to understand their needs and to treat each user differently based on their preferences.

Feasibility and viability become less of an issue	The dashboard project was supported by the organisation in terms of budget and resources, the feasibility and viability aspects of the dashboard design project were not considered as problems.	Executives in the organisation have given their support and endorsement for the dashboard project. Nonetheless, as a not-for-profit organisation, their limited budget and resources cannot be overrun. This will inevitably become one of their main constraints of the project.
Latest technologies provide advanced lead time in dashboards implementation	The design team has been using Tableau for a few years and found it fairly easy to use and implement in UniOne's current IT infrastructure.	CareOne appointed an external IT consultant to handle the implementation so the design team can focus on other important matters such as requirement gathering and user collaboration.
Groundwork activities in preparation of the design process [Emerging Category]	There was a limited discussion in this category in UniOne's case study. It is possibly due to the design process has reached a more matured stage at the time of interview compared to CareOne's case.	Prior to starting the dashboard project, the design team had been working with users in identifying key business processes and had looked into ways to improve some of inefficiencies from the perspective of information systems. This is an important exercise as the dashboard implementation would go hand-in-hand and facilitate the business process changes.
Co-evolution of problem and solution spaces on the dashboard design process [Emerging Category]	The design team tends to focus more on analysing on the best way of solving problems. Nonetheless, through prototyping and envisioning the end result of the dashboard, the design team balances their time spent in analysing the problem with the time spent in the solution space.	The design team seemed to have spent more time on analysing problems although at the same time discussed on the solution options too. Care-Proj-Lead's explanation articulates activities that were done in the solution space while describing the process of analysing problems.

Figure 7.5 summarises key takeaway points for Theme 3 which include theoretical and practical importance.

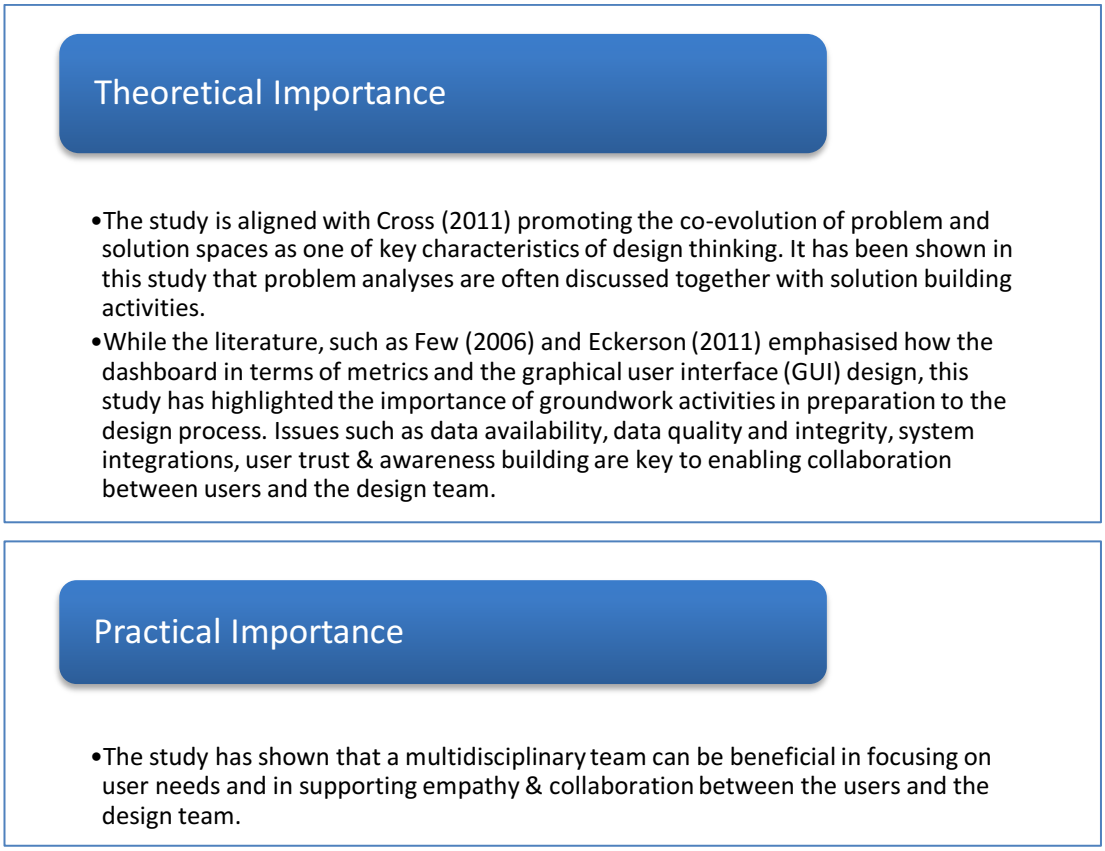


Figure 7.5 Takeaways from Theme 3

7.6 Theme 4: Ways to deal with challenges in realising a desired dashboard design

In UniOne, the culture of decision making is that users like to judge based on what worked in the past. Information is viewed as only a small part of the equation in decision making (Keen 1981). Similarly, in CareOne's case, it appears that some users like to use anecdotal evidence. Concerns were raised by key users about the prevalent culture of lack of accountability in CareOne. Therefore, there is a crucial need for reliable information expected from the dashboard to support decision making. When it comes to cultural issues, undoubtedly this would be more difficult to overcome. Nonetheless, dashboards can stimulate cultural change in an organisation in such a way that users become more aware of the performance of their organisation (Dover 2004). Furthermore, dashboards enable users to fix problems more promptly and increase the accountability of decision makers in the organisation (Nagy et al. 2009).

Another challenge faced by UniOne relates to office 'politic'. As mentioned briefly in Theme 2 earlier in this chapter, UniOne seemed to have a number of user groups that operate in 'silos'. In a way, they have their own data analysts who produce reports for themselves. It was unclear as to

whether these groups of users were willing to share their data with the design team. The design team's idea was to have integrated data and to provide a single platform of information for all users in the organisation. This has certainly added complexity to the design process.

Similarly, CareOne was facing an issue with managing their users and stakeholders. At the time of interviews, the design team had started working on the ERP system as the foundation of the dashboard. It was established that a group of users had been holding up the process, causing a delay in completing a major milestone in the project. The design team also had to deal with resistance and anxiety from users. Some presented with scepticism due to a failed project in the past, job insecurities, and/or fear of their performance being monitored through the dashboard. Admittedly, the issue with managing users and stakeholders has proven more difficult to handle than new technologies.

As discussed earlier in Theme 1 (refer to section 7.3), both UniOne and CareOne seemed to agree on the top-down approach for the design process, in which they get buy-ins from executives so the use of the dashboard can be promoted to other users in the organisation. Simply getting the executive's support however is not enough. The use of the dashboard "must start at the top", which means executives must use the dashboard actively to set an example to management and operational users on how information from respective dashboards help in business decision making and support business processes (Houghton et al. 2004, p. 32).

Alternatively, Pankaj, Hyde and Rodger (2006) argue that a bottom-up approach is possibly more effective, as the dashboard is likely to more valuable to users at operational level. So they suggested the dashboards should be introduced to the users at management and operational levels before the executives. The issue with a top-down approach, according to Pankaj, Hyde and Rodger (2006), is that the executives would only be giving a mandate for dashboard users. But this may not reflect that users at executive level are going to use the dashboard too. By giving access to users in management and at operational level, it enables cultural change so that users can become familiar with dashboards thus increasing the adoption rate (Pankaj, Hyde & Rodger 2006).

To deal with some of the challenges in dashboard design, UniOne considered early prototyping as a tool to collaborate with users and to understand their experience. In design thinking, it is about learning by making which can be achieved through early prototyping (Brown 2009) or models as tools for thinking instead of merely as ways to represent ideas (Boland & Collopy 2004; Boland et al. 2007). In UniOne's case, not only does the prototype help in visualising how the information is being presented on the dashboard, but the design team can gather feedback from users at the same time. By incorporating feedback as they build the prototype, improvement can be made accordingly.

Although CareOne is still fairly early in the design process, the design team has used a prototype of the dashboard in requirement gathering and training sessions. Similar to UniOne, CareOne used early prototyping to involve users in the design process and gather feedback. Indeed, prototyping can help "build empathy for users" (Dow & Klemmer 2010, p. 112) and doing it early in the design process is key (Brown 2009). It enables iterations and invites feedback from users which might lead to discovery of "unknown attributes, constraints, and opportunities" (Dow & Klemmer 2010, pp. 112-113). Furthermore, CareOne considered that early prototyping might give users clarity in relation to what the dashboard can do, hence they know what to expect. Also, it would help in requirement elicitations as articulating what the users want in a dashboard can be difficult. In fact, it is not uncommon to find users feeling uncertain about what they really want during the dashboard design process (Houghton et al. 2004).

In terms of design constraints, UniOne's design team discussed that having constraints made them think thoroughly about key aspects of dashboard design. In a way, constraints refined user requirements. CareOne's design team was well aware of their design constraints. For example, their limited budget dictates the extent of customisation of the new system; hence they would use standard templates of the dashboard and improve the design as the project progresses. Both UniOne and CareOne view the dashboard design process as an ongoing project. Hence, the real challenge is not about finishing the project but to "deliver a certain amount of value and functionality within a predefined period" (Airinei & Homocianu 2006, p. 329).

Cross-case analysis of Theme 4 is summarised in Table 7.5.

Table 7.5 Cross-case analysis for Theme 4

Categories	**UniOne**	**CareOne**
Challenges in realising the desired dashboard design	Information is viewed as only a small part of the equation in decision makings. This has caused an inertia to the design process. Apart from that, data is being treated as political assets which has hindered the effort in integrating data to be used on the dashboard.	There is a culture of lack of accountability in CareOne in terms of task owning and decision making. This has become one of triggers of the dashboard project. However, CareOne is facing resistance and anxiety from majority of users whom predominantly were social workers and/or had been working in the field for decades.
Early prototyping as a collaboration tool on the dashboard design process	Prototyping helps in visualising how the information is being presented on the dashboard. It can also be used a tool to collaborate with the users and to understand user's experience in using the dashboard. The design team can also gather feedback from the user. By incorporating the feedback	Although CareOne is still fairly early in the design process, the design team has used a prototype of the dashboard in requirement gathering and training sessions. Early prototyping might help giving users a clarity of what the dashboard can do hence they would know what to expect. Also, it would

	as they build the prototype, improvement can be made accordingly.	help in requirement elicitations as articulating what the users want in a dashboard can be difficult for some.

Figure 7.6 summarises key takeaway points for Theme 4 which include theoretical and practical importance.

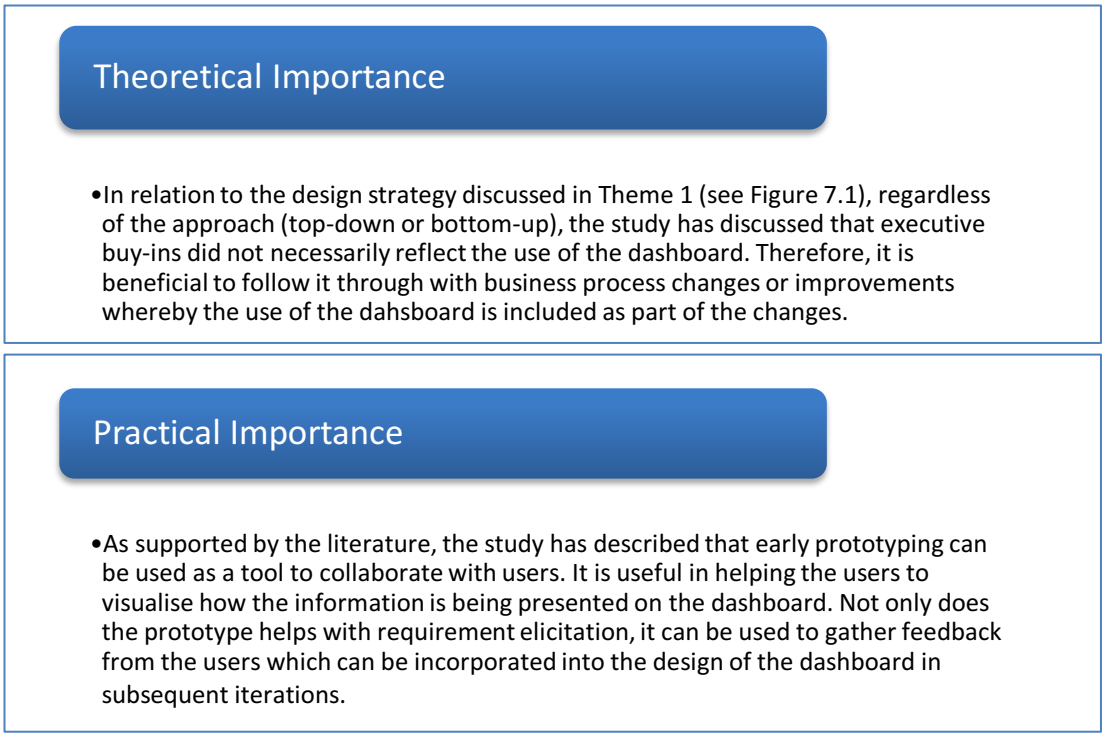


Figure 7.6 Takeaways from Theme 4

7.7 Theme 5: The notion of impact on dashboard design and use

In UniOne, a few issues with the data source that impacted the design of the dashboard such as data unavailability, source system upgrades, and data source sustainability were discussed. With the issue of data unavailability, creation of a new process or changes to source systems could be required in order to capture the data plus issues with source systems as a result of change might have a domino effect regarding the dashboard. Hence this needs to be managed to minimise risk and disruption. Furthermore, the design team should maintain collaboration with other groups responsible for source systems to ensure data can be supplied to the dashboard in a consistent manner. A contingency plan should also be prepared in case the source systems can no longer provide the data.

CareOne differs, as time and financial constraints have driven this organisation to make do with less dashboard customisation. CareOne also performed business process improvements based on best practice in the sector and to support two government changes (NDIS and CDC). CareOne will continue to monitor current situations in the industry and in government to adapt the design of the dashboard if necessary. Both UniOne and CareOne expected the dashboard to enable their users to be more proactive in spotting problems and to take corrective action accordingly. With increasing competition to secure government funding, UniOne has to be more accountable in allocating the funds and in justifying expenditure. Likewise, CareOne expected the dashboard to offer information transparency to support accountability in owning tasks and decision making, which is still lacking in CareOne.

Furthermore, according to UniOne, the dashboard can develop real insights to performance which can be used to monitor employee performance. Users can also identify areas of improvement and be empowered to improve their performance. Also, the dashboard enables UniOne to compare their performance against other organisations in the industry. In this matter, the design team and key users in CareOne were well aware that performance monitoring might trigger a fear of being monitored amongst some group of users. Information transparency in relation to individual performance creates peer pressure (Treude & Storey 2010) and can be viewed by some users as loss of control (Pankaj, Hyde & Rodger 2006), which resulted in resistance to use the dashboard, as discussed earlier in Theme 4.

In terms of decision making, UniOne argued that the dashboard can influence users and to effect change in the organisation. Although CareOne was still in the early stages of the design process, it is expected that the new ERP system and dashboard would be a solid foundation for CareOne to use information to support business processes and decision making. Notably, as discussed in Chapter 6, decision outcomes should be reflected in ensuring that the organisation is making social impacts to the community ultimately, as it is one of their reasons for existence as an organisation. Thus, having reliable information is essential to help the organisation remain viable in the long term.

As discussed in Chapter 5, although UniOne suggested that the information on the dashboard has helped them make some decisions, it was established that there were other aspects influencing users in making decisions other than information, such as the use of historical data or gut feeling, time pressure, and political issues in the organisation. Although data and information on the dashboard can support decision making, it may not guarantee effective decision making as according to Marsh, Pane & Hamilton (2006), it would depend on how the data is being used.

UniOne expressed their concerns about the possibility of the dashboard causing information overload or 'analysis paralysis', while CareOne did not raise this matter. Houghton et al. (2004) suggested that the dashboard will not lead to information overload, given the key metrics have been carefully selected and used on the dashboard. Arguably, in UniOne's case overload might have stemmed from their inability to agree on key metrics for the dashboard. At the time of interviews, they had prepared around sixty metrics. The design team was still discussing key metrics to select based on their ideal dashboard design using the pyramid model (refer to Figure 7.3, section 7.4). This suggests more emphasis has been placed on the importance of metrics selection for the dashboard design process. By aligning dashboard design with organisational strategic goals, attention will be focused on the most important metrics for selection (Houghton et al. 2004).

Cross-case analysis of Theme 5 is summarised in Table 7.6.

Table 7.6 Cross-case analysis for Theme 5

Categories	**UniOne**	**CareOne**
Issues impacting the design of the dashboard	There are a few issues with the data source that impacted the design of the dashboard such as data unavailability, source system upgrades, and data source sustainability. Apart from that, restructuring of the organisation would certainly impact the design of the dashboard as information needs would change according to the new structure.	Time and financial constraints have driven CareOne to make do with less customisation in their dashboard. CareOne also perform business process improvement based on best practices in the sector and to support the two government changes (NDIS and CDC). The dashboard project is going to be an ongoing one. CareOne will continue to monitor current situations in the industry and adapt the design of the dashboard if necessary.
The use of dashboards enables performance monitoring and increases accountability in the organisation	The dashboard enables UniOne to be more proactive in spotting problems and to take corrective actions accordingly. With rising competitions in getting Government funding, UniOne has to be more accountable in funding allocation and output justification. Furthermore, the dashboard can be used to monitor employee's performances. The users can also identify areas of improvement and be empowered to improve their performances.	The dashboard is expected to be used daily to monitor the organisational performance and to provide alerts in areas needing attention. It is also expected to offer information transparency to support accountability in task ownings and decision making which is still lacking in CareOne. As a result, the dashboard should enable the users in making a corrective action when necessary.
The use of information on the dashboard supports an evidence based decision making in the organisation	UniOne argued that the dashboard can influence users in making decisions and to make changes in the organisation. Especially when making	Although CareOne was still in the early stage of the design process, it is expected that the new ERP system and the dashboard would be a solid

	strategic decisions, information is needed to support them, in which the dashboard would come handy. Furthermore, the dashboard enables UniOne to compare their performance against other organisations in the industry.	foundation for CareOne to use information to support business processes and decision making. Apart from that, the dashboard would enable the users to be more proactive in making evidence based decision making.

Figure 7.7 summarises key takeaway points for Theme 5 which include theoretical and practical importance.

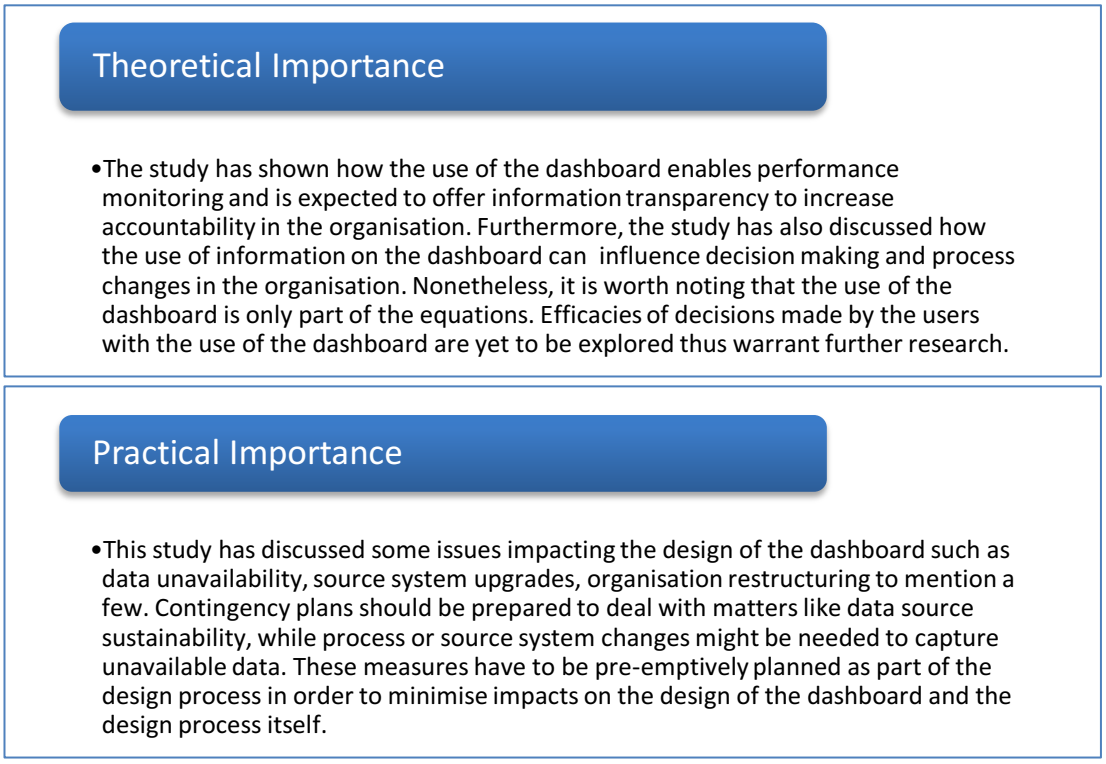


Figure 7.7 Takeaways from Theme 5

7.8 Summary

In this chapter, cross-case analysis for UniOne and CareOne were discussed. Key similarities and differences were outlined. Subsequently, in-depth discussion on comparison between cases has been further discoursed in terms of themes. When the interviews took place, UniOne had completed at least a single end-to-end dashboard design process, in which users had managed to use the dashboard. The design process will be an ongoing process where the design team can evaluate the current design and make plans for improvement for the next iteration. While CareOne

also suggested the same thing, they were still in the early stages of the design process when the interviews occurred. Although, it might seem that CareOne's case study is not as comprehensive as UniOne's, it has helped the researcher in avoiding impulsive and possibly inaccurate conclusions by "counteracting these tendencies by looking at the data in many divergent ways" as suggested by Eisenhardt (1989, p. 538). Furthermore, it also increases the possibility of capturing fresh and novel findings from the data (Bourgeois III & Eisenhardt 1988). In this case, three new categories have emerged from the second case study.

The first emerging category is 'Dashboards support and enable business process improvements'. In CareOne, prior to starting the project, key business processes were analysed in order to identify inefficiencies and redundancies. Subsequently, improvements which incorporate the use of dashboard would be implemented along with the project. This enables changes to be implemented together with the new system. The second emerging category is 'Groundwork activities in preparation of the design process'. Prior to starting the dashboard project, CareOne's design team had been working with users in identifying key business processes and had looked into ways to improve some inefficiencies from the perspective of information systems. This is an important exercise, as dashboard implementation would facilitate changes in business processes. There was a limited discussion of these two emerging categories in UniOne's case study, and this is possibly due to the design process having reached maturation at the time of interview compared to CareOne's case.

The third emerging category is 'Co-evolution of problem and solution spaces in the dashboard design process'. UniOne's design team tends to focus more on analysing as the best way of solving problems. Nonetheless, through prototyping and envisioning the end result of the dashboard, the design team balances their time spent on analysing the problem with that spent on the solution space. Similarly, CareOne's design team seemed to spend more time on analysing problems, they also discussed solution options. Their descriptions in the interviews suggested an articulation of activities in the solution space while describing the process of analysing problems.

In the next chapter, key findings will be presented, research questions addressed, and implications for practice discussed.

Chapter 8: Addressing Research Objectives and Questions

8.1 Introduction

This study so far has explored the process of designing a dashboard beyond its functionality and graphical user interface. It uses the notion of design thinking as its theoretical lense to understand the intricacy of the design process. This includes groundwork in preparation for the design process, actual dashboard design, and impacts on current information systems and/or organisational processes. This study has also examined key elements and design principles in dashboard design.

This chapter is significant because it discusses how this study will address the three research questions outlined in Chapter 1. The seven key findings of this study following cross-case analysis discussed in the previous chapter will be highlighted. This is followed by a discussion on how the findings address the research questions. Subsequently, reflections on the research objectives are presented. Lastly, implications of this study for theory and practice will be outlined.

8.2 Key findings

There are seven findings resulting from this study. These findings are described as part of the research outcomes. Subsequent sections will discuss how each finding fits and addresses the research questions.

8.2.1 Finding 1: Innovations as 'ends' and 'means'

As discussed in Chapter 3, design thinking aims to create innovation (Boland et al. 2007; Brown 2008). When it comes to defining innovation, this varies between organisations. In general, innovation denotes efforts made by an organisation to improve the possibility of success of its businesses which includes but is not limited to changing processes to be more effective, productive, and to deliver better product or services (business.gov.au 2014). It "means change: creation of the new and letting go of the old" and notably this is hard to achieve due to the unexpected and disruptive nature that change brings to organisations (Wölbling et al. 2012, p. 122). Not every innovative idea has to be disruptive and certainly focus should reach beyond new product development (Kanter 2011).

UniOne generally looks at the end result when it comes to innovation. Collectively, as an organisation, they did not think that their dashboards were innovative at all. CareOne shared this perspective as they regarded their ERP and dashboard project as a technological overhaul. This

view reflects how organisations undermine and classify their dashboard project not as an innovation. In reality, Drucker (2011) argued that innovation has to be simple, so long as it has a clear focus and goal to improve a current situation in the organisation.

Clearly, there is a distinction between 'ends' and 'means'. While as an end product, the dashboard might not be viewed as an innovation by UniOne and CareOne, the study identifies potential innovations in the design process. CareOne mapped out business processes to phase out inefficient and ineffective processes as part of the project. This activity is in fact a good starting point to identify innovation opportunities, according to Bettencourt and Ulwick (2011). Furthermore, Drucker (2011, p. 208) added that most innovations result from "a conscious, purposeful search for innovation opportunities", especially when external factors like industry and government regulation changes were faced by both UniOne and CareOne. Subsequently, innovation can be created by simplifying processes, eliminating unnecessary steps, and giving users useful information (Bettencourt & Ulwick 2011). CareOne embraced process and cultural change that work alongside the dashboard design process. In a way, the dashboard acts as a catalyst for process change and enables them to operate more efficiently and effectively.

Furthermore, the design team's efforts in collaborating with users and in building awareness of their dashboard's capabilities can be considered as a journey on the road to innovation (see Theme 3, Chapter 7). In essence, they were trying to create an innovation through dashboard design, which is beyond merely designing the dashboard as an end product, as it includes efforts to change users' mindsets about evidence based decision making and how the dashboard can facilitate knowledge discovery. The dashboard certainly enables them to be more innovative in delivering services to their students or clients. In the long term, the design process should be viewed as ongoing and might lead to the creation of organisational business strategies. Thus in order to improve dashboard design, the design team has to continuously collaborate with users, and to consider both internal and external factors which might impact the design of the dashboard.

8.2.2 Finding 2: Organisational data-driven activities

The study has shown how both organisations aspired for their users to use data to support business processes and decision making. In CareOne, Care-User-Strat, who appeared to be very data savvy, demonstrated how to use data from multiple sources to help with decision making. Whilst in UniOne, Uni-CFO emphasised the importance of informed decision making and performance monitoring using the dashboard. At the same time, the study also revealed a majority of staff in both organisations used anecdotal evidence, gut feeling, or past experience to support decision making. As highlighted in Theme 5 (refer to Chapter 7), there is a prevalent culture of lack of

accountability and a call for information transparency in which the dashboard is expected to bring about organisational change.

Consequently, there seems to be a mismatch between organisational expectation of data-driven activities (e.g. evidence based decision making and performance monitoring) and the apparent reality in the organisations. With current organisational culture not being data driven, this expectation can be viewed as an ideal notion by the majority of the users, if it is not accompanied by a proper execution plan. In the design process, there is a possibility that users might be struggling to incorporate data into their existing business processes, thus affecting them in articulating design requirements: not to mention constraints and limitations which might impact the design of the dashboard. As discussed in Theme 1 in Chapter 7, aims and purposes of the dashboard have to be determined at the beginning of the design process. However, the study has also emphasised the importance of translating and operationalising aims and purposes into the design of the dashboard.

Therefore, just as CareOne handled their constraints, as they have to make do with limited resources and money, plans and priorities have to be defined and set right from the beginning. In order to get users to be actively involved in data-driven activities, a culture of using data in meetings, discussions, and decision making has to be cultivated throughout the organisation. For that to be achieved, the foundation has to be solid. The development of source systems or the data warehouse has to be prioritised so the dashboard can source reliable data. Apart from that, improvement plans for subsequent iterations are also important. Users need to be given ample time to use and adopt the dashboard in their daily business processes. Subsequently, they would be able to articulate further requirements to improve dashboard design.

8.2.3 Finding 3: Evolution of roles in the design team

Roles in the design team were discussed as key aspects in the dashboard design process in Theme 2 (refer to Chapter 7). When it comes to the dashboard design, UniOne tends to view the process from an Information Systems (IS) perspective. Terms such as requirement gathering, dashboard development, and implementation amongst others were constantly used. In CareOne the use of terms such as project, project governance, project lead, and subject matter experts suggests a strong project management lens is being used to view the design process. Despite this difference, essentially the dashboard design process entails initiation, a design goal, existence of a design team and users, collaboration between the design team, users and stakeholders, and development of the dashboard. Depending on how the design process is initiated, Ottersten and Balic (2007) suggested the design team should take charge and drive the design process.

As discussed in Chapter 3, a design team consists of individuals involved in IS design (Stolterman 1999), which can include some key users (McKay, Marshall & Hirschheim 2012), even if they are not formally trained in design (Lindberg et al. 2012). This has been the case with UniOne and CareOne. Their design teams consisted of managers, analysts, and key users involved in the dashboard design process. They did not seem to have been formally trained in the design field and their backgrounds varied. The study also observed that design roles have extended to data preparation activities as well as the need to understand the context of the data and its related business processes. For example, Uni-Mgr1's background was in statistics and Uni-Mgr1's responsibilities prior to the start of the dashboard design process were mainly in developing financial models and analyses for the Finance department. Subsequently, Uni-Mgr1's role has extended to present and visualise data on the dashboard.

At the same time, as discussed in Theme 3 in Chapter 7, the design team also need to understand the technologies used in the design, to foster relationships with users, and to recognise working cultures and politics in the organisation in order to really drive the design process and make it succeed. In a way, this view confirms what has been discussed in Chapter 3, where IS design process requires emphasis on "social complexity" in the organisation plus technical aspects, thus a balance is needed (Lindberg et al. 2012, p. 230).

Furthermore, Stolterman (1999) argued that design has a different aspect compared to science or art, as it is characterised by limited time and resources, a very complex situation and conflicting requirements. The study also corroborates this argument. Changes to government regulations and increasing competition have added more pressure and urgency on UniOne and CareOne in their efforts to design a dashboard which might be essential to the growth of their respective organisations. In CareOne's situation, being a not-for-profit organisation means they have a strictly limited budget and resources. Nevertheless, the study suggests that the complexity and limitations provided a perspective for the design team to remain focused and did not deter the design team from moving forward.

In both case studies, the composition of the design team is comparable to Eckerson (2011), who suggested an executive steering committee along with a project champion, governance board, business analysts, 'KPI team', and the technical team to make a dashboard project successful. While this study does not favour a specific design method or approach amongst others from the perspective of IS, there is an inevitable implication for practice as the role of design team members evolved. Multidisciplinary communication skills would be valuable as suggested by Meinel and Leifer (2011). Additionally, a holistic approach in analysing design problems should be embraced

and co-existence with solution concept development should be allowed (Brown 2009; Cross 2011).

8.2.4 Finding 4: Design thinking as a fundamental notion of the design process

Both UniOne and CareOne were not aware of the notion of design thinking prior to the interviews. Nevertheless, the study suggests their dashboard design process and activities, to a certain degree, denoted the main characteristics of design thinking, as discussed in Chapter 3. The prevalence of design thinking is shown through the existence of empathy and collaboration, the active involvement of users, as well as the use of early prototyping and a multidisciplinary team in the design process. The design teams in UniOne and CareOne have demonstrated all three key aspects of desirability, feasibility and viability in their respective dashboard projects.

Furthermore, as discussed in Theme 1 in Chapter 7, design thinking can be manifested as the way in which CareOne regarded their dashboard project as an enabler for their business process improvement. Essentially, CareOne has outlined the big picture, of which the dashboard is a part, and taken a holistic approach to the design process. They have encountered the need to think ahead, to collaborate with users, and prepare a solid foundation for the dashboard design process such as data, infrastructure, and underlying business processes. This supports what has been discussed in Chapter 3, where design thinking "enables a multidisciplinary team to creatively collaborate with users in creating solutions to problems" (Wölbling et al. 2012, p. 124). Notably, the study has also suggested that it is difficult to explore and analyse design problems without discussing solution options at the same time. Co-evolution of problem and solution areas reflects the core of design thinking, as suggested by Cross (2011).

Generally, the study has shown the plausibility of design thinking to be adopted or applied as a fundamental philosophy of a design process regardless of the design and development method employed by the organisation, as suggested by Lindberg et al. (2012). Essentially, design thinking does not replace or be regarded as another design/development method in IS. The finding corroborates the perspective of design thinking as "an integrated development philosophy" which impacts strongly on organisational processes and structures (Lindberg, Meinel & Wagner 2011, p. 15). In a way, this aligns with Wölbling et al. (2012) where design thinking is an overall culture adopted by organisations to enable user-centred innovation in the design and development of the software.

8.2.5 Finding 5: The ideal dashboard design

When it comes to designing a dashboard, the study suggests that organisations tend to follow best practice or a textbook approach, as outlined in Theme 2 in Chapter 7. Essentially, a single page display for all users, be they executives, managers, or operational users, is ideal, as suggested by Few (2006). The major difference is the level of detail or granularity of information being displayed on the dashboard, as discussed in Chapter 2 (refer to Figure 8.1).

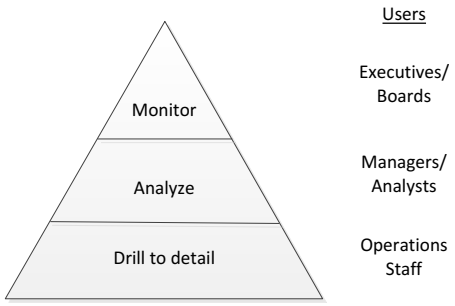


Figure 8.1 Pyramid structure in dashboard design adapted from Eckerson (2006)

Nevertheless, this study has shown that ideal dashboard design can be difficult to realise. In UniOne's case, for instance, as discussed in Theme 4 (refer to Chapter 7), even after months of discussion, they have not reached an agreement as to which key metrics will be selected for their single page dashboard. As pointed out in Chapter 2, there is no widely accepted 'guideline' on selecting key metrics for the dashboard, hence this adds to the complexity of dashboard design. Clearly, some can use the standard metrics provided by any of the dashboard design tools as a baseline for dashboard design (Wisan 2002). But more often than not, organisations are left with more than enough metrics. In UniOne's case, they have more than sixty metrics designed and prepared for the dashboard.

Following the earlier analogy of an organisation as a 'ship', all users should have the same visions displayed on the dashboard, as mentioned by Clark, Abela and Ambler (2006). However, consensus on the most important metrics to be selected for the dashboard is difficult, as the study suggests. Additionally, the selected metrics have to be agreeable and relevant to all users in the organisation. Notably, the use of a dashboard can be very idiosyncratic for each user. Although best practice or a textbook approach in designing a dashboard is ideal, it is doubtful that an organisation can achieve such ideal dashboard design. Possibly, it might still be achievable if the context is restricted to a group, division, or department.

8.2.6 Finding 6: Dashboard composition

As discussed in Chapter 2, Few (2007) contended that the term 'dashboards' has been used inaccurately to describe any type of screen-based display which contains multiple charts regardless of its purpose. In addition, Few (2007) argued that the main purpose of the dashboard is merely for monitoring, not for analysis. The study considers this definition limiting and contradictive to other dashboard definitions discussed in the literature (see Chapter 2, section 2.2). The study corroborates what has been discussed in Chapter 2: that the purpose of the dashboard goes beyond merely monitoring. For instance, as discussed in Theme 1 in Chapter 7 in UniOne's case, the dashboard is used for performance monitoring and to extract information for further analysis to support business decision making.

UniOne's dashboards would fit what Few (2007) described as "Faceted Analytical Displays" and thus it is not considered a dashboard (p. 1). Nonetheless, this study does not intend to focus on discussing whether or not UniOne's dashboard is indeed a 'dashboard', stemming from Few's (2007) definition. Both case studies have shown that their descriptions, ideas, and goals of the dashboard corroborate what had been discussed in the literature. Therefore, the focus of the discussion should move on to their design process and other important issues covered in other findings of this study. In turn, the findings contribute to and inform how dashboard design can be improved to become more valuable and more effective for the organisations.

Furthermore, with modern dashboard design tools (such as Tableau used by UniOne) allowing users to build their own dashboards, defining what makes a dashboard can be very tricky and idiosyncratic. In some cases, it appears there is no strong agreement when it comes to defining a dashboard, and terms such as dashboards and scorecards are often mistakenly used interchangeably (Lawson, Stratton & Hatch 2007). In CareOne's case, they know exactly that dashboards and scorecards are different as they used Balanced Scorecards as a guideline to define key metrics for the dashboard. Generally, the study shows that both organisations were well aware of the definition of a dashboard, as discussed in the literature. Getting consensus and agreement from many different stakeholders would be a key part of the design process in order to achieve the desired dashboard design.

In relation to Finding 5 in the previous section, it was discussed that organisations were presented with a lot of metrics available to be selected. This could leave users feeling overwhelmed and thus lose perspective on key relationships between metrics (Matthews 2011). It has proven difficult to select and prioritise metrics, as supported by Wisan (2002). So it would be difficult for them to end up with a single page of dashboard, as argued by Few (2006). Nonetheless, it is

clear that the study supports Pankaj, Hyde and Rodger (2006) who argued that dashboards "should be positioned as a unique and different information delivery mechanism to enhance their value proposition" (p. 1429). This means that the dashboard should not be viewed as another reporting platform which might present redundant information available in other systems in the organisation.

8.2.7 Finding 7: Dashboards as a catalyst for change

As discussed in Chapter 2, Eckerson (2011) suggested dashboards can drive organisational change. In a way, designing dashboards could impact or trigger various activities or processes in the organisation. It has been shown in both case studies that the dashboard design process generally was triggered by an idea or a request to create metrics to monitor a certain type of key performance indicator (KPIs). After thorough requirement analysis, there is a possibility that the design team might come to the realisation that the data required for the metrics is not available, or captured by existing processes or systems. In this instance, changes need to be made as a part of the dashboard design process. These changes were not necessarily only at systems level, but also in terms of creating a new process in order to capture the required data to be displayed on the dashboard.

As an example, in UniOne's case, the design team identified the source system where the data were supposed to come from. Subsequently, the design team would negotiate with a number of relevant parties to work out the best solution. Depending on the urgency and priority of the KPIs, changes to the data structure or the current system would be made accordingly. In CareOne's case, as discussed in Theme 1 in Chapter 7, it was emphasised that changes in business processes or improvements needed to happen as part of the dashboard design process. Inefficient and redundant business processes need to be identified, as CareOne aspired to follow best practice in the sector. This is aligned with Nagy et al. (2009), who argued that process changes can be made by integrating one process with another process, possibly eliminating inefficiencies.

Additionally, this study has discussed that process change should be implemented together with the dashboard. In a way, users would use the dashboard as part of the newly improved business processes. Therefore, the dashboard can be considered a catalyst or enabler for such change in these organisations. This notion corroborates Dover (2004) who stated that dashboards could be a "catalyst" for something broader to take place when properly implemented (Dover 2004, p. 48). Furthermore, this view is supported by Houghton et al. (2004) who described the design process and use of a dashboard at Western Digital. The design process has stimulated some process

improvement in the organisation, while the use of the dashboard has shortened their daily five-hour production meeting to less than two hours (Houghton et al. 2004).

As the study has discussed these possible changes in relation to current systems or business processes triggered by the dashboard design process, organisations should be prepared and better equipped for change. As outlined in Theme 5 in Chapter 7, pre-emptive measures should be planned as part of the design process in order to minimise impacts on the design of the dashboard and the design process itself. Although the degree of impact might not always be the same, it would be sensible if organisations were aware when designing a dashboard.

This chapter now turns to how the findings address the research questions.

8.3 Addressing the research questions

As mentioned in Chapter 1, this study has three research questions. Following the discussion in the previous section, each research question will be addressed based on the findings of this study. Table 8.1 describes the relationships between research questions and findings.

Table 8.1 Mapping between research questions and findings

Research Questions	Findings
RQ1	Finding 2, Finding 3, Finding 7
RQ2	Finding 1, Finding 4
RQ3	Finding 3, Finding 5, Finding 6

8.3.1 RQ1: How does the dashboard design process affect the organisation in terms of its existing systems and processes?

RQ1 asks how the dashboard design process affects the organisation in terms of its existing systems and processes. Based on the findings, it is gathered that the notion of impacts could happen in two ways. Firstly, the current organisational processes, systems, and/or cultures might influence dashboard design. Issues such as data unavailability, constraints and limitations from other systems, and changes in current processes and/or the structure of the organisation can significantly impact dashboard design. Thus the design might need to be adjusted accordingly, depending on the feasibility and viability of the project. In UniOne's case, there were some structural changes in terms of faculties and departments. Inevitably, it has prompted the design team to perform an impact analysis on dashboard design and specifically data structure. Some metrics, especially those with comparisons between departments or functional groups, have

become irrelevant. Therefore, the presentation of information on the dashboard needed to be changed to match the new organisational structure.

Secondly, the use of the dashboard could impact current organisational processes, systems, and/or cultures. The findings suggest that dashboards can be used as a catalyst or vehicle for business process change. Inefficient and redundant business processes can be identified during the dashboard design process. Subsequently, business process improvement which includes the use of the dashboard can be made alongside the design process. In CareOne's case, business process changes are to be implemented along with the ERP and dashboard project. The new processes would include the use of the system so users do not have to work around it. In UniOne's case, the use of dashboards enables performance monitoring to increase accountability and transparency in the organisation. For example, the dashboard has helped UniOne to identify lower performing units so they can make an action plan to improve the performance of the units accordingly. Users can also use the information obtained from the dashboard to support evidence based decision making and business processes.

Nonetheless, the findings also suggest a mismatch between organisational expectation of data-driven activities (e.g. evidence based decision making and performance monitoring) and the apparent reality in the organisations. Especially in CareOne's case, the working culture suggests a lack of accountability in terms of owning business processes or decision making. The intention of the organisation is for users to be more data savvy and this is perceived as an ideal notion. In reality, users may be unwilling to incorporate the use of data from the dashboard into their existing business processes. Unless people are held accountable for actions or decisions, it is going to be challenging to change their habits and culture in order for the organisation to change (Eckerson 2011).

The dashboard design process will bring about an evolution of roles in relation to design team members. The study suggests that these roles have extended to data preparation activities, as well as the need to understand the context of the data and its related business processes. Also, the design team need to understand the technologies used in the design, to build relationships and collaborate with users, and to comprehend working cultures and politics in the organisation to drive the design process. This study does not aim to focus on a specific design and development method in IS. Nonetheless, the study emphasises the inevitable impact to practice as the role of design team members evolved. As a part of key characteristics of design thinking, a holistic approach in analysing design problems should be embraced, multidisciplinary communication skills should be cultivated, and co-existence with solution concept development should be

allowed (Brown 2009; Cross 2011). Further discussion on characteristics of design thinking is addressed in the next section.

8.3.2 RQ2: In what ways does the design process corroborate with the fundamental characteristics of design thinking?

As first mentioned in Chapter 3, Figure 8.2 represents design thinking characteristics synthesised from the literature.

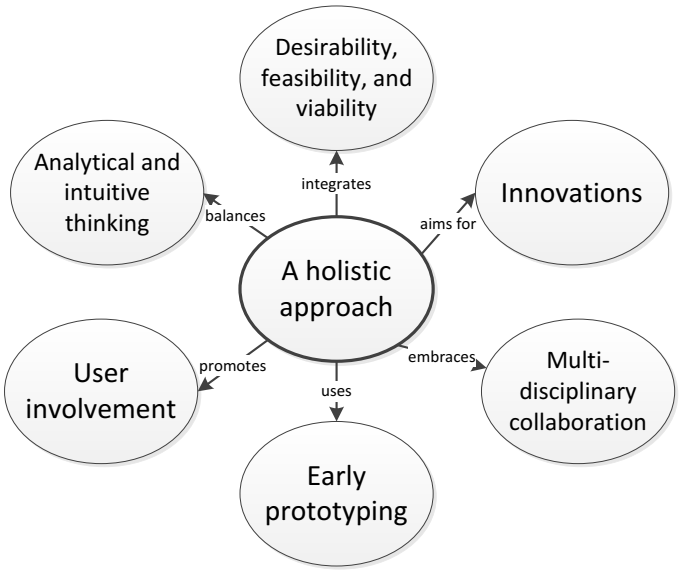


Figure 8.2 Characteristics of design thinking synthesised from the literature

Based on the findings, it can be synthesised that a design thinking mindset is prevalent in both organisations. Essentially, this study demonstrates that design thinking can exist in a design process, even though the notion was not formally initiated by the design team. As Tjendra (2013) suggested, a design thinking initiative is normally undertaken in a private and formal session, with or without engaging a third party advocate to the design team. But from this study, it can be established that characteristics of design thinking exist and were apparent throughout the design process. Table 8.2 summarises how each characteristic is prevalent in both case studies.

Table 8.2 Analyses on design thinking characteristics

Characteristics	UniOne	CareOne
A holistic approach	The design team focused on the big picture which includes a long term engagement with users and a sustainable data sourcing. Although it is the nature of dashboards to get the data from other systems, the design team should have pre-emptive measures and contingency plans to ensure that the dashboard design would not be too dependent on other systems.	The design team has been thinking ahead to prepare for the foundation for their dashboard project (i.e., data, infrastructure, and underlying business processes). Their holistic approach views the project as a business process change instead of a mere technological overhaul.
Uses early prototyping	The design team used Tableau to design a working prototype instead of a mere mock-up of the dashboard user interface to capture feedback and to facilitate collaboration with the users.	The use of prototypes early in the design process has helped users in understanding what to expect from the dashboard and in articulating user requirements.
Promotes user involvement	Although, it does not appear that the users have played a very active role in the design process, the design team seemed to have worked together and consulted with the users throughout the process, especially in key metric selection process.	User involvement has been very prominent since the beginning of the design process. Key users were involved in crucial design decision making including the vendor selection. By so doing, the design team anticipated that it would increase the use and acceptance rate at a later stage.
Balances analytical and intuitive thinking	The design team tends to focus more on analysing on the best way of solving problems. Nonetheless, through prototyping and envisioning the end result of the dashboard, the design team allowed some intuitions in exploring the solution space.	The design team seemed to have spent more time on analysing problems although at the same time discussed on the solution options. An activity, like envisioning how the dashboard would look like, demonstrates their effort in balancing analytical and intuitive thinking during the design process.
Integrates desirability, feasibility, and viability	The dashboard design process was supported by the organisation in terms of budget and resources. Hence the feasibility and viability aspects of the dashboard design project were not considered as problems. As a result, the design team can focus on designing the dashboard that displayed the most significant metrics aligned with the organisation's visions and goals.	Executives in the organisation have given their support and endorsement for the dashboard project. However, as a not-for-profit organisation, there would always be a limit to its budget and resources. This will inevitably become one of their main constraints of the project. Most importantly, their biggest concern now tends to be on the user aspect, to ensure the dashboard is designed based on user needs, to be useful, and to reach the goals they were aiming for.
Aims for innovation	Innovation was manifested in the way the design team's efforts in engaging the users and in building awareness on information and dashboard's capabilities. In essence, they were trying to create an innovation through the dashboard design. That is beyond just designing the dashboard as an artefact as it includes their effort to change users' mindsets about data and in educating users on benefits of data integration.	As a way to identify innovation opportunities, the design team mapped out business processes to phase out inefficient and ineffective processes as part of the project. Then, innovation can be created by simplifying processes, eliminating unnecessary steps in the processes, or giving users useful information through the dashboard. With the new processes in place, users would be enabled to operate more efficiently and effectively.
Embraces multidisciplinary collaboration	The design team come from the finance planning and performance department. Their different backgrounds in terms of trainings and qualifications. They believe that innovation comes from difference as it promotes discussions and creates a broader range of ideas and solutions than a team of people with similar expertise.	There was a limited discussion in this matter. However, it is worth noting that while the design team was formed by the IT department, they have subject matter experts from other departments to join the design team.

Furthermore, as explained earlier in Finding 4, design thinking can be manifested in such a way that organisations consider their dashboard project as an enabler for business process improvement. They would need to think ahead, collaborate with users, and prepare solid groundwork for the dashboard design process such as data, infrastructure, and underlying business processes. Overall, the study has shown the plausibility of the notion of design thinking, to be adopted or applied as a fundamental philosophy of the design process regardless of the design and development method used by the organisation. This view essentially corroborates with the complementary nature of design thinking in relation to traditional IS development methods, as suggested by Lindberg et al. (2012) and discussed in Chapter 3.

The design thinking dashboard development strategy model was used as a foundation for the conceptual framework of this study. Figure 8.3 describes reflections or take-away points based on how the two case studies corroborate the model.

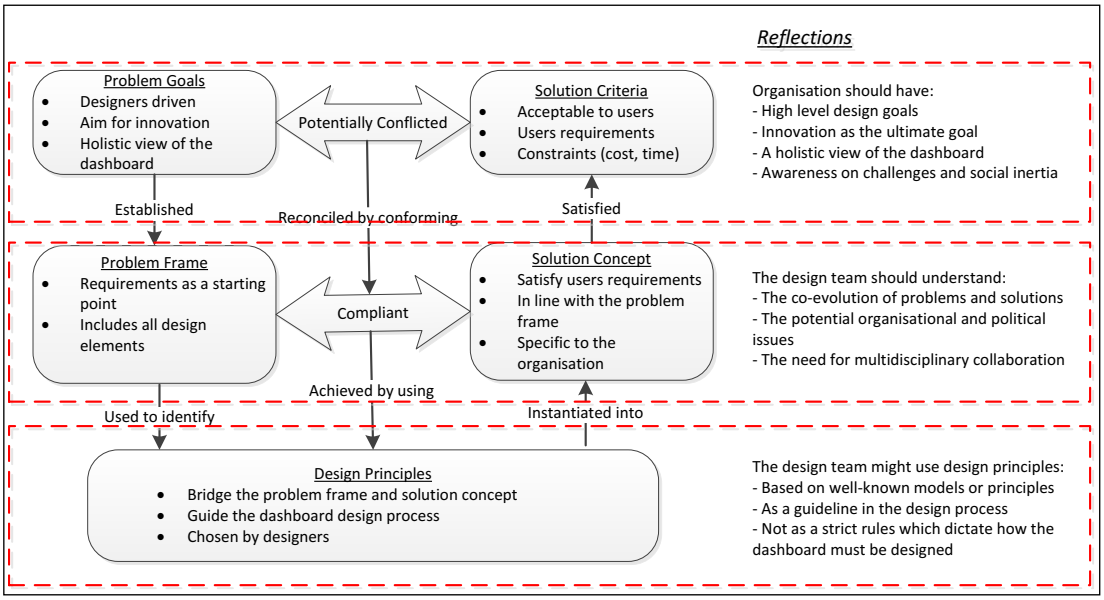


Figure 8.3 Reflections on the design thinking dashboard development strategy model

The top part of the model suggests a likely gap between problem goals and solution criteria. In UniOne's case, the holistic view of the dashboard is represented in a form of long-term engagement with users, self-service access to information, and performance awareness, which would affect the performance of the organisation. UniOne had their long-term design goals set up and they were fully aware of design constraints. However, reconciling the gap between problem goals and solution criteria has been difficult for them to achieve. As discussed in Chapter 5, the term 'social inertia' was used to explain the phenomenon which could be due to many reasons

such as information being only a small part of the equation decision making activities, the complexity of organisation, as well as data being used as political assets (Keen 1981).

In CareOne's case, the holistic view of dashboards was instantiated in such a way that the dashboard provided information to help the organisation to survive in a very competitive and changing marketplace. When this design goal is achieved, the dashboard will enable the organisation to be innovative. In terms of constraints, the design team was conscious of their limited financial resources as a not-for-profit organisation. Thus, it worked with users to work out acceptable user requirements accordingly. In sum, the study has shown that organisations should have high level dashboard design goals with innovation as their ultimate goal. Accordingly, a holistic view of the dashboard should be determined by the design team to help with user requirement elicitation considering design constraints. Lastly, the design team should be aware of potential challenges in the design process which include social inertia, as explained earlier in Chapter 5.

The middle part of the model suggests, as designers attempt to reconcile the gap between problem goals and solution criteria, they would further explore the problem area and frame the problem. As explained in Chapter 3 (Literature Review), problem framing is to perceive and to depict the condition of the problem in a certain way, leading to the possibility to act (Dorst 2010). When the problem frame has been defined, solution concepts can be discussed accordingly. As a result, the designers can move forward to explore the solution space within the determined problem frame.

In UniOne's case, while working on the design problem and solution concept, interdisciplinary communication skill has become an important skill for the design team to enable collaboration with users. Apart from that, the design team had to be mindful of organisational political issues which might impact collaboration with users from various departments. For CareOne, although the design team seemed to favour analysing problems, they have actually struck a balance with solution building activities such as envisioning how the dashboard would look, to ensure it would be useful for users. Also, the design team embraced multidisciplinary collaboration and worked closely with their users and stakeholders. In sum, co-evolution of problems and solutions has been demonstrated in this study. It is indeed difficult to discuss the design problem without considering user requirements, constraints, and solution options or concepts, as discussed in Chapter 7.

The bottom part of the model (Figure 8.3) suggests the problem frame would inform designers when choosing design principles. The principles would help designers to instantiate and make a conjecture of the solution concepts. This study has demonstrated the use of design principles by the design team while designing the dashboard. These principles were used as guidelines in the

design process and there were no strict rules as to how the design principles would be adopted. This will be discussed in more detail in the next section.

8.3.3 RQ3: What are the key design principles and elements in dashboard design?

In Chapter 2, key elements in dashboard design gleaned from the literature were discussed. The dashboards should provide visibility of key performance metrics which were sourced from integrated databases. Features should include actionable data visualisation and a capability to drill-down information. The dashboards should provide necessary alerts, allow users to view and forecast trends, and undertake comparative analysis (Houghton et al. 2004). This study corroborates that those key elements discussed in the literature were indeed crucial. But most importantly, the study also demonstrated the importance of groundwork preparation leading to the actual design of the dashboards beyond their user interface design, features and functionality.

Furthermore, as discussed in Chapter 2, based on the literature, components of a dashboard typically could be categorised into three main categories, namely Users, Technologies, and Contents. The first category, Users, entails not only the users of the dashboard but the organisation they belong to. The second category, Technologies, is based on technologies on which the dashboard was built, including but not limited to database technology, infrastructures, and design and development tools. The third category, Contents, includes other dashboard components such as the data being displayed, features, graphs and metrics. As the literature review did not discuss the design team, the study highlights their importance in the design process. Table 8.3 displays key elements in dashboard design based on the findings of this study.

Table 8.3 Key elements in dashboard design

Category	Key elements
Users	User Desirability Organisation Viability Organisational Cultures Dashboard Goals Business Processes Use & Adoption
Contents	Analytics Capabilities Data Integration Graphical User Interface Metric Selection Dashboard Features
Technologies	Technological Feasibility Current Information Systems
Design Team	Design Team Readiness Team Diversity Empathy & Collaboration Design Principles

Based on the conceptual framework discussed in Chapter 3, there are three inter-related stages of the dashboard design process discussed in this study, namely preparedness for the design process, the dashboard design process, and making impacts from the dashboard. The first element covers important aspects to check and gauge the preparedness of an organisation as a whole to start the dashboard design process. The second element covers the actual design process, while the third element is rooted in the notion that design thinking strives for innovation. As such, the design and the dashboard itself should impact users and/or their organisations. Each of the key elements in dashboard design discussed earlier (refer to Table 8.3) can be associated with the three inter-related stages of dashboard design.

Figure 8.4 depicts this association, which demonstrates the applicability of each key element of dashboard design at each stage of the design process. Similar to the conceptual framework discussed in Chapter 3, while each stage is positioned alongside the next, they should not be viewed as steps or phases to be completed in sequence. Instead, each stage informs the others, and the double directional arrows suggest iterations where possible or that are necessary for further improvement.

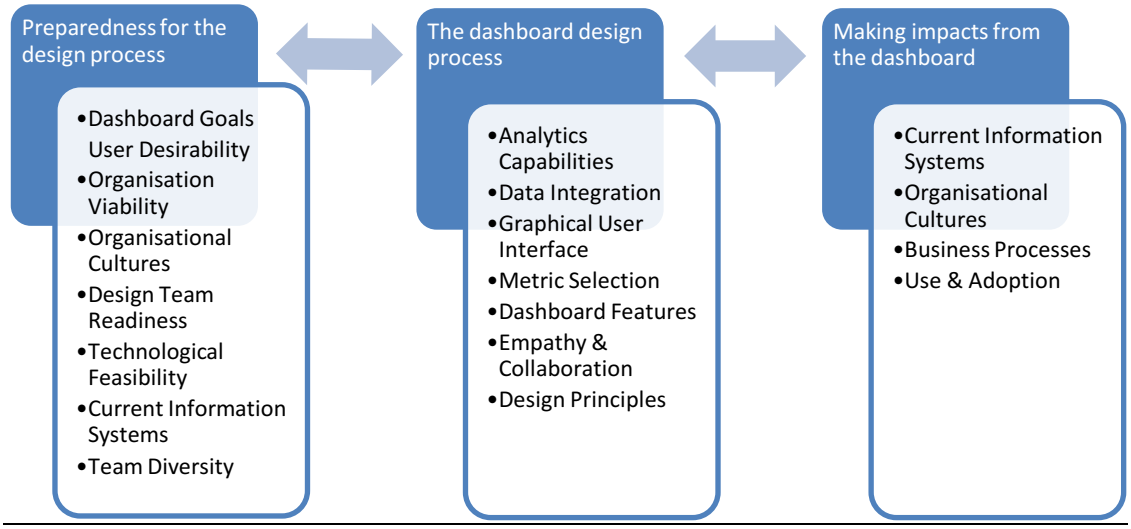


Figure 8.4 Key elements in dashboard design categorised by stages of the design process

Apart from key elements, this study explored dashboard design principles used by the design team. Essentially, dashboard design should be kept simple to avoid 'information overload', in which each element must serve a purpose. The dashboard should present useful, meaningful and actionable information which can be achieved through analytics. It is not uncommon for the

design team to adopt well-known design principles to guide them in the design process. For instance, the Balanced Scorecard (BSC) can be used to guide and inform users in defining and selecting key metrics. Another example is using the 80-20 rule as a guide to determine the metrics to select. As discussed earlier, the 80-20 rule, one of the vast numbers of universal design principles, states that 80% of impacts come from 20% of sources (Lidwell, Holden & Butler 2003). Therefore, most of the information needed by the users would need to be sourced by about 20% of the metrics on the dashboard.

In Chapter 3, it was discussed that "the best designers sometimes disregard the principles of design. When they do so, however, there is usually some compensating merit attained at the cost of the violation. Unless you are certain of doing as well, it is best to abide by the principles." (Lidwell, Holden & Butler 2003, p.11). There was limited discussion in this study on how the design principles were going to be used and translated into dashboard design. Nonetheless, this study has shown that the respective design teams used well-known design principles or models as guidelines for the dashboard design process. There were no strict rules as to how the design principles would be adopted, which is in line with Tufte (2001). Designers should not blindly translate the principles suggested and should instead be flexible (Tufte 2001). Overall, design principles should help rather than hinder their work and bring positive impacts to the design process (Lidwell, Holden & Butler 2003).

Figure 8.5 summarises key design principles based on the findings of this study.

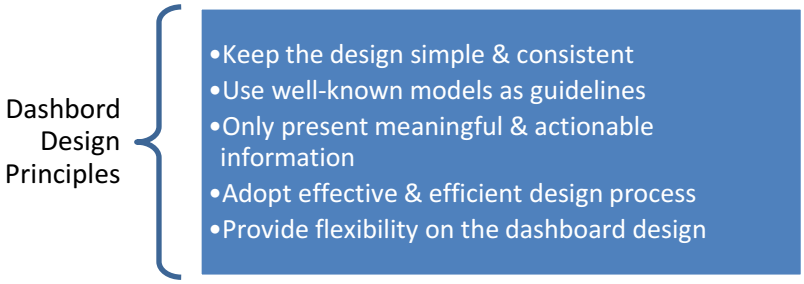


Figure 8.5 Key dashboard design principles

Furthermore, as discussed in Finding 5, organisations tend to use a textbook approach in dashboard design which follows a pyramid structure, as depicted in Figure 8.1. The findings suggest the approach proves to be difficult to achieve. Although it is ideal, in reality it is very hard to interpret the same metrics to be monitored by different people at the three different levels. Getting consensus on the most important metrics for on the dashboard is difficult. When it comes to selecting metrics, it would be very idiosyncratic for an individual or a group/division. Having

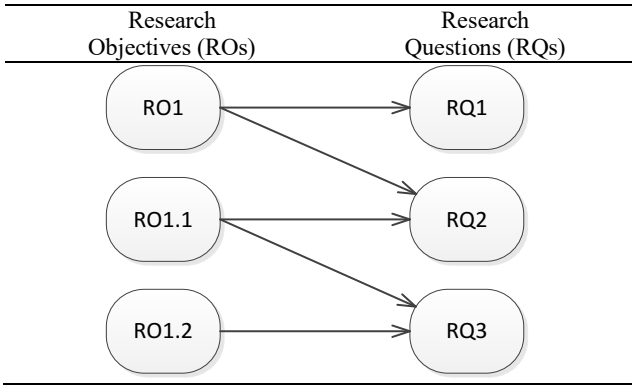
said that, it would be good for the organisations to have their ideal dashboard design achieve or arrive at a benchmark for comparison.

Lastly, as discussed in Finding 6, this study does not intend to focus on discussing if dashboards are indeed 'dashboards' based on the definition by Few (2007), so long as organisations have a clear idea in terms of the purpose of the dashboard. As discussed in Chapter 2, the purposes of the dashboard are to monitor organisational performance and to provide users with valuable information that can be used to support decision making. In the long term, dashboards could drive the organisation towards "a culture of transparency" as everyone in the organisation can access the information (Dover 2004, p. 44). Also, focus should be on important issues in the organisation's preparedness for the dashboard design process, the actual design process, and impacts on the organisation as a result of use of the dashboard.

8.4 Reflections on research objectives

As discussed in Chapter 1, this study has a main objective and two related sub-objectives. The main objective is to explore and understand the dashboard design process and how it impacts organisational performance, processes, and IS/IT environment. The first sub-objective is to explore if there are elements in the design process of the dashboard indicative of the concept of design thinking. The second sub-objective is to explore key principles in elements in dashboard design. The three research questions discussed in the previous section were framed to achieve the research objectives. Table 8.4 describes the relationships between each research objective and research questions.

Table 8.4 Relationships between ROs and RQs



In this study, relationships between the dashboard design process, current business processes, the IS/IT environment, and/or other matters in the organisation have been explored. Discourses or activities leading to or conducted prior to the dashboard design process were explored. This study

also examined key aspects influencing the design process, design best practice, guidance, and rules and constraints to be considered when making design decisions. As each research question has been addressed and elaborated in the previous section, the objectives of the study to explore the notion of impacts and key elements of dashboard design have been accommodated.

Outcomes of the study provide a better understanding of the dashboard design process, particularly in relation to the impacts of the design process on current organisational processes. The study has also shown the plausibility of the notion of design thinking to be adopted or applied as a fundamental philosophy of a design process regardless of the design and development method used by the organisation. Lastly, this study also provides a better understanding of how key elements and a set of design principles can be used to inform and support the dashboard design process in organisations.

8.5 Implications of theory

This study aimed to explore key aspects related to dashboard design beyond its functionality and graphical user interface. It has used the notion of design thinking as its theoretical lens and as a part of the conceptual framework of this study to understand the intricacy behind the dashboard design process. As discussed in Chapter 3, Johansson-Sköldberg, Woodilla and Çetinkaya (2013) criticised the notion of design thinking as a popular concept developed merely based on practice thus an empirical study is needed. This study has contributed to theory in extending the empirical grounding and understanding of the notion of design thinking in the context of dashboard design process.

As discussed extensively in Finding 4, the study has shown the plausibility of the notion of design thinking to be adopted or applied as a fundamental philosophy of a design process regardless of the design and development method employed by the organisation, as suggested by Lindberg et al. (2012). Based on the results of this study and by using design thinking as its theoretical lens, a seminal framework is prepared and described in Figure 8.6. This framework represents an improved conceptual framework, as discussed in Chapter 3. It is an ongoing dashboard design process in which design thinking mindset is prevalent. Key elements in dashboard design, discussed in section 8.3.3, were included in the framework accordingly. Double directional arrows between stages of the design process suggest possible iterations when further improvement or refinement is necessary.

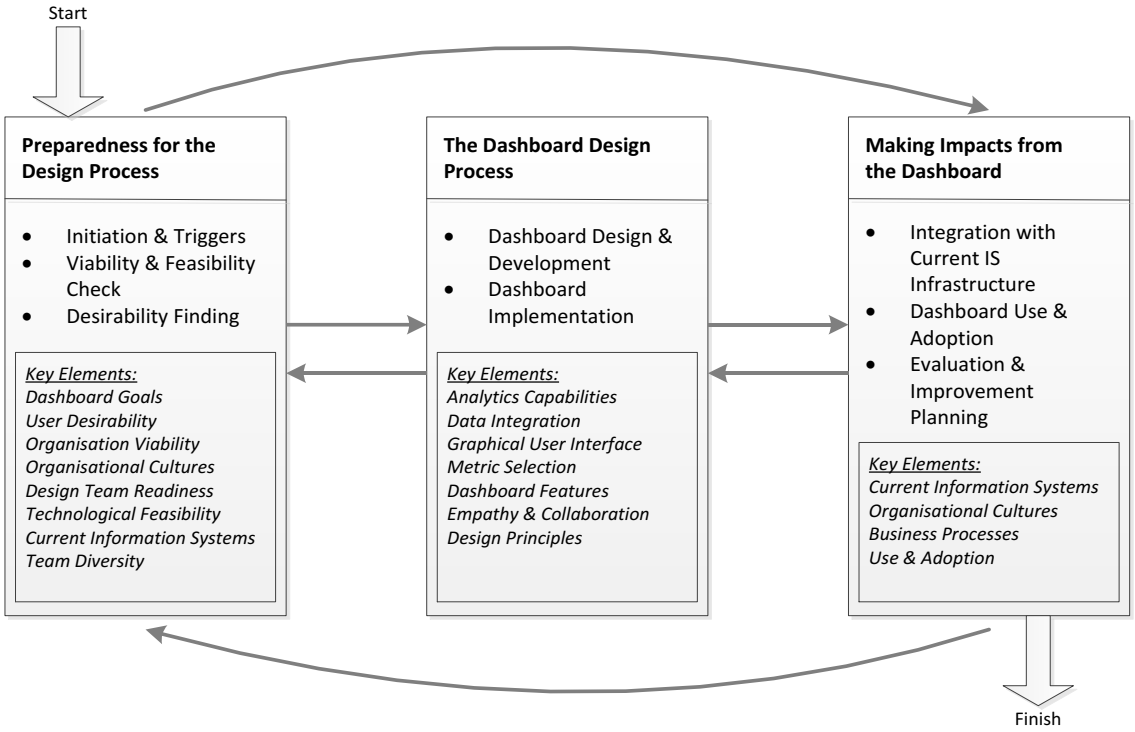


Figure 8.6 Ongoing dashboard design process framework

In general, a dashboard design process *starts* with an initiation or trigger from internal or external sources. Purposes and goals of the dashboard should be defined and aligned with organisational strategic goals. There are important elements to check and gauge the preparedness of an organisation to start the design process. Essentially, the design team should work with key users and stakeholders in determining the viability and feasibility of the initiative before requirement gathering can be initiated. Multidisciplinary collaboration exists throughout the process, where users and stakeholders would be actively involved in making dashboard design decisions. Early prototyping is used as a tool in designing and collaborating with users. Throughout the process, designers should endeavour to balance analytical thinking and their intuition, as it is an important characteristic of design thinking. This would enable designers to remain open minded in framing problems and exploring solution concepts.

Finally, when the design and development process has been completed, the dashboard can be implemented and integrated with the current IS infrastructure in the organisation. The whole process potentially *finishes* when users have used and adopted the dashboard. Though in general, the dashboard design process continues with an evaluation and improvement plan, as the study suggests that dashboard design process should be ongoing and aligned with organisational business strategies. Additionally, the design team has to continue to engage and collaborate with

users to continually improve and gauge the progress of dashboard adoption in the organisation. As a result, users can also evaluate if the use of the dashboard brought positive impacts.

8.6 Implications for practice

This study makes the following contributions to the body of knowledge:

- The study provides a better understanding of issues surrounding the dashboard design, strategic changes in current processes and/or the structure of the organisation which can significantly impact the design of the dashboard.
- This study informs IS design practitioners on the evolution of roles in a dashboard design team. The importance of a holistic approach in analysing design problems and co-existence with solution concept development has been highlighted as a notion that should be embraced, apart from possessing multidisciplinary communication skills.
- This study suggests a design team composition that is comparable to Eckerson (2011), who suggested an executive steering committee along with a project champion, a project governance board, business analysts, 'KPI team', and the technical team to make a dashboard project successful.
- This study provides a better understanding of how key elements and a set of design principles could be used to inform and support dashboard design process in organisations.
- The study has developed a seminal framework in relation to ongoing dashboard design (see Figure 8.6), in which design thinking mindset is prevalent, as elaborated in the previous section. The framework includes key elements in ensuring the organisation's preparedness for the design process, actual dashboard design process, and impacts from the dashboard.

8.7 Summary

This chapter is considered significant in this thesis. It has highlighted the seven key findings of this study following cross-case analysis discussed in the previous chapter. Discussion on how the findings addressed the research questions was then presented. Subsequently, reflections on the research objectives were discussed. Lastly, implications of this study in relation to theory and practice were discussed. Chapter 9 will offer concluding remarks.

Chapter 9: Conclusion

9.1 Introduction

This study has focused on issues related to the process of designing dashboards. The notion of design thinking was used as the theoretical lens of this study to understand the intricacy of the design process. This includes groundwork activities in preparation for the design process, the actual dashboard design, and understanding its impacts on current information systems and/or organisational processes. Furthermore, this study also examined key elements and design principles of dashboard design.

Two interpretivist case studies were completed in this study. The UniOne case study was conducted over a period of fifteen months. During that period, organisational changes including structural change, staff turnover, and release of the dashboard to a select group of users took place. Similarly, the CareOne case study was also conducted over a period of fifteen months. When the CareOne case study began, it coincided with the organisation's initiation of the dashboard project. In subsequent months, the project materialised as part of their major Enterprise Resource Planning (ERP) project. Each case has its own idiosyncrasies although some similarities have been identified. Through cross-case analysis, some significant findings were identified and discussed in the previous chapter.

This chapter begins with conclusions of the research, reflections on the quality of the study, a discussion about strengths and limitations, suggestions for future research, and concluding remarks.

9.2 Conclusions of the research

With an increasing interest in Business Intelligence, dashboards have played an important role in giving a summary of information presented for users in an organisation at a glance. In this study, the literature showed that the focus on dashboard design has previously been graphical user interface as well as providing features and functionality. Through utilising a case study method, this study aimed to explore and understand the impacts of the dashboard design process on organisational performance, business processes, and the IS/IT environment. Also, this study explored whether elements in the design process were indicative of the concept of design thinking. Lastly, this study explored key principles and elements in dashboard design.

The findings confirmed a dashboard design process is initiated or triggered by internal or external issues. Purposes and goals of should be defined and aligned with organisational strategic goals. Subsequently, the design team should work with key users and stakeholders in determining the viability and feasibility of the initiative before requirement gathering can be initiated.

Multidisciplinary collaboration exists throughout the process, where users and stakeholders are actively involved in making dashboard design decisions. Throughout the process, designers should endeavour to balance analytical thinking and intuition, as it is an important characteristic of design thinking. Finally, when the design and development process has been completed, the dashboard can be implemented and integrated with current IS infrastructure in the organisation. The whole process potentially stops when users have adopted the dashboard. However, in general, the dashboard design process continues with evaluation and improvement, as this study suggests that dashboard design process should be ongoing and aligned with organisational business strategies. Additionally, the design team continues to engage and collaborate with users to continually improve and gauge the progress of dashboard adoption in the organisation. As a result, users can also evaluate whether the dashboard brought positive impacts to the organisation.

Significantly, this study has confirmed that dashboards can be considered as a catalyst or enabler for organisational business process change. This notion corroborates Dover (2004) who stated that dashboards could be a "catalyst" for something broader to take place when properly implemented (Dover 2004, p. 48). Especially when the design team came to realise that the data required for the metrics is not available, or captured by existing processes or systems. In this instance, changes needed to be made as part of the dashboard design process. These changes were not necessarily at systems level, but created a new process in order to capture the required data to be displayed on the dashboard. Essentially, changes or improvements to the business process needed to be made as part of the dashboard design process. In this study these changes should be implemented together with the dashboard. In a way, users would use the dashboard as part of the newly improved business processes.

This study provides a better understanding of issues surrounding dashboard design, strategic change in current processes and/or the structure of the organisation, which can significantly impact dashboard design. Furthermore, this study has informed IS design practitioners about the evolution of roles in a dashboard design team. The importance of a holistic approach in analysing design problems and co-existence with solution concept development has been highlighted as a notion that should be embraced, apart from possessing multidisciplinary communication skills. Also, this study has provided a better understanding of how key elements and a set of design principles can be used to inform and support the dashboard design process in organisations. Lastly, this study has developed a seminal framework for ongoing dashboard design process in which a design thinking mindset is prevalent, regardless of the design and development method employed by the organisation.

9.3 Reflections on the issue of quality of the research

In Chapter 4, the issue of quality in qualitative research was discussed. Essentially, researchers need to ensure that conclusions drawn from their research are an "accurate description of what happened" as well as "a correct explanation of what happens and why" (Harding 2013, p.5). More importantly, the researchers want assurance that "we have done the right thing" (Angen 2000, p. 380). As discussed earlier in Chapter 4, four criteria to improve and address the issue of quality were selected and discussed based on suggestions from various qualitative researchers (refer to Table 4.4). Self-examination was conducted as the study progressed based on the proposed techniques. Table 9.1 presents reflections on the criteria and proposed techniques to increase the quality of this study. These criteria in Table 9.1 can also be used as a research quality framework, which can be transferable and beneficial to other qualitative researchers who subscribe to the interpretivist paradigm.

Table 9.1 Reflections on criteria to increase the quality of the research

Criteria	Proposed techniques	Reflections
Reflexivity	A memo has been created as an audit trail to record my data analysis activities on my qualitative data analysis software (NVivo). A journal was maintained to write down thoughts and decisions made throughout the research journey.	The memo has proven to be useful during the data analysis of the second case study. The journal containing thoughts and decisions made throughout the research journey was useful during the thesis write-up.
Participant checks	A confirmation has been sought from key participants in regards to research results.	Only one key participant from each organisation was able to be contacted for participant checks. This particular criterion is proven difficult to achieve due to further follow-ups expected from the research participants.
Consider rival explanations	In Chapter 2, rival theories specifically on critics of design thinking, analytical thinking, decisions thinking, and systems thinking have been discussed.	Discussions on rival theories in Chapter 2 has provided a balance perspective in determining the notion of design thinking to be used as this study's conceptual framework.
Triangulation	Possible ways to collect data: interview, observation, follow-up emails. Information on participants' background situations and positions in terms of their jobs were collected. This is to see if there is a possible source of bias.	Publicly available marketing information, annual financial reports, organisational visions and missions were used in this study to complement the interview transcripts. Observations however were not possible as the time of the study did not coincide with the actual time when design process occurs. Significant efforts have been made to make sure triangulation is achieved to give more complete perspectives in this study.

Furthermore, the notion 'research frames' consisted of four framing types: extra textual, intra textual, inter textual, and circumtextual (see Chapter 4). As suggested by Grbich (2013), for research accountability, researchers should discuss each of the frames that are relevant to their research. By doing so, it helps inform the readers of any pre-conceptions including ideas or biases

which may potentially impact their interpretation of research findings (Grbich 2013). This exercise is considered to be essential, as it would help make sense of the interpretation process.

Two dominant frames influencing the way this study was conducted have been identified: extra textual and circumtextual. This study was undertaken on the topic of dashboard design process due to the researcher's personal interest and past experience as a dashboard designer. Inevitably, a comparison or reference to researcher's accumulated knowledge and work experience were often made when observing a phenomenon in this study. In that instance, the researcher is tapping into the extra textual frame to interpret and make sense of the phenomenon. Nonetheless, a comprehensive literature review has been conducted to identify research gaps and to ascertain the relevance of the research topic in relation to the body of knowledge. Constant self-examination and critical analyses have also been carried out throughout the study to ensure the researcher's perspective was balanced. With these quality assurance techniques in place, this study will make a significant contribution.

9.5 Limitations and future research

Following the reflections on the issue of quality discussed in the previous section, this study is still subject to certain limitations based on two case studies (i.e. UniOne and CaseOne). This may be an issue with transferability of results. However, this study has focused on the design process, its impacts on existing systems and/or processes in organisations, and the notion of design thinking as the conceptual framework rather than the dashboard as a final design artifact. Therefore, findings, insights and results can be transferable from this study to a similar context in other types of information systems. This includes the ongoing dashboard design process framework, as one of the results of this study, which is presented as a guideline which can be adopted and adapted. In any case, studying a limited number of case studies has benefits which enable the researcher to focus and delve into more in-depth insights from the data.

Apart from that, the scope of this study is confined to exploring the dashboard design process based on research participants' recollections. This could be subject to inaccuracies in recalling past activities in detail. Therefore, as explained in Chapter 4 and in the previous section, triangulation is used in this study, "enlarging the landscape of their inquiry, offering a deeper and more comprehensive picture" (Tobin & Begley 2004, p. 393). Publicly available marketing information, annual financial reports, and organisational visions and missions were used in this study to complement the interview transcripts. Significant efforts have been made to ensure triangulation gives a more complete perspective.

Nonetheless, the results of this study have also led to an opportunity for further study. In Chapter 8, six findings were discussed in terms of how each addressed the research questions. From those findings, there are interesting emerging areas which warrant further investigation.

Organisational data-driven activities

Organisational data-driven activities such as evidence based decision making and performance monitoring have been discussed in Chapter 8. In order to get users to be actively involved in data-driven activities, a work culture of using data in meetings, discussion, and decision making should be cultivated throughout the organisation. Further research is needed to investigate and examine the efficacy of dashboard use in supporting such organisational data-driven activities. Efforts and detailed processes during transition periods, whereby users were given time to use and adopt the dashboard in their daily business processes, need to be explored further.

Evolution of roles in the dashboard design team

The composition of the design team is comparable to Eckerson (2011), who suggested an executive steering committee along with a project champion, a project governance board, business analysts, the 'KPI team', and technical team to make a dashboard project successful. Further research is required to investigate and describe characteristics of evolving roles for each member of the design team along with respective key skills. As a result, this will benefit organisations in achieving design team readiness as part of their preparedness for dashboard design.

Design thinking as a fundamental philosophy

Design thinking can be adopted or applied as a fundamental philosophy regardless of the design and development method employed by the organisation. This finding corroborates the perspective of design thinking as "an integrated development philosophy" which impacts strongly on organisational processes and structure (Lindberg, Meinel & Wagner 2011, p. 15). On the other hand, as discussed in Chapter 3, design thinking can be applied as a separate phase at the beginning of the design and development process (Lindberg, Meinel & Wagner 2011). Further research can be carried out to explore this option in applying design thinking to supplement traditional software development approaches.

The ideal dashboard design

The study has shown that it can be quite difficult to realise ideal dashboard design for various reasons. As organisations tend to follow best practice or a textbook approach, consensus in relation to key metrics to be selected for a single page dashboard can take more time than

expected. With no widely accepted guidelines on selecting key metrics, it adds to the complexity of dashboard design. Further research is therefore needed to investigate whether ideal dashboard design is achievable if the scope and/or context of the dashboard is restricted to a group, a division, or department in organisations.

9.6 Concluding remarks

This study aimed to explore dashboard design process based on recollection of events by practitioners in the industry and to analyse the results using a qualitative research method. Design thinking framed the overarching conceptual framework. The study has shown that plausibility of design thinking should be adopted or applied as a fundamental philosophy of the design process regardless of the design and development method employed by the organisation, as suggested by the literature. Essentially, design thinking is instantiated as an overall culture adopted by organisations to enable user-centred innovation in the design and development process rather than to replace or be regarded as another design/development method in IS.

Moreover, this thesis has discussed and exhibited the novel approach and the rigour of this study. Significant findings have been presented and research questions and objectives addressed. Criteria to increase the quality of this study have been consolidated, reviewed, and reflected. The results of this study have provided insights for future research and informed practitioners in understanding the complexity of dashboard design process.

Further updates were obtained from UniOne and CareOne as this study concluded. CareOne's dashboard and ERP project has been progressing well. Technological overhaul has been performed in UniOne with the implementation of Amazon web services and a new analytics system supplements the dashboard. The advancement of the dashboard project has stemmed and permeated from what had been discussed in the early stage of this study. Essentially, users wanted to monitor their key performance indicators (KPIs) through the dashboard but further analyses showed that UniOne had not been collecting the required data for the dashboard. Overall, this has emphasised that organisational impacts have been made by its dashboard design process. While the thesis ends here, a quest to design an effective and useful dashboard continues.

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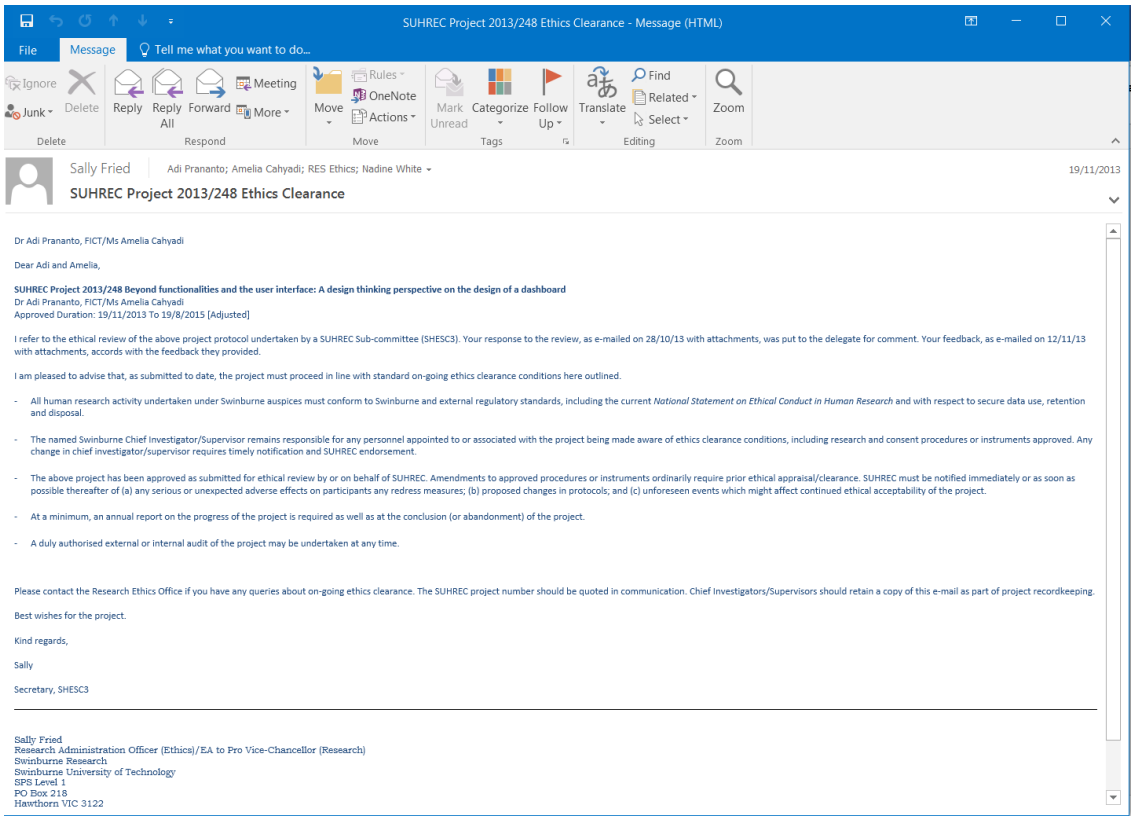
Appendices

Appendix A – Ethics Documents

A.1 Ethics Approvals



SUHREC Project 2013/248 Ethics Clearance - Message (HTML)

File | Message | Tell me what you want to do...

Ignore | Junk | Delete | Reply | Reply All | Forward | Meeting | More | Move | Rules | OneNote | Actions | Mark Unread | Categorize | Follow Up | Translate | Find | Related | Select | Zoom

Delete | Respond | Move | Tags | Editing | Zoom

Sally Fried | Adi Prananto; Amelia Cahyadi; RES Ethics; Nadine White | 19/11/2013

SUHREC Project 2013/248 Ethics Clearance

Dr Adi Prananto, FICT/Ms Amelia Cahyadi

Dear Adi and Amelia,

SUHREC Project 2013/248 Beyond functionalities and the user interface: A design thinking perspective on the design of a dashboard
Dr Adi Prananto, FICT/Ms Amelia Cahyadi
Approved Duration: 19/11/2013 To 19/8/2015 [Adjusted]

I refer to the ethical review of the above project protocol undertaken by a SUHREC Sub-committee (SHESC3). Your response to the review, as e-mailed on 28/10/13 with attachments, was put to the delegate for comment. Your feedback, as e-mailed on 12/11/13 with attachments, accords with the feedback they provided.

I am pleased to advise that, as submitted to date, the project must proceed in line with standard on-going ethics clearance conditions here outlined.

- All human research activity undertaken under Swinburne auspices must conform to Swinburne and external regulatory standards, including the current *National Statement on Ethical Conduct in Human Research* and with respect to secure data use, retention and disposal.
- The named Swinburne Chief Investigator/Supervisor remains responsible for any personnel appointed to or associated with the project being made aware of ethics clearance conditions, including research and consent procedures or instruments approved. Any change in chief investigator/supervisor requires timely notification and SUHREC endorsement.
- The above project has been approved as submitted for ethical review by or on behalf of SUHREC. Amendments to approved procedures or instruments ordinarily require prior ethical appraisal/clearance. SUHREC must be notified immediately or as soon as possible thereafter of (a) any serious or unexpected adverse effects on participants any redress measures; (b) proposed changes in protocols; and (c) unforeseen events which might affect continued ethical acceptability of the project.
- At a minimum, an annual report on the progress of the project is required as well as at the conclusion (or abandonment) of the project.
- A duly authorised external or internal audit of the project may be undertaken at any time.

Please contact the Research Ethics Office if you have any queries about on-going ethics clearance. The SUHREC project number should be quoted in communication. Chief Investigators/Supervisors should retain a copy of this e-mail as part of project recordkeeping.

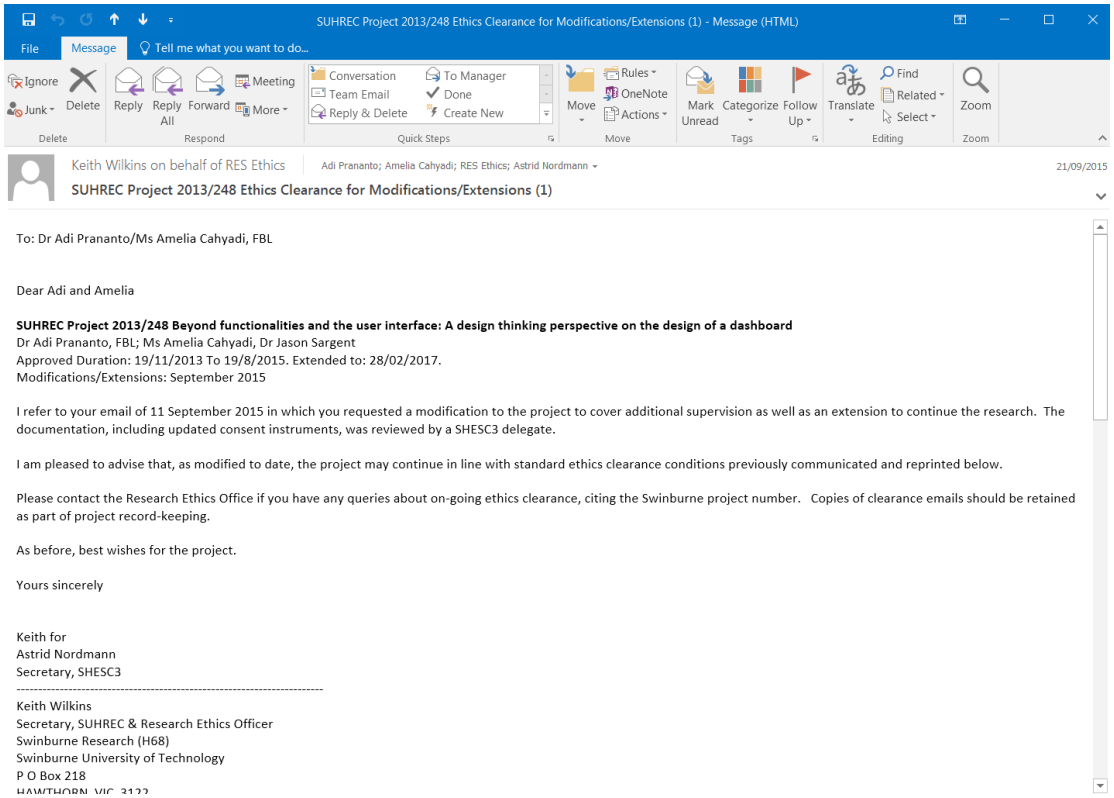
Best wishes for the project.

Kind regards,

Sally

Secretary, SHESC3

Sally Fried
Research Administration Officer (Ethics)/EA to Pro Vice-Chancellor (Research)
Swinburne Research
Swinburne University of Technology
SPS Level 1
PO Box 218
Hawthorn VIC 3122



To: Dr Adi Prananto/Ms Amelia Cahyadi, FBL

Dear Adi and Amelia

SUHREC Project 2013/248 Beyond functionalities and the user interface: A design thinking perspective on the design of a dashboard
Dr Adi Prananto, FBL; Ms Amelia Cahyadi, Dr Jason Sargent
Approved Duration: 19/11/2013 To 19/8/2015. Extended to: 28/02/2017.
Modifications/Extensions: September 2015

I refer to your email of 11 September 2015 in which you requested a modification to the project to cover additional supervision as well as an extension to continue the research. The documentation, including updated consent instruments, was reviewed by a SHESC3 delegate.

I am pleased to advise that, as modified to date, the project may continue in line with standard ethics clearance conditions previously communicated and reprinted below.

Please contact the Research Ethics Office if you have any queries about on-going ethics clearance, citing the Swinburne project number. Copies of clearance emails should be retained as part of project record-keeping.

As before, best wishes for the project.

Yours sincerely

Keith for
Astrid Nordmann
Secretary, SHESC3

Keith Wilkins
Secretary, SUHREC & Research Ethics Officer
Swinburne Research (H68)
Swinburne University of Technology
P O Box 218
HAWTHORN VIC 3122

A.2 Organisation Consent Form

Appendix A.1

SWINBURNE UNIVERSITY OF TECHNOLOGY

ORGANISATION CONSENT FORM

Project Title: An exploration on the process, impacts and the thinking of a dashboard design

Principal Investigator(s): Dr Adi Prananto, Amelia Cahyadi

1. On behalf of my organisation _____.
   I authorise our employees to participate in this research project.

2. *In relation to this project, please circle your response to the following:*
   - I agree that he/she can be interviewed by the researcher **Yes No**
   - I agree to allow the interview to be recorded by electronic device **Yes No**
   - I agree that he/she can make him/herself available for further information if required **Yes No**

3. I acknowledge that:
   (a) participation in this project is voluntary and that my employees are free to withdraw from the project at any time without explanation;
   (b) the Swinburne project is for the purpose of research and not for profit;
   (c) any identifiable information about my employees which is gathered in the course of and as the result of the participation in this project will be (i) collected and retained for the purpose of this project and (ii) accessed and analysed by the researcher(s) for the purpose of conducting this project;
   (d) my employees' anonymity is preserved and he/she will not be identified in publications or otherwise without their written consent.

Name of Person of Authority: .....
Position: .....
Signature & Date: .....

This project has been approved by or on behalf of Swinburne's Human Research Ethics Committee (SUHREC) in line with the *National Statement on Ethical Conduct in Human Research*. If you have any concerns or complaints about the conduct of this project (SUHREC No. 2013/248), you can contact:

Research Ethics Officer, Swinburne Research (H68), Swinburne University of Technology, P O Box 218, HAWTHORN VIC 3122.
Tel (03) 9214 5218 or +61 3 9214 5218 or
resethics@swin.edu.au

A.3 Participant Consent Form

Appendix B.1

SWINBURNE UNIVERSITY OF TECHNOLOGY

PARTICIPANT CONSENT FORM

Project Title: An exploration on the process, impacts and the thinking of a dashboard design

Principal Investigator(s): Dr Adi Prananto, Dr Jason Sargent, Amelia Cahyadi

1. I consent to participate in the project named above. I have been provided a copy of the project consent information statement to which this consent form relates and any questions I have asked have been answered to my satisfaction.

2. *In relation to this project, please circle your response to the following:*
   - I agree to be interviewed by the researcher **Yes** **No**
   - I agree to allow the interview to be recorded by electronic device **Yes** **No**
   - I agree to make myself available for further information if required **Yes** **No**

3. I acknowledge that:
   (a) my participation is voluntary and that I am free to withdraw from the project at any time without explanation;
   (b) the Swinburne project is for the purpose of research and not for profit;
   (c) any identifiable information about me which is gathered in the course of and as the result of my participating in this project will be (i) collected and retained for the purpose of this project and (ii) accessed and analysed by the researcher(s) for the purpose of conducting this project;
   (d) my anonymity is preserved and I will not be identified in publications or otherwise without my written consent.

By signing this document I agree to participate in this project.

Name of Participant: .....

Signature & Date: .....

This project has been approved by or on behalf of Swinburne's Human Research Ethics Committee (SUHREC) in line with the *National Statement on Ethical Conduct in Human Research*. If you have any concerns or complaints about the conduct of this project (SUHREC No. 2013/248), you can contact:

Research Ethics Officer, Swinburne Research (H68), Swinburne University of Technology, P O Box 218, HAWTHORN VIC 3122.
Tel (03) 9214 5218 or +61 3 9214 5218 or
resethics@swin.edu.au

Appendix B – Interview Protocols

B.1 Interview Protocols for Design Teams

B.1.2 Interview Protocol for the Design Team in UniOne

Dashboard	**Design Process**

• Background: role in company/design team.
• Related business processes (end to end).
• Dashboard goals, visions, purposes, users.
• Project initiators, what/who triggers the needs.
• The relationships with existing systems/current business processes/activities.
	1. Discussions/Discourses/Brainstorming activities
	2. Wicked/straightforward problems
	3. How did you approach/frame the problem? Diff probs diff approach??
	4. How did you feel about constraints? Accepting/embracing/refusing/…?
	5. Thinking process (***recall the thought process during that time***): *can u take me back to …*
	6. Holistic approach/integrative thinking (balance/harmony):
	  • Balance analytical and intuitive thinking (deliberate/by design, by intuition, by accident/opportunistic, structured?)
	  • Balance **desireability, viability and feasibility** (user reqs, tech constraints, budgets, ROI, economically sound etc.)
	7. Think like designers:
	  • user-centered? → *to what extent the users get involved?* **Empathy** and **collaboration** with users?
	  • Spend more time on analysing problems or building solutions?
	  • "Building to think, learning by making" – models, prototypes. Use models as tools for thinking? **Early prototyping**?
	8. Abductive logic - new ideas can only be validated through unfolding a future event
	  • Past experience – "then and now", changes in tech, price, environment.
	  • Apply explicit logic to intuition → *hesitation, thinking twice? Just go with it?*
	9. Utilize "first principles", heuristics, rules of thumbs? *What's your fave?*
	10. Inspired by constraints. Exploit contrasting ideas and constraints to generate solutions
	11. Avoid fixating to a certain idea too soon: keep new ideas flowing? Allow creativity? Generate few alternatives?
	12. Strive for designing an innovative product/result/solution → *consider your dashboard innovative?*
	  • Elaborate on "innovation": Create something new and remarkable? Change things for the better?
	13. Choosing the best solution from some available alternatives/solutions/templates; or (2) Generating a fresh new solution?
	14. The key aspects influencing the design process? → Users? Features? Technologies? Data? Metrics/KPI? Organisations?

	• in what ways were those aspects (mention some…) considered important to you? 15. Were there any other considerations in designing a dashboard? ***16. In retrospect, is there anything that you would do differently?***

Impacts	**Use**	**Perceived value (Users only)**
a. Changes triggered by dashboard design process (data unavailability, etc.) i. Elaborate (how, who approved, etc.) ii. Other changes? IT/IS upgrades? Processes? b. Positive changes (improvement) from the use if the data from the dashboard. c. Any other changes (direct/indirect)?	a. How did the users feel about the dashboard? b. Did the idea come from users? c. Is it mandatory for users to use it? d. Were there any other important aspects in relation to the dashboard use that you like to discuss?	a. Describe the relation between the dashboard and the working culture/policy in the organisation (i.e. is the use of the dashboard considered as something common in the organisation? b. Any tangible/intangible and/or positive/negative values from using the dashboard? c. Would you describe that the values (positive/negative) would have any relation to the way the dashboard was designed? Elaborate.. i. Would you describe the dashboard design as a success/fail one? Could you tell me why you think so? d. Is there anything you would change in terms of the design process (or the design team) (perhaps by changing that, you would gain a better value out of the dashboard)? Could you tell me why you think so? e. Would you think that the design team could enhance the dashboard by changing the way it was designed? Could you tell me why you think so? f. Were there any other important aspects in relation to the value of the dashboard that you like to discuss?

B.1.2 Interview Protocol for the Design Team at CareOne

Dashboard	**Design Process**
• Background: department's work scope, role of the interviewee in the company/design team. • Related business processes (end to end). • Dashboard goals, visions, purposes, users. • Project initiators, what/who triggers the needs.	*Problem space* 1. Discussions/Discourses/Brainstorming activities 2. Wicked/straightforward problems 3. How did you approach/frame the problem? Diff probs diff approach?? 4. How did you feel about constraints? Accepting/embracing/refusing/…? *Solution space* 1. Inspired by constraints. Exploit contrasting ideas and constraints to generate solutions

• The relationships with existing systems/current business processes/activities. • Type of the dashboards. • Number of users: one dashboard for all, customised dashboard for different user who requested for it.	2. Avoid fixating to a certain idea too soon: keep new ideas flowing? Allow creativity? Generate few alternatives? 3. Choosing the best solution from some available alternatives/solutions/templates; or (2) Generating a fresh new solution? *Iteration between problem and solution space* 1. Thinking process (***recall the thought process during that time***): *can u take me back to …* 2. Holistic approach/integrative thinking (balance/harmony): • Balance analytical and intuitive thinking (deliberate/by design, by intuition, by accident/opportunistic, structured?) • Balance **desireability, viability and feasibility** (user reqs, tech constraints, budgets, ROI, economically sound etc.) 3. Think like designers: • user-centered? → *to what extent the users get involved?* **Empathy** and **collaboration** with users? • Spend more time on analysing problems or building solutions? • "Building to think, learning by making" – models, prototypes. Use models as tools for thinking? **Early prototyping**? 4. Abductive logic - new ideas can only be validated through unfolding a future event • Past experience – "then and now", changes in tech, price, environment. • Apply explicit logic to intuition → *hesitation, thinking twice? Just go with it?* *Miscellaneous* 1. Utilize "first principles", heuristics, rules of thumbs? *What's your fave?* 2. Strive for designing an **innovative** product/result/solution → *consider your dashboard innovative?* • Do you think this project is considered an **innovation** on your organisation? • To be on the same page, define on "**innovation**": Create something new and remarkable? Change things for the better? 3. The key aspects influencing the design process? → Users? Features? Technologies? Data? Metrics/KPI? Organisations? • In what ways were those aspects (mention some…) considered important to you? • Technologies: **How involved was the developers?** • Data: **Has it increased your trust level to the data?**

	4. Were there any other considerations in designing a dashboard?

B.2 Interview Protocols for Users

B.2.2 Interview Protocol for the Users in UniOne

Culture 1. Could u **tell me** about this Tableau dashboard that you're using? 2. Are you **excited** with Tableau dashboards, etc.? 3. How did you **normally use** the dashboard (when you needed **a quick answer**? Or more on the **long term** like when you wanted to **analyse** on something?)? 4. How **often**? How **dependants** are you to the dashboards? 5. How is it **different**, **ring** them and ask for reports, go to Uni's websites or wiki and **download** reports, compared to **logging** in to Tableau server and viewing the dashboards from there? Which one do you **prefer** and why? 6. Do you think this process/practice [logging in to Tableau server and viewing the dashboards from there] could be **improved**? Why? How [a **better way** to do it]? 7. If you're **not** using the dashboards, where did **source** the information that you needed?	**Use of dashboards** 1. Do you think the dashboards are **valuable**? How valuable? 2. What **feelings** have you **experienced** from this exercise [using Tableau dashboards] so far? 3. How **certain** were you about the **outcomes** or results of using dashboards towards your **main job** (making **decisions** based on those information)? Do you feel uncertain about the outcome? 4. Do you think the information displayed on the dashboards could **help** you making **decisions**? **NICE TO HAVES** 5. ***IF UNCERTAIN***: After using, did you still have the same feelings about that uncertainty? About the **believability** of the information? 6. **What did you do** about the feeling of unknowing the outcomes/expected outcomes? **Communicate** with design team?
Design of dashboards 1. How **involved** were you in **designing** the dashboards that you used? 2. Did you **focus** more on **analysing** your *requirements* (feasibility, viability, time and resources constraints) or **thinking** about how the *end result* would look like?	**Changes related to dashboards** *1.* Do you think the information on dashboards could potentially **influence changes** in Uni? *As a simple and perhaps quite extreme e.g. I saw the figure of International Students failing in a first year was high, so I decided to commission a*

3. Do you think that the **design team** [including **yourself** as a member of the team] are ***balancing*** *the desirability, feasibility, and viability*? 4. Do you have any **rules of thumbs** when it comes to **envisioning** how the dashboard should be designed? Elaborate? 5. What are the **key aspects** that you think when designing dashboards? Users? Organisations? Features? Data/Information? Infrastructure? Why? 6. Do you think the design team have **accommodated** all **different types** of **users** in Uniburne? 7. Do you think the design team have designed a dashboard that **suits** your **needs**/all the **requests/constraints**?	*language and academic support to help them…* Another example: *your dashboard shows excessive number of government supported scholarships application, then based on that you decided to add/design a new scholarship program that was only available on the full-fee cohorts, etc.* 2. Or maybe **on the other way round**… I need to display a figure of International Students failing in a first year on my dashboard. But, our student management system **didn't capture** that figure. So, I have to **request** the SMS team to do so in order to get my dashboard displaying such figure.

B.2.2 Interview Protocol for the Users at CareOne

About the user	**Culture**
1. How **long** have you been working here? 2. What do you **do** here? 3. In relation to the need of information, **which part** of your jobs is the most **critical** one? You have to have information to do your job.	7. How familiar are you with the project? 8. Are you **excited** with the whole proj including dashboards, etc.? 9. How would you **envision** yourself as a dashboard user? Positive/negative/neutral **outlook/feelings**? 10. **Without** dashboards, where did **source** the information that you needed? 11. What is the overall **culture** in here in terms of using information to support **decision** making and business **processes**?
Expectations in Design	**Decision Making & Changes**
1. Which one do you prefer, **ring** people and ask for information/reports, OR use dashboards (**self-service**)?	1. Do you think the dashboards would be **valuable**? In what ways?

2. **Self-service** dashboards, do you think it would **work**? Why or why not? 3. What is your **expectations** on the dashboard design? 4. What kind of design process do you prefer? **Prototype** and **trying** out? **No involvement**? **Active** involvement? 5. Did you **collaborate** with the design team at all? Were you being asked of '**wish list'** or **requirements**? Do you **want** to be **involved** at all? 6. Were they **showing empathy/understanding** when you had concerns or **constraints** with the design of the dashboard? 7. What is the **most important aspect** that a dashboard must have? 8. Do you think the design team is being **reasonable** with the dashboard design goals? 9. Do you think this is all **worth** the **effort**, **time** and **resources**? 10. Why/why not? If **not**, where/in **which areas** should they **focus** on? 11. Do you think this & Dashboard project is **aligned** with the organisational **strategic** goals?	2. ***How confident are you with the data and information on the dashboard?*** 3. Do you think the information displayed on the dashboards would **help** you making **decisions**? *4.* Do you think the information on dashboards could potentially **influence changes** in the organisation? *As a simple and perhaps quite extreme e.g. I saw the figure of bed vacancy raising in winter, so I decided to commission a campaign to promote it/do something about it…*

B.3 The Mapping of Research Questions and Interview Protocols in General

Research Objectives	Research Questions	Interview Protocol	Potential Contributions
RO1: To explore and understand the dashboard design process and how it impacts organisational performance, processes, and IS/IT environment.	RQ1: How does the dashboard design process affect the organisation in terms of its existing processes?	About the organisation 1. Have successfully designed a dashboard/In the midst of designing a dashboard/on the early stage of designing a dashboard? 2. Designing for internal business users/Designing for other organisation's use? About the interviewee 3. Role in terms of a dashboard design team. 4. How long in the role? About the business process 1. Describe the related business process from end to end (from the very top mandate to the deliverables). 2. Describe what changes (if any) needed in any business processes required to achieve the required dashboard. 3. How about indirect changes (any changes made based on the information/knowledge obtained from the dashboard)? About the dashboard 1. Dashboard's goals and visions. 2. What/who triggers the need for a dashboard?	C1: To provide a better understanding of dashboard design process, particularly in understanding the perceived impacts of the design process to the organisational current processes.

		3. Is there any relation between the dashboard and the working culture/policy in the organisation (i.e. is the use of the dashboard considered as something common in the organisation? 4. Did the design process trigger to process changes, IT/IS upgrades, and new technologies/systems implementations due to unavailability of data? How did it go? Who involved in making decisions/approvals to go ahead with the changes? About the initiatives leading to the design of a dashboard 1. Who are the main users of the dashboard? 2. Who is the initiator? Who commissions the dashboard? Is this person involved in designing (or stayed on the project – in what role)? Is this person going to use the dashboard? 3. How did the initiative come about? About the design team 1. Who are the members? How and why are they chosen? 2. How does the collaboration work? Who responsible of what? About the activities after design is done 1. Is the dashboard being used? 2. Is the use of the dashboard being enforced or mandated? By who?	

		3. What is the level of engagement by the users towards the dashboard use? 4. To what extent does the use of the dashboard result any changes in the organisation (e.g. process streamline, process innovation/initiation, etc.)?	
RO2: To explore if there are elements in the design process of the dashboard indicative of the concept of design thinking.	RQ2: In what ways does the design process corroborate with a holistic approach to achieve innovation and/or balancing the analytical and intuitive thinking as the fundamental	About the design process, principles, and thinking 1. Describe the design process? i. Discussions/discourses ii. Brainstorming activities iii. Process of making decisions iv. Analysis	C2: To develop a seminal framework on design thinking that could be used to inform a design process in organisations.

	characteristics of the concept of design thinking?	v. Intuition vi. Thinking process vii. Holistic approach (taking a broader point of view) viii. Concentrate on defining problem or working on solutions? ix. Consideration in designing an innovative dashboard? x. Any use of templates? xi. Relationships with existing systems? With current business processes/activities? xii. The use of well-known design principles, or any specific design principles or first principles? xiii. Always strive for innovation, something new and remarkable, doing it the unconventional way xiv. Respecting/Embracing constraints but not being limited by them xv. Avoid fixating to a certain idea too soon, keeping ideas flowing xvi. Expecting changes (for the better), moving towards changing things for the better 2. Main goal on the design process: (1) Choosing the best solution from some available alternatives/solutions; or (2) Generating a fresh new solution.	
RO3: To explore key principles in elements associated with perceived successful design and implementation of a dashboard.	RQ3: What are the key design principles and elements in designing a dashboard? RQ3.1: Are there any specific design principles recognized during the process of designing a dashboard? In what ways could these principles be useful to the design of the dashboard? RQ3.2: What are the design elements and other considerations in designing a dashboard? Why are they considered important?		C3: To develop a set of design principles and to produce a better understanding of the key design elements that supports the design process of a dashboard.

		About design principles 1. Is there any? Such as? 2. Who decides on choosing the principles? 3. How did the principles translate into the design of the dashboard?	
		About the design elements 1. What are the key aspects influencing the design process of the dashboard? Why are they considered to be important? 2. Are there any other considerations in designing a dashboard? Why are they considered to be important? About the perceived success from the dashboard users 1. Are there any tangible/intangible and/or positive/negative values from using the dashboard? 2. Do you think the values (pos/neg) have any relation to the way the dashboard was designed? Do you think the dashboard design was a success/failure? 3. Is there anything you would change in terms of the design process (or the design team) (perhaps by changing that, you would gain a better value out of the dashboard)? 4. Do you think that the design team could enhance the dashboard by changing the way it was designed?	

Appendix C – Initial Codes

C.1 Initial Codes for Research Question 1

Codes	Sub-codes/Descriptions	Reference
Decision Making Activities	A different level of granularities, improving the quality of decision makings, having an access to information, a single source of information, 'what-if' analysis.	Keen (1981), Hennen (2009), Gurbaxani and Whang (1991), Nagy et al. (2009)
Organisational Processes	Process changes, process integration, collaboration, positive impacts, adding values to businesses, eliminate inefficient processes.	Gurbaxani and Whang (1991), Nagy et al. (2009)
Organisational Performance	Performance monitoring, self-monitoring, being aware of organisation's performance, knowledge discovery, root-cause finding, performance improvement, increase accountability.	Nagy et al. (2009), Gurbaxani and Whang (1991)

C.2 Initial Codes for Research Question 2

Codes	Sub-codes/Descriptions	Reference
Idea generation	Building the solutions by thinking and making, early prototyping, creating many choices.	Brown(2009), Boland and Collopy (2004), Boland et al. (2007)
Innovation inspired by constraints	Creating something new and 'remarkable', start anew on each design task, exploit contrasting ideas and constraints, keep new ideas flowing, balance between the desirability, viability, and the feasibility	Brown(2009), Boland and Collopy (2004), Boland et al. (2007)
Human-centred design	Empathy and collaboration, understanding the cultural context and environment, users participation,	Brown(2009)
Balance between analytical and intuitive thinking	Analytical thinking involved past-and-proven or tried-and-tested data, intuitive thinking involved creativity and innovation, designer's principles as an initial point of solution explorations, intuition derived from their experience, prior learning and familiar situations.	Martin (2009), Cross (2011)
Abductive logic as the core of design thinking	"New ideas can only be validated through the unfolding of future events"	Martin (2009)
Design thinking strategy	Holistic approach to design problems, frame/reframe the problem in a unique and subjective way, utilise "first principles".	Cross (2011), (Lindberg et al. 2010)

C.3 Initial Codes for Research Question 3

Codes	Sub-codes/Descriptions	Reference
Importance of quality data and infrastructure technologies	Data warehouse, database systems, data quality, platform, system architecture, software, information systems	Nagy et al. (2008), Olsha-Yehiav et al. (2006), Wadsworth et al. (2009), Hranac and Petty (2007), Devillers et al. (2007), Pauwels et al. (2009).
Roles of users and organisations in a dashboard design process.	User characteristics (profile, background, experience, preference), User roles in organisations, organisational culture, requirements, policy, goals, decision-making style, business rules definition	Malik (2005), Yigitbasioglu and Velcu (2012), Hennen (2009), Pauwels et al. (2009), Clark, Abela and Ambler (2006), Eckerson (2006), Hranac and Petty (2007), Rasmussen, Bansal and Chen (2009), Devillers et al. (2007).
Intuitive and flexible features.	Functionality, flexible drill-down and/or slice-dice features, intuitive user interface, various metrics selections	Malik (2005), Hennen (2009), Sloane et al. (2006), Wadsworth et al. (2009), Few (2006), Hranac and Petty (2007), Pauwels et al. (2009)

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Appendix D – Summary of Interview Transcripts

D.1 UniOne

About participants					
	Uni-Mgr	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Roles in the organisation	various roles as an analyst, a designer as well as a team leader	a director (Roger's boss)	One of Roger's team members, as a reports/dashboards designer and an analyst	One of Roger's team members, as a reports/dashboards designer and an analyst	Same level as Roger. Works with Roger and his team.
About impacts/changes related to dashboards (RQ1)					
	Uni-Mgr	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Long term impacts	Having a *transparency* of information through dashboards, BI, or analytics.				to reach transparency of information and dashboards help to reach that goal.
Issues detection	People can see information and be *proactive* when they encountered *issues with their processes*. Metrics help them detect issues that might result in an undesired repercussion.	Dashboards help investigate a root cause of an issue	Dashboards help identify/spot issues.		
Changes to dashboards		Changes in the uni prompted them to do adjustments to data structures, etc. to fit into the new structures.	Changes in the uni triggered her to perform impact analysis on dashboards and adjust them accordingly to reflect the changes.		
Direct relationships		Help determining the viability of courses in the Uni.	Poor quality data could lead to unnecessary actions and result into misleading information.	She felt that it was hard to establish a relationship between the changes and the dashboards. • Data or information could be manipulated or transformed into a different type of reports.	*Direct* relationship: influences *strategic directions*.

Indirect relationships					Enabled a *reality check* and possible make a follow up action/an improvement, *bust myths* with evidences.
Decision makings	Information provided them a real *evidence* to base their decision makings on. It is important to have the right information so that we can make sense of the information and could base our decisions on it.	Dashboards support *big decision* makings & make improvement plans.		Unknown to her if users had made decisions in relation to the changes purely based on the dashboard.	Positive impacts: supports users making informed decisions.
Due to data unavailability			If data unavailable, inform data/process owners to collect the data in a good quality.		□f data unavailable -> contact data/process owners to negotiate/work on solutions -> if changes needed to be done, the effort depends on the priority/importance of the requests (and the requesters).
Due to user requirements			Changes on her side as she needed to change and manipulate data to suit the needs.		
Concerns/Challenges			Hard to point out changes on the other way round (changes in uni bcos of dashboards)		
About Design Thinking (RQ2)					
	Uni-Mgr	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Wicked problems	*Struggling* with unclear (wicked) requirements and in some cases with time and resource constraints.	A difficult exercise: dealing with different users (with different preferences).		A wicked problem due to office politics involved that could potentially hinder the effort to collaborate with users, as well as data ownerships and accountability.	An *extremely complex* task (wicked).

Different approaches to different problems			Always start from scratch (start anew), use different approach for different users/requests.	She has a diverse type of users therefore she would approach every task in a different way.	Need to *approach it with fresh eyes as that was a new problem every time*. But for regular requests, reuse the *already available* solutions rather than build it entirely new every time.
Balancing analytical & intuitive thinking		Spent more time on designing: *discussions* with stakeholders and *figuring out solutions to their problems*.	Analyse requirements and designing the dashboard at the same time.	Analyse users requirements, at the same time envisioning of how the design or the end result would be.	Acknowledged the role of her intuition in the design process though preferred to combine her intuition with a careful thinking and reasoning/analysis.
Past experience with new technologies	Tapping from past experience in Excel, combine it with new technologies & environment.		Tapping from past experience in Excel, combine it with new technologies & environment.		
Collaboration	Collaborate with users to adjust the metrics, reports, or dashboards until they reach a desired outcome.	Collaborate with users (to get feedback and to have a same understanding).	Collaborate with users to understand expectations and requirements.	It is important for her to *communicate* with users and to understand how they work in their *daily life* (empathy and collaboration).	Involves a lot of collaboration and *negotiation* between different stakeholders.
Empathy	Show empathy to users and *have an appreciation of what they need.*	Empathy: be *responsive* to user needs, *we're here to give users what they need*.		It is important for her to *communicate* with users and to understand how they work in their *daily life* (empathy and collaboration).	Through collaboration with users, she understands purposes&why their needs are important (*empathetic*).
Early prototyping	Work on an early prototype of the requested metrics, reports, or dashboards.	Used early prototypes (brought in by users/built by them) to start of the design		Creating an early prototype help as she could think by making or building the dashboard.	Create early prototypes
Build to think		requires *a continual refinement/changes/adjustments/improvements* (build to think).		*Brainstorm* and assess the feasibility of the requirements and the usefulness of the dashboard.	Build and see(build to think): Discussions -> Early prototype -> Users feedback -> "tweak"/refinement.

Desirability, Feasibility, and Viability	Agreed that there is a need to strike a balance between what users want, feasibility, and viability.		Trying to balance desirability, feasibility and viability.	Agreed they'd try to set priorities right and achieve a balance between desirability, feasibility and viability.	Agreed to this idea but apart from the desirability, there is a need to assess the need vs wants and the usefulness of dashboards.
Constraints	Embracing constraints			Trying to find a workaround such that the constraints would not hinder her effort.	Constraints *forced innovation, distilled* the design problem and *got people to* contemplate on their needs.
Concerns/Challenges	The desirability aspect is still lacking in the university likely due to recent changes and staff movements in the university.			Though other organisations might have already started doing the same thing if not more (See innovation).	
Design Principles		DP: balance in presentation (to avoid information overload), have a *glossary* (metrics *definition* and *scope*), use a consistent colour palate (define the meanings of colours), consistent UI formats, user friendly.	DP: supports users interactions (flexibility), simple (to avoid information overload, hyperlinks for more info), intuitive UI (colour codes).	DP: focus on users, every element must *serve a purpose*, simple navigations, support multiple devices.	DP: 1) check if similar solutions available; 2) has to *suit more needs for more users*; 3) *clear and simple.*
Innovation		He believed they have made an innovation and have tried to strike a *balance* between what users need *at all levels*, *whether it is technically feasible*, as well as the viability in terms of the Uni as a whole. Innovation: something *new but not just a really tiny modification, a new way of presenting things, found to be very useful, something fairly substantial.*		Concurred that they were trying to achieve an innovation by changing the way people think about the data, seeing the benefits of sourcing the data from different sources, and giving users a self-service access.	Innovative in the uni's context, others might have done better.

About dashboards (RQ3)					
	Uni-Mgr	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2

Dashboards' functions	should *mimic* the **university's grand plans**, visions, and aligned with the core business processes in the university	Should be aligned with **major strategic plans** in the Uni.			A good dashboard should be designed *strategically* in line with the **university's grand plans**, and holistically to set a higher priority to dashboards used by most users (hence saving budget and resources).
Visions/Goals	to *empower* users to do their own *analytical work* (**self-service**) and to enable them to make decisions based on the information obtained from the dashboards.	Wanted users to be able to perform their own queries to dashboards (**self-service**).	a **self-service** dashboard (DIY in terms of designing a dashboard, drag and drop) to save resources in the long term, to be *one source of truth*.	providing **self-service** dashboards for users across the university.	Eventually looking into giving a **self-service** access so users could *interrogate* the data themselves.
Importance	as we're living in the information age, dashboard could help us not to *fall behind* and to support ***evidence based*** **decision makings**. Dashboards enabled them to utilise **data collected over the years** and encouraged them to use more performance metrics related to business operations and strategic goals.	to utilise *the* ***mountains of data*** that have been stored and to provide information to users.		The university has been **accumulating data year after year** yet they have not *made the most of it*.	*Central* to what she does.
Advantages	as a ***competitive advantage***		Been using Tableau for 2-3 years: a better tool than Excel, easy to use and better visualisation, offers flexibility in many ways including server/desktop deployment/implementation, can take in different types of data source.	Been using Tableau application for about two to three years. Information awareness would become a **competitive advantage**.	Could help people **unleash useful information** to help them grow.

Key aspects	users and organisational culture, metrics, *reliable and clean data*, technology of the database and infrastructures, drill down features, as well as analytic models.	drill-down feature (to show different granularities to different levels of users), KPI/metrics (with built-in flexibility in adjusting the *flag* or *threshold* or *target*), infrastructure/data warehouse, organisational culture, users.	users (determined granularities of information to present), features (drill-down/aggregate), database (automated data pooling, data quality, accessibility, definition, integration, standardisation), quick turnaround time, analytics (trends), metrics, infrastructures/data warehouse.	a *centralised* database, a reliable infrastructure, a data warehouse, turnaround time, advanced analytics feature, *user-friendly*, filters and a drill-down feature, organisational *culture*, users attitude.	*purpose,* strategic measures or metrics. The most important one: *usefulness*.
Concerns				By shortening the turnaround time, it encourages users to make a **fast start** and use the dashboard, making the design process more agile as well as changing users' conception about the dashboard.	The initiative has not been *particularly strategic* (pushed, more *ad hoc, happened to have the data available*).
About design process and dashboards use (RQ3)					
Dashboards use					
	Uni-Mgr	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Initiatives	More likely, Roger and his team were the ones pushing information than getting requests from users.	Initiated by users or his team. In some areas, the use was mandated and followed through		Her team is currently being the initiator in approaching users to gather users requirements and see how they might design a dashboard fits for the users.	Although started by being "pushed", users responded positively with their requests.
Users' responses	Collecting feedback from users on the value of information and necessary *adjustment*.	Users were excited at first but don't have time to explore and play around.	Users were impressed and appreciative on the extent of data available for them.	Users have been very *appreciative* and embracing the dashboards design process. Users were *impressed* as the dashboard could offer them *a lot more insights* through *visualisations* and multiple *layers* of information.	Useful but not *earth-shattering*: *lukewarm* responses. Data visualisation excites users (useful/not??).

Users involvement	Some active users have been requesting for information and triggering the idea.		Transition from Excel to Tableau: need to change users' perceptions.	Need to convince them on the benefits of using Tableau to produce reports and dashboards by showing them with some examples.	Senior management people seemed to be more appreciative and perceived it as being useful.
Users preference		The older group of users prefer to *ring up and ask* rather than go to dashboards to find answers.		Some users preferred to ring up and ask for reports to be sent through emails. Some were used to get the reports from organisation's websites and wikis.	
Concerns/Challenges	Creating *awareness* to users on information collection and dashboards capabilities.	The Uni has not been actively embracing the use information to support decision makings (org culture).	Need to create users awareness on the extent of data that they have.	Need to increase users' awareness of what they can provide for the users in the university.	Big data: overwhelming hence sometimes hard to catch users' attention on some useful information. Dashboard is not a new technology -> expected by people (they won't easily be blown away by it).
Design process					
	Uni-Mgr	Uni-Dir	Uni-An1	Uni-An2	Uni-Mgr2
Preparation works	Data clean up		Data clean up and manipulation	Data clean up	Works with the reporting team: create *data portfolios*, inform *what goes into the dashboard* and put different metrics together based on users requirements. Data need to be *cleaned, relevant,* and up to date before linking them onto the dashboard.

Key activities	*Engage and collaborate* with users to get their *feedback* and *confidence* so that they could use the dashboards to *support their decision making.*			In response to user's requests, they loaded those reports onto the Tableau server, users would login and generate the reports, create a dashboard on their own, or export results into various types (self-service).	Design team speaks the same "language" (context, meanings, scope, and definitions of the metrics). Regular users: convert excel reports to Tableau. New users: *consultative,* more discussions before prototype built, analyse if multiple needs met at once.
Users/Stakeholder involvement			Gather users' feedback and expectations.	Collaboration to *fine tune* user's requirements and to design a dashboard *fits for its purpose*.	*A back and forth* communication with users to *continually improve* the design of a dashboard
Concerns/Challenges	Need to *vary their expectations* depending user roles and functions in the university.	The *real challenge* is to deliver the most *important* and *useful* information to the right person.	Data owners need to be accountable. Wanted to make *a whole process easier* and to provide better data visualisations.	Planning contributes to a better design, though there is limited resources and time.	The distribution of reports or dashboards was still done manually.

D.2 CareOne

About participants							
	Care-CEO	Care-Mgr	Care-Proj-Lead	Care-User-GMOps	Care-User-Strat	Care-User-HR	Care-User-Prac
Roles in the organisation	CEO	IS&T Manager	Senior HR officer	General Manager	Strategic Principal	HR Manager	Practice Manager
Roles in the project	Project Sponsor	Project Coordinator	Project Liaison	User	Governance board member, expert user, executive user.	User	User
About impacts/changes related to dashboards (RQ1)							
	Care-CEO	Care-Mgr	Care-Proj-Lead	Care-User-GMOps	Care-User-Strat	Care-User-HR	Care-User-Prac

Long term impacts					to see if the organisation is making social impacts (aligned with strategic goals).		Social impacts "Long term sustainable change takes about 15 years to see the effects, lucky to be part of the change process and seeing the impacts made to the community."
Decision makings		"the part of the system is to provide the data so that they can make the right decisions"		want evidence based or informed decision making. Culture of decision making is based on hearsays and annecdotal evidences.	culture of decision making: limited use of data reactive instead of proactive (similar to Care-Proj-Lead's view). Driven by urgency of the case/situations.		culture of making decisions based on anecdotal story.
impact to current business processes/people in the organisation/organisation performance		Refining business processes to align with the ERP project. Due to limited budget, they can't afford to do much customisation. So they will need to do some process change based on best practices on the sector. To be more efficient and effective.	Past experience on heavy customisation leads to problem on the system changes/**upgrades** in the future. ERP --> biz process changes to be more efficient. "humongous change management exercise".	"when such significant change – and this is a big change for our – for our organisation – when roles are asked to do things differently, or tasks are moved from one role to another, people get a big **anxious** about that. And so, just helping – helping everyone move through that change process I think is what's required."	dashboards as catalyst/enabler for organisational changes, to enable more effective and efficient processes. business process changes embedded in the project. so users cannot work around the system. see "approach" make IT changes aligned with business process changes to support adoption in the future.		to measure organisational performance : social impact "what we're trying to prove is, if you get a package from CareOne, you're more likely to stay at home longer. Not moving into a nursing home or an institution. So they're kind of the little bits and pieces that would evolve around… how would we know people are better off by getting a service from CareOne."

The impact of using information from the dashboard		Information help them survive "on a very competitive and changing marketplace… Once we survived, we get to be innovative".	for survival. See "remain commercially viable".		social impact awareness "Now, they're all important. That's not what we're here for. We're here for the betterment of the people we support."		
Environmental/Govt changes/Competitions		2nd:the industry has to face such 'gigantic change' with NDIS looming around, and with the recent CDC changes too.					
About Design Thinking (RQ2)							
	Care-CEO	Care-Mgr	Care-Proj-Lead	Care-User-GMOps	Care-User-Strat	Care-User-HR	Care-User-Prac
Wicked problems		"We're stepping a little bit into the unknown now." - abductive logic. The logic of what might be.					
Different approaches to different problems			The IS&T team helps users reframe problems and work out proper solutions.				
Problem vs solution space <new sub code??> - **Co-evolution of problem and solution (added 19th Oct 2015 from Lindberg et al)**		Solution space: envisioning the end result, the upcoming design process, user engagement. Based on his experience working in the organisation & on the same "space".	Although Lead seemed to lean or on the "problem space" spectrum. It's about balance (DT). Mgr can **Co-evolution of problem and solution: can't talk about one without the other!**				

Past experience with new technologies	Mgr: combining something tried and tested with something relatively new - dashboards. or at least a new tech to the organisation (though it may not be new to the field). Balanced scorecards to help them evaluate, track, and monitor each areas & to identify relevant KPIs to measure.	Yes: see "solution space".	using a well-known model/tool (balanced score-card) to help selecting/setting up KPIs.				
Collaboration		The design team has to guide users (esp newbies) to articulate requirements. Users involved in deciding which vendor to go to, see "nutshell" on the transcript. By involving them, will increase acceptance rate (and the use as well) when the system is finally implemented.	Comforting & advocating.	Collaboration can be improved. The operation dept felt being left out after initial first few collaborations. As the first focus is in the finance module (as the backbone, building charts of accounts as foundations). They feel the design team should do more in involving them and in understanding how the "operation" dept works.	Comfortable with the level of involvement or collaboration. Design team has communicated well with users and stakeholders.	The HR dept has nominated a subject matter expert to be part of the design team.	'we work really closely with the IT, really closely. We have to. Cos the system has come out of there. And when it breaks, I can call them. I have no idea… So it'd have to be."

Empathy		"Listening. Genuinely listening to people. But also knowing when is the limit to when you reached the level to what you can do to accommodate them. There would be a limit." 2nd: subject matter expperts "They had to be trusted by their colleagues because they're representing their colleagues for the project. They're quite clear of what the expectations were"	has to speak the same "language" with users. Treat users differently (preferences). Comforting & advocating.	Not as satisfactory. **SELF NOTE**: It will be hard for the design team to keep everyone happy. they have to prioritise well and this is where the governance comes handy, to set priority and make sure users are informed.	user-centred: "It's been very deliberate in the way thus far that's been developed and people – the needs of people to engage is being considered, as it's – as I understand, as it's been developed."	Collaboration and user engagement can be improved to make sure user needs are being accomodated enough (although she admitted that it might have been because she's too busy to get involved).	
User-centred		User feedback "survey monkey" "It's very important to get to know each user. … We'll press people's button and some resistance will come up that we didn't expect. But then we've taken the people along the journey already. … So we know we're taking people along."			Early collaboration and involvement "people have been given the opportunity to participate and that's really positive."		
Early prototyping				The importance of early prototyping : prototyping might help.		Early prototyping has occurred.	
Build to think		start with the standard template and improve on it later. "A meeting between dreams and reality."					
Desirability, Feasibility, and Viability		Feasibility - checked! "our senior managers were quite taken by the systems…" Viability - checked! "we went through all the contracts, negotiate all the rest of it…"					

Constraints		Mgr accepted contraints. they create focus. Constraints as motivations to move "faster" with the project. Money Size of organisation not-for-profit nature integration with legacy systems Time People - "One of the biggest"					
Concerns/Challenges				ways to deal: early prototyping, and early involvement of key users and stakeholders, constant communication			
Design Principles			consistencies in using terms and language "consistent across-the-board" 80-20 rule. See "80%".	To source at least 80% of information needed. A quick glance.	simplifies information provide visualisation		Simplicity, consistency, meaningful information (trend analysis and comparative information).
Innovation		Yes: Information empowers the organisation to be more innovative in delivering services to clients. No: The use of dashboards and the ERP software is barely an innovation. Most of their competitors have already done so. The stuff on the ERP like finance and HR were just basic stuff, there's nothing innovative there.	Lead agrees that this dashboard project can be considered one of their innovative effort to grow as an organisation. As an organisation they strive for innovation especially in delivering services to their clients.				The organisation always looks for ways to innovate processes. “we’re looking at innovative or different ways of doing things” innovation as part of the process not just as a result.

Ongoing, continuous improvement		"Well the job is never done. "			"I don't think it will ever be done 'cause …using reports to make more informed decision making."		
About dashboards (RQ3)							
	Care-CEO	Care-Mgr	Care-Proj-Lead	Care-User-GMOps	Care-User-Strat	Care-User-HR	Care-User-Prac
The project initiative/triggers	Lead: 2 in 1 KPIs for dashboard & improvement to the current reporting. (although later on, the project was piggybacking the ERP project). CEO: government changes and environmental changes (means competitions, not environment as in 'nature').	As part of the ERP implementation Initially the project started with KPI initiative but didn't really take off well. The board then approved the funding for the ERP project. So the dashboard project now is part of the ERP proj. 2nd int: initiated as a HR system but IT suggested an integrated system.	comes from IS&T according to Lead. The steering committee was talking about KPIs and object settings, Mgr thought it's a good opportunity as they're also in the midst of upgrading their ERP system. Dashboard proj piggybacks the ERP project.	Limitation of current systems. Manual checking on different parts of the organisation in order to get information.	government changes have been measuring the wrong KPIs	all manual and labour intensive: Performance review is done manually, when it's done, nobody cares, so it will eventually be scraped. the whole project started as an upgrade to HRIS system. then priorities changed.	
Dashboards' functions	Mgr: performance monitoring.		performance monitoring at a glance. Information to support decision making. "**one source of truth**".	will be used to utilise data collected by other/existing systems, from various sources. The need of one source of truth to increase efficiencies of processes (less or no duplication).			

Visions/Goals	Mgr: at a glance information CEO: aligned with strategic plans.	textbook approach (pyramid) data integration	pyramid approach. Mimicked or aligned with organisation's strategic plans.	help with future planning be more competitive information awareness identify inefficiencies an improvement of the current systems to support decision making	to be aligned with organisation's strategic plan although it is still in the early inception of the project. Would be self-service for some users dashboards to enable them to be proactive instead of reactive to situations (similar to care-proj-lead).	to alleviate manual paper-based processes. Self-service HR portals automation of processes & report generation annual government reporting to support business processes and make them more effective and efficient.	the organisational strategic goals are being translated into daily goals at a department level. Aligned with strategic goals.
Importance/Aims/Background	Mgr: accumulating data years after years and haven't made the most of it. KPIs at a glance.	Consistent processes (more streamlined). For survival. See "annecdotal" on the transcript. Environmental factor (pressure from competitions). **Government changes** - CDC. Need good systems (ERP) as a backbone of the organisation to deliver good services to clients.	of the project: (for "of the dashboard", see "functions") integration. need consistency in reporting, and more streamlined and efficient reporting processes. Background: **govt changes** - CDC,	Aligned with strategic plans. "I think the – the intent of the program meets the organisational imperatives. Yeah. So I do think they're focusing on the right area." environmental changes in the sector, competitions.	performance monitoring support decision making utilising data that has been collected over the years.	aligned with organisation strategy	Data to support decision making and to achieve overall strategic goals:
Advantages		Getting exec buy-ins as early as possible. "So getting her buy-ins into that vision to make sure her vision and our vision were congruent and work together."					

Key aspects	CEO: data quality drill-down feature. Granularity of information, see also: user preference.	Being upfront about scope, budget, and to users on what they'll get & won't get. "Manage user expectations". Features: support users from different levels. Metrics : using a well-known model to help select KPIs. Presentation : using a provided template to start with. Tech: System integration.	metrics selection : key metrics - a manageable number of key metrics. Meanings of metrics/indicators (e.g. green lights) must be explained..	aggregated information drillable for further investigation highlight problem areas. Actionable information integrated with the enterprise systems, a one stop shop..	metrics selection and evaluation to make sure strategic goals were achieved. KPIs. Analytics, quantifiable outcomes data, database infrastructure as backbones.	integrated data sources Filtering integration with other systems data, data prep to avoid old and inaccurate data.	metrics/indicators. Customer service indicators. Using public indicators as benchmark (Community Indicators Victoria). Example of KPIs: see "**CIV**". what this means"	
Prior work/prep work/ viability & feasibility check.		2nd int: about Proj_lead "what she did in the lead up to the purchasing of technology one was she did almost a year of business process analysis and improvement around all of the processes that are going to be involved in the project so that was a great way for her to get used to the finance processes and the payroll processes that she didn't know, and the business intelligence part."	Has been working with the marketing department to map current "inefficient" reporting process and suggested to make processes more effective and efficient. Finance and budgeting sides were fine.		measure them." Existing KPIs but have not been measured. meaning/context of data is crucial to make sense of it and to get something out of it. analytics: predictive, comparative. aggregated and integrated data from various sources so relationship can be drawn.			
~~Issues~~				Data quality issue. The importance of accurate info in supporting decision making, the importance of dashboard and the project.				
About design process and dashboards use (RQ3)								

Dashboards use							
	Care-CEO	Care-Mgr	Care-Lead	Care-User-GMOps	Care-User-Strat	Care-User-HR	Care-User-Prac
~~Initiatives~~							
Information needs				Complex information needs : **Carelink** as the main input system. Need one source of informaion. See "without manual duplication".	External & internal reporting on organisation's performance, social impact, community impact.		
Users' responses		"the dashboards were the things that got them excited"					
User Attitude		**Dissonance???** "People nod their heads and agree cos the CEO is in the room and they walk out and do something totally different"	social worker background needs convincing. The finance team "are quite sceptical" due to prev "failed" system development. Bad experiences in the past.	Confident, positive outlook on the project.	Feeling optimistic although Some users probably won't know it exists (not very high in terms of awareness) - selfnote: as mentioned by Care-Mgr, probably because they're focusing on the subject matter experts and have involved key users from the beginning (vendor selection, training, etc.)	positive.	
User's Expectation				daily use of dashboards (for health check). To source at least 80% of information needed. A quick glance.	Analytics, quantifiable outcomes	Unsure, don't know what to expect, overwhelming. To monitor and identify risks and to provide alerts in areas needing attention..	

Users involvement		The key users were involved during the vendor presentation. EARLY in the process. Users involved in deciding which vendor to go to, see "nutshell" on the transcript. By involving them, will increase acceptance rate (and the use as well) when the system is finally implemented.				The HR dept has nominated a subject matter expert to be part of the design team.	
Users preference	CEO-assist: Board wants less frequent and the highest level of granularity. Whereas managers want more detailed and more frequent.	"people simply want flexibility"	GUI/presentation : need flexibility based on user preference.	A quick glance.			
Design process							
	Care-CEO	Care-Mgr	Care-Proj-Lead	Care-User-GMOps	Care-User-Strat	Care-User-HR	Care-User-Prac
Preparation works	CEO: data needs prep work as currently not fully integrated, need to be sourced from various sources. Needs overhaul. Important to understand the context. See transcript: "bluntly".	Dashboards will start with templates from the ERP suite. Data integration with legacy systems including Carelink+. Set a solid foundation starting with the main legacy system, build the ERP around it.	Prepared a project brief. **Knowledge transfer** on balanced scorecards, KPIs, and the importance of the project (KPIs and reporting). The end goal is to have a **shared-knowledge** about the importance of the project.		the use of the sytem needs to be considered early on the design process, not so much on the GUI design, but the overall process changes aligned with it.. "If people don't know about something, they don't know what they don't know, and I have seen endless systems in business that had been developed. They've spent millions and millions and millions and millions of dollars. They don't get used."		

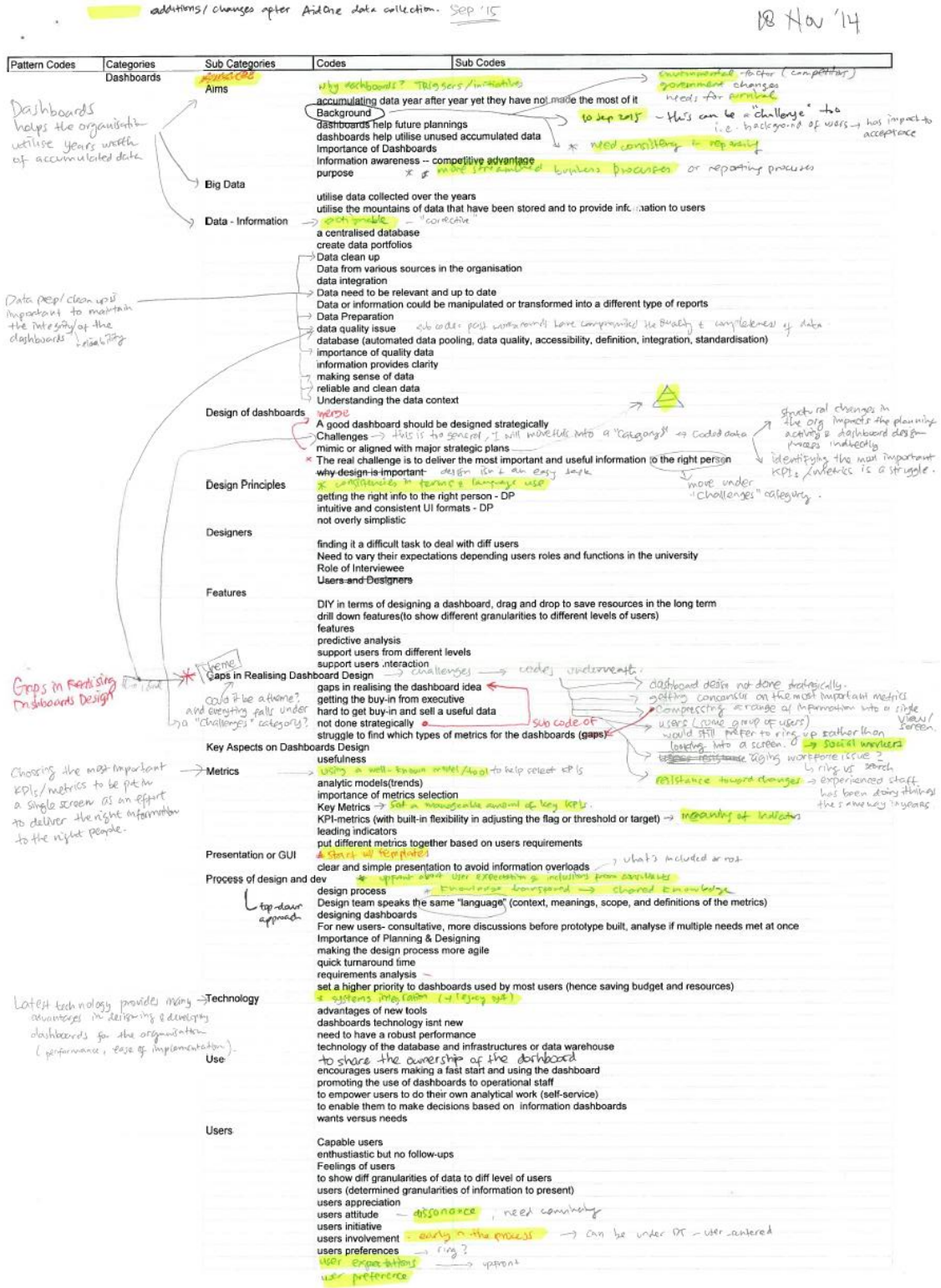
Key activities		Although Mgr initially said it's going to start with exec level first. but Mgr admitted it's llike "stepping into the unknown". then from Mgr's explanation, it seemed like the project will start with lower level dashboards (finance and HR), like knowing staff turnover, sick leave. As data gathered from the new ERP system. It would later (phase 2) be brought "up to a pyramid". Process of design/dev : rapid. requirement analysis : list of must haves etc, see "shopping list". 2nd: "it kills two birds with one stone", application training and preso together with requirement elicitation. "very efficient".					
Users/Stakeholder involvement		in attending vendor presentations which in turn influencing the vendor selection process. Users have difficulties in articulating what they need (see Org Issues & Background). 2nd int: Members of design team consist of proj leader, subject matter Subject matter experts, prj assurance, BA, IT supports, Carelink people. (see transcript for full role of each person). The whole IT team is involved in one degree or another. But the core team of the project is nyreda and the subject matter experts.					

Concerns/Challenges	CEO: some key data has not been collected at all.	Future changes/improvement/customisation : "how flexible the BI dashboard design is". Can the changes be done in house or must it go through to the vendor? Project risks & governance. See: **Governance**. 2nd: Expect the unexpected : key people going on a long leave disrupting the project. inertia: still waiting for the chart of accounts to be setup. taking too long. See below: politics.	Gaps: Old employees with social workers background. New managers came from the commercial background "cannot understand how we survive". Current legacy systems have no integration at all.		see : approach. It's a challenge for them and they way they deal with it is : to embed business process changes to inform users and involve them early on.	inertia??? "Look, this – this process has been – they've been trying to get this up and running for about five years and it's still not there"	People, culture, lack of accountability. "Having said that though it is still challenging… challenging in terms of… people understanding the reason, understanding the need for change.
Organisational Issues/Culture		Corporate vs not-for-profit (hard to articulate user requirements). Culture : "Like us we like to get in a r 2nd: in relation to chart of accounts issue: politics. CFO was the one holding them up. He reports to the CFO. So it makes it hard for him to take actions or reports the issue to anyone else. importance of **governance** board. as it is an expensive project.	Old way of reporting: Excel spreadsheets, word documents (both inefficient and ineffective). Culture of decision making: more reactive. Purely based on intuitions, but they'd done nothing till it's happened. See: "my gut" on the transcript. Social workers mind set.			lack of accountability (in task owning and decision making).	Measured the wrong thing which results in people not being held accountable or only become acountable for those wrong KPIs.

Resistance to change		See : old ways of doing things. Some groups of users might not like the changes. 2nd: rebutting the resistance issue. He said generally the resistance comes from the troops….	"Because it's against them having a social work bachkground. bad experiences in the past that might influence/lead to resistance. see "sceptical".	Potential resistance, job insecurities "well, anxious about their job security. Is there still a job for me if I don't have to do this anymore? But it could be that the region might – might do a particular process in one – one way and they can't see any other way of doing it."	anticipated on other users' reactions. it can result in people leaving the organisation. "it's like any – any interaction between human beings when, you know, there will be some who are early adopters and you would know this better than I – there would be some who won't.	Expecting some resistance of being monitored, being held accountable, responsibility.	anxieties, fear of being monitored job insecurities, but these challenges were not merely caused by the new system but also stemmed from the overall reform happening across Australia in aged care and disability fields. Fear of change: see "how safe are people feeling"
User Background		Most have social workers background which can be challenging to accept changes			Very data savvy, executive user Expert		
Designers/The Design Team		Has to guide users (esp newbies) to articulate requirements. - has an active role in the design process. Need a **governance** role-> see "mitigate risks" on the transcript. 2nd int: Multidisciplinary team, not just people with IT background. Proj Lead was from HR seconded to the team. BA and subject matter experts from various department make up the design team.	has to speak the same "language" with users. Need "**governance**": define what goes in/out, who applies the changes. See "accountability".	keeping everyone informed/involved. See "custodians of the information and the rollout".			
Approach	Mgr: realistic "we don't aim for the moon."	Top-down. Get exec buy-ins first.	top-down approach, get exec buy-ins. Pyramid approach. See: "OH&S"		top down approach is good, exec buyins is imprtant, but it's not the silver bullet. people can always work around the system and go back to the old ways of doing things. so business process changes need to happen and be embedded to the system change.		

Appendix E – Themes, Categories, and Codes

E.1 List of Categories (Pattern Codes) and Codes



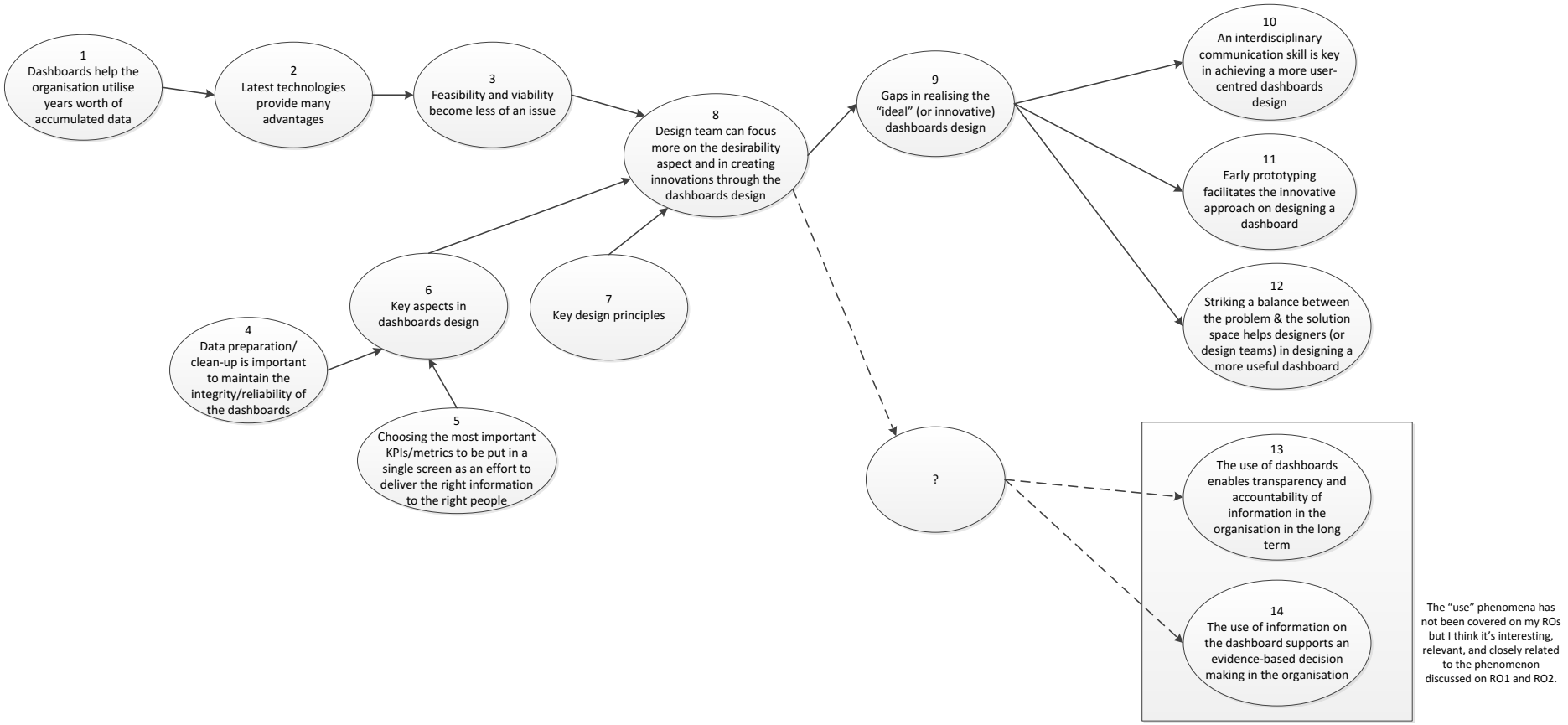
Pattern Codes	Categories	Sub Categories	Codes	Sub Codes
		Visions		
			Future idea of providing dashboards	
			help unleash useful information to help them grow	
			one source of truth	
			Self-service dashboards	
			users could interrogate the data themselves	
			users to be able to perform their own queries to dashboards (self-service)	
			Vision of dashboards	
			Wanted to make a whole process easier and to provide better data visualisations	
	Design Thinking Characteristics			
		Balance		
			Back and forth prob-sol space	A back and forth communication with users to continually improve the design of a dashboard
				balance between problem and solution space
			Desirability-Viability-Feasibility	
				feasibility and viability became less of an issue
			Past Experience and New Tools	
				similar request allows reusing past solutions
				tapping into past experiences and combine with new tools
			Problem space	
				diff approaches to diff problems
				holistic assessment
				unclear requirements
				wicked problems
			Solution space	
				envisioning the end result
		Early prototyping		
			Building to think	building to think
			Early prototyping	early prototyping
			Learning by making	
		Innovation		
			Constraints	
				constraints
				constraints distilled design problems
				constraints forced innovations
				Creating a better design, though there is limited resources and time
				embracing constraints
				finding workarounds - constraints
				IT and tech related constraints
			Efforts leading to innovations	
				change the way users think about data
				changing user's perception about the value of information
				changing users' conception about the dashboard
				mix people on a team supports innovations
			Innovative approach	
				dashboard design process impacts the way they value data
				diversity in a team supports innovation
				users to be able to perform their own queries to dashboards (self-service)
			Roles of interviewees	
				Central to what her work (as a user and provider)
				define what goes into the dashboard
				informs what data goes into metrics
			Start anew	
				start from scratch
			View of innovation	
				modest view of innovation as other organisations have done better
				view of innovation
		Users-centered		
			Collaboration	
				collaboration
				Collaboration to fine tune user's requirements and to design a dashboard fits for its purpose
				discourse and stakeholder engagement - collaboration
				Engage and collaborate with users to get their feedback and confidence
				Gather users' feedback and expectations
			Empathy	
				empathy
	Impacts to Decision Making Activities			
		Decision makings		
		evidence-based		a real evidence to base their decision makings on
				bust myths with evidences
		Culture		culture of decision making based on gut feelings not based on data
		Data		data as a part of the equation on making decisions
				data influence decision makings
				decision making is subjective
				influences strategic directions
				support big decision makings & make improvement plans
				unknown if decisions made purely based on dashboards
		Due to data unavailability		
				inform data or process owners to collect the data in a good quality
				inform data or process owners to collect the data when data unavailable
				Issue with data unavailability
				negotiate or work on solutions with process owners
		Due to user requirements		
				manipulate data to suit the needs
	Impacts to Organisational Performance			
		Indirect impacts		
				indirect impact to reputation
		Performance Accountability		
		Performance Awareness		
				encouraged users to use more performance metrics related to business operations and strategic goals
		Performance Improvement		
				a follow up action or an improvement
		Performance Monitoring		
				Enable staff performance self monitoring
				Enabled a reality check
				information helps monitor organisation's performance
				performance and target monitoring

The use of dashboard creates transparency of information in organisations in the long term

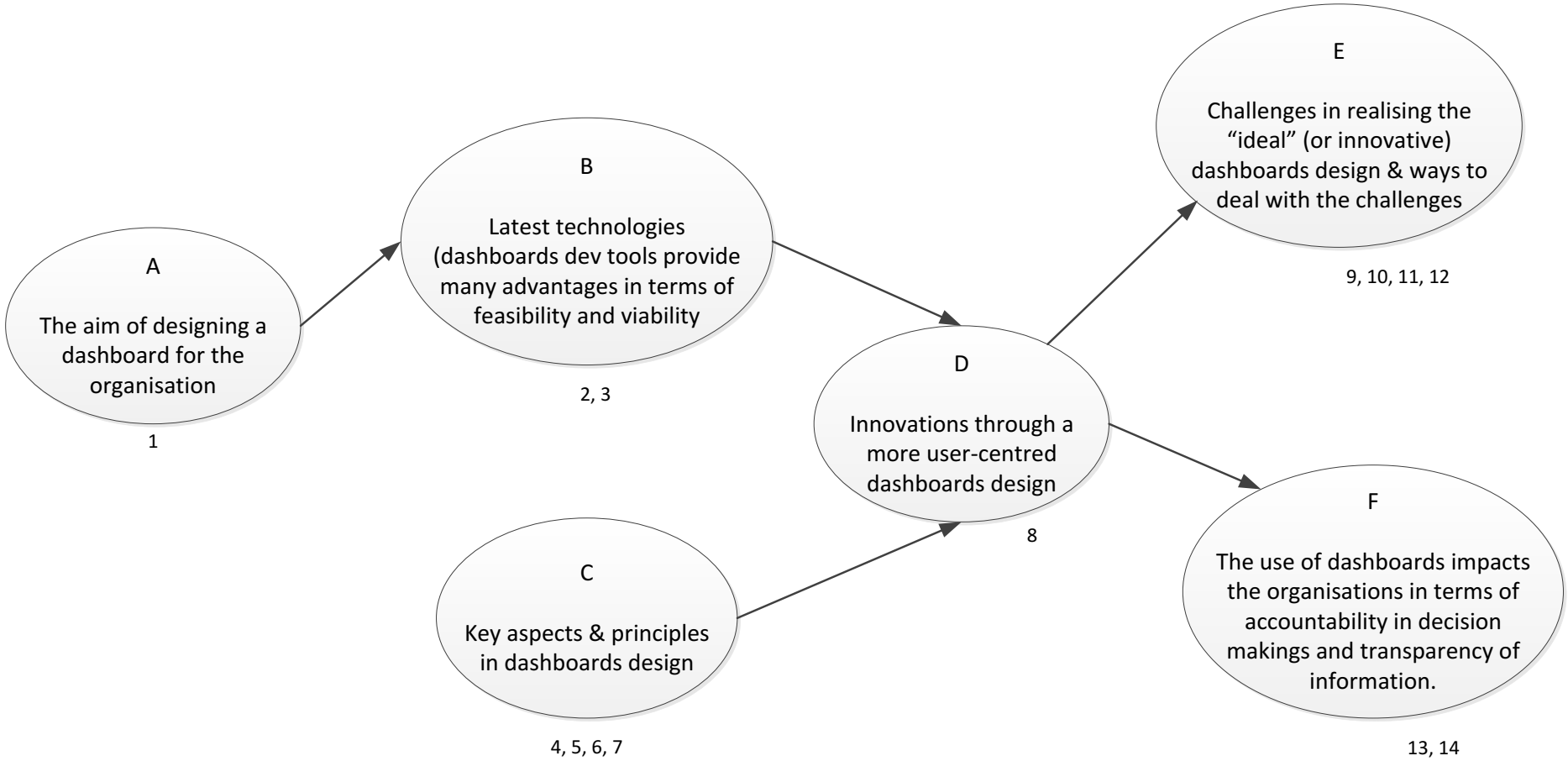
Pattern Codes	Categories	Sub Categories	Codes	Sub Codes
19 Nov	Impacts to Organisational Processes			
		Changes to dashboards	→ move it to "Impacts to Dashboards Design"	* Check BR's interview again on "Impacts" or "Changes".
			Changes in the organisation prompted adjustments to data structures, etc	
			Changes in the organisation triggered impact analyses	
In order to investigate changes in the organisation, research 'interview' investigation observation must be done on the strategic level team or with		Changes to organisation	* changes to current biz processes due to the project (incl. dashboards)	
			Hard to point out changes in organisation bcos of dashboards	* to make processes more efficient & effective; * changes for survival (closely related)
		Direct relationships		
			determining the viability of courses	
			Poor quality data -- misleading information -- unnecessary actions	
Changes to the organisation cannot happen overnight. They need to be consulted with the stakeholders. Need to be contemplated and risk-analyzed.		Indirect relationships		
		Issue detection		
			identify or spot issues	
			investigate a root cause of an issue	
			proactive when encounter issues	
		Long term impacts		
			transparency of information	
Especially when the org is complex, that will add to difficulty for applying changes.	Organisational Issue	corporate vs not-for-profit — as perceived by the designer who has been in both sides		
		Age groups		
			ageing workforce issue	
		Changes due to dashboards design	→ review this category again	
		Changes in org trigger changes in dashboards		
			Hard to point out changes in organisation bcos of dashboards	
		Changes triggered (influenced) by info from dashboards	seems like I have some codes / data on this category (should have)	
		Culture	some group of users would prefer to ring & ask → TA & BR "ring"	
			endorsement from the authorities helps gain user appreciation → exec buy-ins	→ social workers
			organisational culture → see GAM → resistance to change (has been doing the same thing for years)	
		Current processes		
			Current ad-hoc dashboard design&development process	
			Current Finance System	
			data help understand the organisation	
		Decision making		
			Old ways of making decisions	
		Performance		
		Politics		
			data as political assets	
			Data owners need to be accountable	
			data ownership	
		Size		
			complexity of the organisation → add BR's "complex"	
		Strategic plans		
	YYY Uncategorised			
	ZZZ-Deleted or Redundant			
		Design Thinking		
		Staff & Organisation's performance		
		Technological Aspects		
		to be one source of truth		

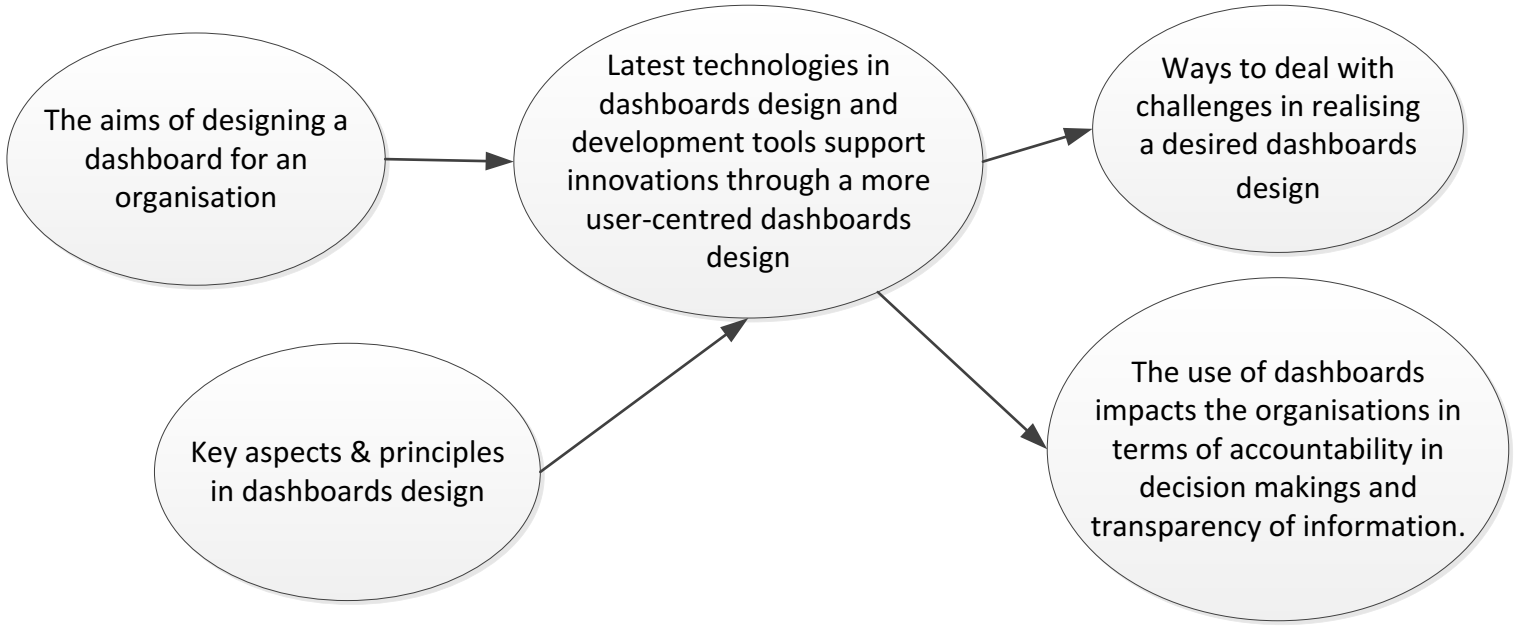
E.2 Themes Development

E.2.1 Drawing Relationships between Categories



E.2.2 Themes Development




The aims of designing a dashboard for an organisation
Latest technologies in dashboards design and development tools support innovations through a more user-centred dashboards design
Ways to deal with challenges in realising a desired dashboards design
Key aspects & principles in dashboards design
The use of dashboards impacts the organisations in terms of accountability in decision makings and transparency of information.