An Investigation of the Managerial Use of Mobile Business Intelligence

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Abstract

As a new trend in business intelligence (BI), mobile BI has been gaining increasing adoption by managers. However, there is little academic research about the managerial use of mobile BI. Adopting the key constructs of Task-Technology Fit theory and the Unified Theory of Acceptance and Use of Technology as the theoretical lens, this exploratory study aims to deliver a preliminary understanding on why and how managers use mobile BI, from both the managers' and the vendor's perspectives. A case study was conducted with a large government authority whose mobile BI vendor is an industry leader worldwide. Semi-structured interviews were carried out with seven senior managers from this organization and the vendor. Through discussing the reasons why managers use mobile BI and their use patterns, a series of emergent propositions are drawn. The empirical results from this study not only contribute to this currently underexplored area of mobile BI, but also help enable the industry to make mobile BI products that better suit managers' needs.

Keywords: Mobile BI, Business Intelligence, Mobile Decision Support Systems, Managers, Technology Use, TTF, UTAUT

Introduction

As part of the decision support systems (DSS) evolution, business intelligence (BI) represents the contemporary large-scale IT approach to provide managerial decision support (Arnott and Pervan, 2005). In recent years, DSS has been growing significantly in the social and mobile computing context. Mobile BI represents this new trend in BI. According to Gartner (2018), BI and mobile technologies have been among the top five technology priorities for Chief Information Officers (CIOs) across the world since 2012. The availabilities and abilities provided by mobile technologies for business managers to view the right information and key facts when making decisions are critical to the decision outcome (Nori, 2013). Organizations that leverage an effective strategy of mobile BI can equip their workforce with the tools to accelerate decision-making when they need and enhance the overall business performance (Lock, 2015).

Over the last half-century, mobile technologies have made unprecedented impacts on the way people communicate in business activities (Bi et al., 2001). With wireless Internet connectivity, the rapidly evolving mobile devices including smartphones and tablets allow users to access business information anytime and anywhere. Power (2013) indicates that most decision-making tasks are very time-sensitive, and managers often work away from their offices. According to the market study conducted by Dresner Advisory Services (2015), executives remain the primary target users for mobile BI, but the increase of middle managers and line managers using mobile BI is highly visible. This market study also indicates that mobile BI ranks as the third highest priority among the mobile applications, only behind emails and personal information management such as calendar. Meanwhile, a growing number of mobile BI vendors and products have entered the market, from mega vendors like SAP and IBM, to emerging independent vendors like Yellowfin.

Adopting mobile BI often involves considerable financial expenditure and organizational changes. Understanding mobile BI users' behaviors and satisfying their real needs are of significance for an organization's successful adoption of mobile BI. However, despite of the increase of managerial use of mobile BI, little is known about its effectiveness in decision support. Furthermore, in the information systems (IS) field, currently there is a dearth of academic research about the managerial use of mobile BI. In addition, research in mobile BI with good theoretical grounding is highly demanded (Gao, 2013). As such, this exploratory study aims to investigate: (1) Why do managers use mobile BI? and (2) How do managers use mobile BI?

To address these questions, a case study of a well-known large government authority in Australia was conducted. The vendor of its mobile BI system is a worldwide leader in the BI area. Two widely recognized IS use theories – Task-Technology Fit (TTF) and Unified Theory of Acceptance and Use of Technology (UTAUT) were adopted as the theoretical lens in this study. Semi-structured interviews with seven senior managers from both this government organization and the vendor were carried out, to elicit their valuable experiences and insights of mobile BI use behavior. Also, since managers can choose to or not to use an IT for various reasons (Silver, 1990), the concept "use" in this study has binary implications: use or no-use. Based on the findings, possible differences between the vendor's view and managers' use of mobile BI are explored.

This paper proceeds as follows. The next section presents the relevant literature for this study, followed by a description of the research design. We then discuss the research results including a series of emergent propositions, and draw a conclusion.

Literature Review

This section first delivers a review of literature on the mobile decision support systems (MDSS) and mobile BI, which identifies the possible research gaps. Then the TTF and UTAUT theories and their applications are discussed to inform the research design.

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MDSS

The remarkable advancement of mobile computing and communication technologies bring a new class of DSS – MDSS that inherits the nature of DSS in supporting decision-making (Haghighi, 2013). In recent years, MDSS has been increasingly gaining interests in both academia and industry. A number of articles have been published in high quality IS journals since 2000s. From the perspective of managerial functions, there are two types of MDSS users: (1) non-managerial users, such as professionals and consumers; and (2) managerial users, from line managers to senior executives.

For the users who don't play a managerial role, related MDSS studies have been conducted in a variety of contexts. There are two main domains. One is healthcare, such as mobile health (Varshney, 2014a; 2014b), the smartphone-based intelligent system with microscopic lens (Bourouis et al., 2014), the patient monitoring through mobile ad hoc network (Sneha and Varshney, 2013), and an application on a mobile platform to support clinical decision-making based on the inputs by users (Vishnu et al., 2017). The other area is commerce, such as MDSS for consumers' in-store purchasing decisions (Van der Heijden, 2006), mobile advertising system (Li and Du, 2012), prediction of mobile customer preferences (Tang et al., 2013), and the like.

For the second type of users who perform managerial tasks, very few studies are available. Mintzberg (1990) indicates that managers are the decision makers in an organizational unit, and the information managers receive is the basic input for decision-making. Senior executives spend most of their time with others, and the time they work alone is often on airplanes or commuting (Kotter, 1999). Obviously, the mobile capability of decision support tools can bring value and benefits to managers on the move. Moore and Chang (1980) argue that the underlying decision context constantly evolves in a decision space, including the managerial preferences and procedures of decision-making. The mobility at work makes the decision process more dynamic and diverse. Managerial tasks are often non-routine, interdependent and time-critical, which appears to have much relevance to MDSS (Gebauer et al., 2010). Stanek et al. (2013) conducted case studies to explore the modern technologies' support for the mobile decision-maker, which covers some managerial roles in studying the applications of mobile videoconferencing technology and the mobile risk management support in trade finance. So far, despite of the increasing research on decision support systems in a variety of industries and scenarios, few other publications have explicitly explored the managerial use of MDSS in high quality journals.

The recent trend of MDSS research in various contexts suggests that the study on MDSS is maturing and evolving, as mobile technologies continue advance and more researchers have realized the importance of theoretical grounds to deliver a rigorous study. For instance, Xiao et al. (2017) explore the use behavior and reasons for managerial use of tablets for decision support, anchoring on the TTF theory. Different from this study that focuses on the mobile BI technology, Xiao et al. (2017) investigated a broader area of mobile applications, such as emails and web browsers, on tablets for decision support. Still, very few MDSS studies have covered the managerial adoption and use behavior, especially for the senior management. Arnott (2010) argues that senior executives hold different decision support needs and information behavior from non-executive professionals. Thus, the gap of MDSS research on managerial use, especially by the senior management, is expected to be reduced in this study.

Mobile BI

The emergence of mobile BI describes a type of enterprise-wide MDSS. Mobile BI not only extends traditional BI onto mobile devices for delivering business insights with more flexibility, but also provides some extra benefits to users, such as the multi-touch interface. Peters et al. (2014 p.2) provided a more sophisticated definition for mobile BI as below, and it is adopted for this study: "*A system comprised of both technical and organizational elements that presents historical and/or real-time information to its*

users for analysis on mobile devices such as smartphones and tablets (not laptops), to enable effective decision making and management support, for the overall purpose of increasing firm performance".

In the last five years, the publications on mobile BI have emerged, though only a few are published in high quality journals. Peters et al. (2016) claim that our understanding on the use of mobile BI and its determinants are limited while recognizing mobile BI's benefits to organizations. Peters et al. (2014) conducted a quantitative study of key mobile BI users to explore the success dimensions deemed important by mobile BI users, and called for further investigation on the factors impacting the use behavior of mobile BI. As pioneers, Verkooij and Spruit (2013) explored mobile BI implementations for the first time, by devising a Mobile BI Implementation (MOBII) framework. This study follows a four-step design: first, a literature review suggesting major implementation themes; second, expert interviews revealing twenty key considerations for the implementation; third, a case study to evaluate the MOBII framework; and fourth, practical demonstration of the utility, quality, and efficacy of the research artifact. They recommended that organizations should not understate the managerial implications for the implementations when planning to adopt mobile BI, and should use the MOBII framework to update their proprietary implementation methods.

As the organizing vision of mobile BI is maturing, mobile BI has evolved to its growth period (Tona and Carlsson, 2013). To understand the organizing vision and growth of mobile BI, Tona and Carlsson (2013) conducted a business literature research and semi-structured interviews with main mobile BI vendors in the industry. Their findings demonstrate that mobile BI is complimentary to traditional BI rather than a substitute, and it is being shaped by different members in the industry including early adopters, consultants, vendors, analysts and media. Although this study was developed from the business perspective without any theoretical grounds, it brought fresh knowledge of the current mobile BI and highlighted some important issues for future

research. In a further study, they explored the motivations of organizations' adoption of mobile BI, and discussed the mindfulness and mindlessness in the adoption of mobile BI (Tona and Carlsson, 2014). Tona (2015) also explored how mobile BI use patterns emerge and develop, and pointed out that the use patterns are changing when users shift among different modes and attention scopes. Tona and Carlsson (2017) particularly investigated and discussed the influence of mobility level of users and time criticality to decision-making efficiency. Still, the reasons why mobile BI is used and how it is used from both users' and vendors' perspectives are not investigated.

In both mobile and managerial contexts, Peters et al. (2016) suggest that it is important to investigate how to design the tool based on end users' working contexts and profiles. They also argue that organizations should comprehensively evaluate managers' responsibilities and the types of decisions they make to understand their actual needs. Buchana and Naicker (2014) developed a model of technology acceptance to explain acceptance and usage behavior of mobile BI for managers' decision making in an organization. To develop their model, they drew on the Technology Acceptance Model (TAM) and TAM2 as the baseline models. However, the lack of explanation and review of these two theories makes the research less rigorous. Overall, given the lack of studies on the managerial use of mobile BI, Buchana and Naicker (2014) still make important contributions and implications for future research in this field. Also, although there are some industry research and analysis about mobile BI, most of them are more from the perspective of organizations, vendors or the industry rather than the end users of mobile BI, such as the report from Forrester (Bennett, 2015).

Based on the reviews and discussion above, it is obvious that little research has explored why and how managers use mobile BI or compared it with the vendor's view on the managerial use of mobile BI. Moreover, it also indicates that the IS theoretical grounds in the published studies related to mobile BI are relatively poor. This study aims to fill these research gaps. In the following sub-

sections two complementary theories – TTF and UTAUT are reviewed. Both TTF and UTAUT are well-recognized theories in studying the adoption and use of an IT/IS. However, each theory represents a stream of research with different focuses. TTF stresses the fit of tasks and technologies, while UTAUT emphasizes user attitudes and perceptions towards the technology.

TTF

As a critical part in the Technology-to-Performance Chain (TPC) model, TTF was proposed by Goodhue and Thompson (1995). The TPC model asserts that the technology must be utilized and fit with the tasks it supports, to achieve positive impacts on individual performance for an IT. To be specific, TTF is a product of two fits: (1) The fit between task characteristics and technology characteristics; and (2) The fit between individual characteristics and technology characteristics. These two fits determine the individual performance of using an IT.

In this study, mobile BI is an emerging *technology* with distinguished characteristics (e.g. mobility) from traditional decision support tools. The users of mobile BI are managers – a group of *individuals* with characteristics different from other non-managerial users (Arnott, 2010). Also, decision making as the *task* of managers is a special kind of task. The fits between the characteristics of mobile BI, managers and decision-making tasks will determine the performance of using mobile BI. Therefore, TTF is adopted in this study to inform the research design and data analysis, through reviewing the applications of TTF for DSS research in the mobile and/or managerial contexts.

In fact, the applications of TTF in the study of IT use on mobile devices started as early as more than a decade ago. Chu and Huang (2005) presented a model of the mobile business services adoption. Lee et al. (2007) proposed and validated a modified TTF model to explore the factors affecting the adoption of mobile commerce in the insurance industry, and found the Personal Digital Assistant (PDA) mobile commerce system suited the insurance industry well.

Also, their study suggests that the major factors predicting the fit of applying PDA technology for insurance tasks are users' position experience, cognitive style, and computer self-efficacy.

Gebauer and Shaw (2004) presented a research framework and an exploratory case study to assess the success factors and the impacts of mobile business applications. They put forward three technology characteristics (i.e. functionality, portability, and system performance and user support) of mobile applications, and three task characteristics (i.e. structure, mobility, and need for emergency handling) of mobile applications. Through the case study at a Fortune 100 company, they suggest 'notification' and 'support for simple activities' are the two most valued task characteristics by users, such as tracking information rather than complex processing. Also, they believe task mobility can predict the usage of mobile applications.

In both mobile and managerial contexts, the number of research projects has been growing recently. Gebauer et al. (2010) expanded TTF by developing a conceptual model to establish fit between managerial tasks, mobile IT, and the mobile use context, assuming that a good fit positively impacts task performance. The managerial tasks were described in three dimensions: non-routineness, interdependence, and time criticality. Also, they stressed functionality, user interface and adaptability as the characteristics of mobile IT. This model makes significant implications for the research area of TTF: (1) profiles for the combination of managerial tasks and mobile IT are proposed; (2) introduces the use context as a third dimension to TTF for the first time, which gains more importance as the use contexts of mobile IT become more varied; and (3) the model can be used by various combinations of tasks, IT and use contexts. Another research model proposed by Yuan et al. (2010) highlights the importance of the fit between mobile task characteristics (i.e. mobility, location dependency, and time criticality) and mobile work support functions (i.e. location tracking, navigation, notification, and online job dispatching). Parkes (2012) deconstructed TTF and suggested a DSS should put

sufficient mechanisms in place to guide and support decision-makers.

All the applications of TTF above prove that TTF is a widely adopted and constantly evolving model to study the use of IT. It can fit in various contexts such as a managerial and mobile context. To summarize the review above and provide a useful guideline for our research design and analysis, Table 1 presents a list of key constructs of TTF in the managerial and mobile contexts. It is noteworthy that our adoption of TTF is not to test or measure its constructs and/or associations, but to take these three constructs from TTF as a starting point to design our study and analyze the collected data. A similar strategy of adopting TTF in a qualitative study was used in Xiao et al. (2017).

Table 1 - TTF Constructs in the Mobile and Managerial Contexts	
Construct	**Characteristics**
Mobile IT	Functionality: capabilities, (e.g. location tracking and notification)
	Adaptability: ability to adapt to various locations, situations and users
	User interface: the experience to use a mobile IT, including portability, storage capacity, process performance, updates and maintenance, and decisional guidance design
	Network: network connection availability, bandwidth and stability
Managerial Tasks	Time criticality: flexibility and urgency
	Interdependence: extent to which a task is related to other tasks or units; coordination required
	Non-routineness: a task's level of difficulty, structuredness, analyzability and predictability
	Mobility: frequency that a person is away from the standard office and the variety of locations to perform the task
Individuals (i.e. managers)	Position experience: the length of time an individual is working in the same area
	Cognitive style: an individual's consistent preference in information processing, such as intuitive and analytical types in information retrieval, field-independent and field-dependent types in information processing
	Computer self-efficacy: a person's level of confidence or belief in his/her own ability to use computers

UTAUT

As a widely recognized theoretical model in the IS filed, UTAUT (Venkatesh et al., 2003) consolidates eight IS models used to analyze IS usage behavior in previous literatures: theory of reasoned action (TRA), technology acceptance model (TAM), theory of planned behavior (TPB), motivational model, a combined TPB/TAM, model of PC utilization, innovation diffusion theory, and social cognitive theory. UTAUT aims to explain user intentions to use an IS and subsequent usage behaviors. The key concepts of UTAUT are explicitly revealed in its title: acceptance and use of technology, which highly matches the research questions of this study.

UTAUT argues that users' usage intention and behavior are mainly determined by four key factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. In addition, gender, age, experience, and voluntariness of use, are four moderators posited to moderate the impacts of the four key factors on usage intention and behavior (Venkatesh et. al., 2003).

As a baseline model, UTAUT has been applied to study the use of technologies in a variety of contexts over the last decade. This sub-section mainly discusses the applications of UTAUT concerning decision support, managerial use and/or in the mobile context, which are closely related to the key concepts of this research project.

To investigate how and why general practitioners (GPs) use DSS, Shibl et al. (2013) conducted interviews with 37 GPs and developed a research model based on UTAUT. The original UTAUT model was modified by removing the social influence construct and adding a new construct called "trust in the knowledge base". Shibl et al. (2013) identified four main factors affecting the acceptance and use of DSS by GPs: (1)

usefulness, including consultation issue, professional development and time; (2) facilitating conditions, including workflow, training, and integration; (3) ease of use; and (4) trust in the knowledge base. Furthermore, they argued that since GPs are independent workers who make individual decisions, their findings potentially have a wider relevance to general DSS users who are independent professionals making individual decisions in other contexts.

In the mobile context, Shin (2009) extended UTAUT with constructs of security, trust, and self-efficacy to study consumers' attitudes and intentions to adopt a mobile wallet, which indicates that perceived usefulness and ease of use are key acceptance factors while perceived security and trust also have impacts on users' attitudes to using a mobile wallet. In the study on the use of PDA, Yi et al. (2006) integrated the predictors of perceived usefulness, perceived ease of use, subjective norm, perceived behavioral control, result demonstrability, image, and personal innovativeness in IT into a new model, and tested their model in a setting of healthcare professionals. Furthermore, Yi et al. (2006) argued that PDA was considered as an emerging technology then, and thus choosing behavior intention rather than actual usage as a dependent variable allows a timely investigation of physician's acceptance when more healthcare organizations using PDAs. This argument also applies to the current situation for studying the use of mobile BI that is a novel and evolving technology.

For the research on managerial use, there are few applications of UTAUT yet. Hou (2014) carried out a study on the user acceptance of BI in Taiwan's electronics industry, through a survey of 330 valid responses among which 119 respondents played managerial roles at different levels. All the applications of UTAUT's constructs have contributed to expanding the understanding of technology adoption and extending the theoretical boundaries of UTAUT. Also, the prior research experience proves that UTAUT is an effective and reliable model for exploring and investigating the user intention and use behavior of technologies in a variety of contexts.

As shown in Table 2, for this study, the key UTAUT constructs in the mobile and managerial contexts are summarized. The adoption of these theoretical constructs is to inform our research design, data collection and analysis, rather than testing UTAUT.

Table 2 - UTAUT Constructs in the Mobile and Managerial BI Contexts		
Construct	**Definition**	**Four Moderators**
Performance Expectancy	The extent to which a manager expects the utilization of mobile BI to benefit his/her job performance.	1. Gender
Effort Expectancy	The extent to which the mobile BI is easy to use.	2. Age
Social Influence	The extent to which a manager perceives the importance of others' believing that s/he should use the mobile BI.	3. Experience of using mobile BI
Facilitating Conditions	The extent to which a manager believes an organizational and technical infrastructure able to support mobile BI use.	4. Voluntariness of Use

Having reviewed the related literature and formed a theoretical framework, the next section covers the research method and design.

Research Design

As mentioned earlier, this exploratory study concentrates on investigating 'why' and 'how' managers use mobile BI, from two different perspectives – managers and the vendor. It is an investigation of contemporary events, and does not require the control of behavioral events. Therefore, the most

appropriate research method for this research is a case study (Yin, 2014). It is also believed that the case study approach is suitable for an area where little research is available (Benbasat et al., 1987).

In this particular study, it is an exploration of the managerial use of mobile BI. The selected case is a well-known large government authority, and the vendor of its mobile BI system is a worldwide leader in the BI area. Based on the research questions, three main criteria were used to select this case. First, the organization has provided managers with a mobile BI system. Second, the researcher has access to the senior managers who have access to the mobile BI or are potential mobile BI users in this organization. Third, the sizes of the organization and its mobile BI vendor are large, considering large organizations normally can contribute more insights than small organizations.

The organization selected for this study matched all the above criteria. It is a semi-autonomous Australian federal government authority, with more than 11,500 staff and AU$1.5 billion annual operating revenue. IT service in this organization is relatively centralized, and BI is one of the major organization-wide services provided by the central IT division. Also, its mobile BI vendor is a mega BI provider. However, its current mobile BI is still in its infancy with a few small explorer views. An upgrade of this mobile BI system has been planned to provide managers with stronger mobile capabilities and richer business information. High quality interview participants were recruited from the senior management, to moderate the restriction of the relatively small size of the participants in this research.

Table 3 - Interview Participants Profile				
From the governmental authority				
	Gender	**Generation**	**Managerial level**	**User of mobile BI**
P1	Female	Baby Boomer	Senior Manager	Yes
P2	Male	Baby Boomer	Senior Manager	No
P3	Female	Gen X	Senior Manager	No
P4	Female	Gen X	Senior Manager	No
P5	Male	Baby Boomer	Senior Manager	Yes
From the mobile BI vendor				
P6	Male	Baby Boomer	Vice President	/
P7	Female	Gen X	Vice President	/

Semi-structured interviews, more flexible than purely structured or unstructured interviews, were adopted as the main data collection technique for this study. There are both established and open-ended questions in semi-structured interviewing that are for exploring emergent events and ideas. Most of the interview questions were inspired by or adapted from the prior literature and the theoretical constructs as discussed earlier. For each interviewee group – users and the vendor, an interview protocol was developed to facilitate the consistent structure of data collection (see Appendix 1 and Appendix 2). Three main sections constitute the protocol for users: (1) personal basics, such as their gender, age/generations, position, and managerial level; (2) the nature of work, such as their mobility at work and task difficulty; and (3) use of mobile BI, such as their motivations to use, target tasks, most used functions, and use occasions. The interview protocol for the vendor is designed to be more open, but cover the above three areas, in order to best elicit their insights on the managerial use of mobile BI. These interview protocols were pilot tested by two business managers to identify possible problems like question sequence and wording issues.

As shown in Table 3, seven participants were recruited from the professional networks of the researchers and their colleagues. In the recruitment, gender

balance and generation balance were both considered. The first group of participants (coded as P1, P2, P3, P4, and P5) are five managers from different organizational units of the large government authority. P1 and P5 are users of the current mobile BI, while the other three are non-users. The second group of participants (coded as P6 and P7) are from the vendor who provides the mobile BI to this government authority. P6 is the Vice President responsible for mobile analytics, and P7 is the Global Vice President in BI. They are both top professionals in their areas.

Each interview lasted 20 to 40 minutes and was audio recorded with the interviewee's consent, to help the subsequent interview transcription and analysis. Meanwhile, the researcher took notes and recorded related observations during the interviews. A transcription was taken after each interview to help shape the manager's profile. The data analysis strategy is inspired by Yin (2014) and conducted in four main steps using NVivo: (1) play with the data to find promising patterns; (2) code each interview using nodes based on interview questions; (3) group the nodes according to the theoretical constructs and promising themes; and (4) compare and analyze the data across different interviews. The unit of analysis in this study is defined as the participant of each interview. Most of the interview questions are associated with the key theoretical constructs that in turn shed lights on the analytic priorities and directions.

Result and Discussion

In the light of the collected data and analysis, this section presents and discusses the relevant results to address the research questions about 'why' and 'how' managers use mobile BI. Some additional findings emerging from the analysis are also discussed.

Reasons for Managerial Use of Mobile BI

As shown in Table 2, the performance expectancy (i.e. usefulness) and effort expectancy (i.e. ease of use) are the two key factors that determine users' usage intention and behavior. Also, the TTF model claims, the fit between the characteristics of individuals and the technology, and the fit between the characteristics of tasks and technology form the task-technology fit that determines the individual's use of the technology. In this subsection, we first discuss the mobile BI's usefulness and ease of use perceived by managers. Then the fit between the characteristics of the managers and mobile BI, and the fit between their tasks such as decision-making and mobile BI is discussed, to explore and summarize the main reasons for managerial use of mobile BI.

Usefulness and Ease of Use

The usefulness and ease of use are regarded as the top two reasons for using mobile BI by all the interviewed managers in this study. This finding is not new or unexpected, as usefulness and ease of use have been identified as the key acceptance and use factors for a technology in many previous studies (Shibl et al., 2013; Shin, 2009; Yi et al., 2006; Hou, 2014) in different contexts.

However, it is noteworthy that both the users and non-users of mobile BI in this study have built up a strong case to support the decisive role of usefulness and ease of use. As the mobile BI users, P1 and P5 both decided to use the mobile BI app when they found it useful and easy to use at the first sight, but they actually used it only for a few times after installing it due to the lack of information provided. P1 decided to remove this mobile BI app when she almost ran out of her iPhone storage. On the other hand, the non-users have little interest in adopting the current mobile BI app, as they find little usefulness for it. However, for the future mobile BI, they both expect the upgraded version will be able to provide more useful information and intuitive design for users.

For example, P1 said, "*I couldn't say I've used it much though, I imagine I will find it useful*" and she believes that "*the challenge is to be intuitive and pretty slim (for mobile apps)*". P2 expects the upgraded version of the current mobile BI will have rich capacities.

P3 said, "*If the mobile BI is available with some functionalities, I would use it. Having said that, I do have VPN. I use VPN at home. I guess VPN is very important, which means I can access BI remotely*" and she added, "*nothing is worse than when you look something, then there is no data there.*" She expected "*the design is very simple, but using tools and colour conveying meanings.*" P4 also indicated that she would be more confident to use the mobile BI if it was intuitive and easy to use with the required information.

P5 said, "*I see the potential of mobile BI, particularly for line managers, as it is much simpler to use than web-based version. The simplicity possibly restricts what you can do with it. It is not necessarily related to people's experience using this technology anyway. I think the web-based BI tool is quite complex. It needs training. I have used a lot of reporting tools, but I still have to think about BI.*"

Similarly, the vendor also considers usefulness and ease of use as the two main reasons for the managerial use of mobile BI. Both P6 and P7 stressed that usefulness is the foremost determinant of managers' intention to use mobile BI. Also, they argue that mobile BI has to be intuitive and simple, as most mobile BI users consume analytics rather than produce analytics. Therefore, regarding these two key reasons of using mobile BI, there is no obvious difference between the vendor's view and managers' perceptions.

Characteristics of the Managers and Mobile BI

As shown in Table 3, all the five managers are senior managers in different organizational units. However, they have different management focus and styles in the job. According to Mintzberg (1973), there are three types of managerial roles: information processing, decision-making, and interpersonal.

Although the five managers all process information, make decisions and coordinate with others in their job, each manager has a different role focus in the managerial work. For example, one of the major responsibilities for P4 is to allocate the space resources in the organizational unit she is in charge of. Similarly, P2's daily job also directly relates to directing resources and service delivery, such as the team management and system service. In fact, in response to the question about managerial level, both P2 and P4 believe that they perform many operational tasks due to the nature of the job, while holding a senior position in this organization. By contrast, the other three participants (P1, P3, P5) are more involved in the roles as a leader, figurehead, or liaison. For example, P1 rescheduled the interview time with the researcher because she became extremely busy in the unexpected absence of the Head of Department. In P3's daily job, a major part is liaising and cooperating with external partners. P5 holds a senior position as the actual figurehead for his organizational unit.

As above, all the five managers are senior managers in this government authority while they have different management focuses due to the nature of their jobs. 80% of them (P1, P2, P3, P5) have more than 20 years experience in their working areas. Even the younger P4 also has over 10 years working experience in her field.

In this study, the five interviewed managers have different experience and confidence in using mobile IT. The two users of the current mobile BI both have gained strong confidence in using mobile IT. P1 identifies herself as a strongly confident user of mobile IT and has extensive experience. P5 also feels confident in using mobile IT, and has increasing use experience. They are the early mobile BI adopters with higher computer self-efficacy and more analytical thinking in the case organization. By contrast, the managers like P4 who has less confidence and experience in using mobile IT, normally adopt mobile BI relatively slowly. Mobile BI is a type of mobile IT specialized in decision support. It can be concluded that, in general, the managers with more experience in using mobile IT and analytical thinking are more likely to adopt and use mobile BI.

Characteristics of Managerial Tasks and Mobile BI

As shown in Table 1, there are four key constructs on managerial tasks: time criticality, interdependence, non-routineness, and mobility. 80% of the interviewed managers agree that their jobs are time critical, highly interdependent, non-routine and highly mobile.

Time criticality refers to the level of time flexibility and urgency (Gebauer et al., 2010; Yuan et al., 2010). Aberdeen's research shows that there is less time available to make critical decisions for both strategic and operational managers (Lock, 2015). P1, P3, and P4 strongly agree that time is critical in their job, as in many cases they need to make decisions immediately. P4 gave an example that she often has to figure out a solution for urgent space allocation issues. P1 and P3 both indicated that they are often required to approve some applications with a short notice. The other two managers (P2 and P5) rate time criticality a little lower.

Interdependence means the level of coordination and interaction with other organizational units or external parties (Gebauer et al., 2010). All the five managers indicated they need to work with other organizational units to perform their managerial tasks. P2 strongly agreed that his job is highly interdependent with other organizational units, as his team is committed to deliver technical products and services to all the organizational units of this government authority. P3 and P4 agreed that they work with other units. As mentioned earlier, P3 often liaises with external parties in her job for various projects. P1 and P5 rated the interdependence a little lower, though they also deal with other units or external parties for work.

Non-routineness refers to the variety, difficulty, and unpredictability of the managerial tasks (Gebauer et al., 2010). Only one manager (P5) had a neutral opinion regarding the routineness in his job. It is because his job consists of two distinct parts – one is routine, and the other is non-routine. P1, P3 and P4 all strongly agree that their managerial tasks are non-routine. P3 said, "*I really don't know what will be coming. In terms of project applications, there are about*

75 staff members, and each is working on different projects. You never know what you will work on, so that's quite a variety of tasks. You can have very simple applications or the million dollars tender which is complex." Similarly, P1 said, "*Like now, I can close the door when I have a meeting, but in the rest of time I don't know what is going to happen. That's what I am enjoying my job. It's very challenging.*" P2 rated non-routineness slightly lower than P1, P3, and P4, though he also agreed that his tasks are non-routine, "*Well, we have standard processes. But sometimes there are different tasks coming through. I would agree that there is a little non-routineness. I have quite a lot of task variety, and can be difficult and unpredictable in many ways.*"

Mobility is defined as the frequency that a person is away from the standard office and the variety of locations to perform the tasks (Yuan et al., 2010). Four managers (P1, P2, P3, and P5) indicated that they often work away from their offices where they can access the computers on desks. Only P4 holds a neutral opinion regarding the mobility in job, as she normally works away from office once a week. P1 said, "*I don't travel a lot. I am always here, but I am often on the walk. I am not always on my desk, so that's why I like mobile capacity.*" P2 said, "*I do work away from office a bit. Probably it is about 15% to 20% of the work time. I may not have a lot of meetings traveling, but I work away from my desk quite a lot. Also, I work away from home occasionally, just because it gives me the chance really focus and get something done without being disrupted.*" P3 said, "*I work one day from home, and also one day at another office. I may visit others for interviews for a system or go with a colleague to visit a partner. It could be in the city, going to a gallery to develop collaborations.*" Also, P5 indicated that he is largely in meetings, sometimes at another area of the organization, and occasionally somewhere else.

In the managerial context, mobility is an important motivation for users to adopt an IT tool. According to TTF, if the characteristic of a technology fits the tasks' characteristics, this fit will impact the task holder's use of the technology. In this case, the mobile nature of mobile BI serves the high mobility of the

managerial tasks, which indicates that mobility in managerial work is another reason for managerial use of mobile BI.

The results reveal that the interviewed managers admit the high mobility of their work. The most common example is that most managers have to attend many meetings during a day, which means they cannot just sit at their desks in the office. Some of them also need to travel to other places frequently. For example, P3 who often works in three different places in one week, and P5 travels to other areas of the organization or outside the organization. The nature of management work determines that the managers have to work away from their offices. According to the managerial work characteristics summarized by Mintzberg (1973), much managerial work is at unrelenting pace and most of managers' activities are characterized by brevity, variety, and fragmentation.

When the managers leave their desks in the office, they cannot access their computers to get the information whenever they need. In the past, they could take laptops when they travelled and attended meetings. Even now, some managers still take a laptop to meetings, such as P2 in this study. P2 has a bag in which he puts his laptop, tablet, and notebook when he goes to meet clients out of the office.

However, from vendor's perspective, like P7 said, nowadays managers often bring a tablet rather than a laptop to meeting rooms. Compared with traditional laptops, a tablet is much quicker to start, lighter, and easier to carry (Kautzner et al., 2015). Managers can put a tablet directly into their pocket, instead of taking a briefcase. In some limited conditions such as on a plane, mobile devices like tablets and smartphones provide managers with a more convenient access to the desired information. P6 also believes that it will benefit managerial work if they can access the information whenever and wherever they need. As discussed above, regarding mobility as a motivation of managerial use of mobile BI, the vendor's view is aligned with managers' view and actual use.

As above, mobility is the main motivation for managers' adoption of mobile BI, while the time criticality, interdependence and non-routineness of managerial tasks also promote their use of mobile BI.

Key Patterns of Managerial Use of Mobile BI

In this section, the patterns and insights on the managerial use of mobile BI are discussed, including some emergent findings that go beyond the main research questions but have important implications for the development of mobile BI.

Required Information Level

The interviewed managers were consistent in demanding high-level summarized information from mobile BI to support their decision-making or benefit their conversations with high-level executives. P1 took the personal banking app as an example to explain the financial data she demands in mobile BI, saying, "*If I go to a banking app, I can see my accounts, the headline information, balances on different accounts quickly.*" P3 stressed, "*I would say if you look at the mobile devices, you really should look at the high-level stuff. You may have to turn up your laptop to use the spreadsheet…it is quite difficult to present a large amount of information on such small screen. So my expectation for mobile BI is the high-level data.*" This point of view also points out the different use purposes between the traditional BI and mobile BI. P5 said, "*If the mobile BI gives me high level information and works well, I would use it relatively often. Like you got to be asked 'what is the FTE (Full Time Equivalent) of the whole organization today' or 'how many of them are female' in the conversation with some senior executives. People at my level would not have this information at top of the head. It is good for me to just have a look and get it. When I say quite often, it is still only a couple of times in one month. Just a quick look for some statistics about the organization.*" P4 provides a similar example to P5, while she was asked for the headcount of her department in the meeting, she would find mobile BI very handy to answer this kind of question. P4 also mentioned that if she looked for other things (lower level information), she would come

back to her office and use the PC-based systems.

According to Mintzberg (1973), management jobs are remarkably alike even though managers work in different areas. So it is not surprising that the five managers from different areas of this organization all demand high-level summarized information to support their decision-making. Senior managers do not monitor transactional data, but often need to see the big picture of a department, an organization, or even an industry to make strategic decisions. In this sense, mobile BI can provide support for strategic decision-making. Also, due to the limited size of mobile devices, it is not suitable to bring up too much information on one small screen. Simple and aggregated information can serve the manager's needs when they just want to have a quick look and get that key piece of information in a conversation or a meeting.

Most Used Occasions

"Before or in the meeting" is recognized as the most common use occasion for mobile BI, by both the interviewed managers and the vendor. Attending meetings is a major activity in management. Managers prefer to bring mobile devices such as a mobile tablet to a meeting instead of laptops. They normally also take the mobile phones, like P5 who regard the smartphone as "lifeline". He finds himself using mobile BI "*more in the meeting and commuting*". While on the way to the meeting room or waiting the meeting to start, managers can access the information related to the meeting via mobile BI. This can benefit managers making actionable decisions more quickly.

For example, P3 said she often receives some urgent calls "*just 10 mins before the meetings*" and she "*want[s] to be able to say 'let me put on the mobile speaker. Yeah, he is qualified and I can forward you the report'*". P4 also has the similar experience, saying "*I guess it's about getting information when you are in the middle of something, usually like a meeting. That will be handy.*" In these cases, the access to the key information in mobile BI will enable them to have a quick look at the data and respond.

From the vendor's view, P7 supposes that managers often have a lot of meetings during a day, and they prefer to take mobile devices with them. P6 also indicates that the most common use of mobile BI is on a call or in meetings.

Most Used Functions

The vendor's view is aligned with the manager's actual use regarding the most used functions of mobile BI, including viewing charts/reports, drill-down navigation, data filtering, and alerts. This finding is a little unexpected, but also reasonable. As P6 from the vendor suggests, mobile BI is still at the early stage. It is not very surprising that the vendors are able to align their views with the users' actual needs and use. As mobile BI matures, the user behavior may become more complex and diverse.

P1 considered the viewing reports, real-time data refreshing and drill-down navigation as her most used functions. However, in P2's eyes, real-time data refreshing is not that critical for BI, but he agreed that viewing reports, drill-down and data selection are all basic functions for mobile BI. Besides, P2 highlighted the benefits of alerts in mobile BI, saying, "*In BI, there is lots of information. Alerts can make the job easier. For example, when you check the dashboard and see a flag saying the forecasted cost is 2% more than your budget, you will click into it; otherwise, you don't have to look at it.*" From P3's perspective, the drill-down navigation is useful, as she can drill down for more information if she finds something unexpected. P4 had a similar viewpoint in terms of using drill-down on mobile BI. In addition, P3 mentioned viewing reports and collaborative support functions like forwarding a report in PDF format via mobile BI.

As an experienced BI user, P5 offered insightful comments for these functions. For the alerts, he said, "*Alerts are useful, and also the dashboard is critical. They all bring things to the surface that you need to pay attention to. For example, we don't want to miss the key dates for some important actions. It is doing something for you, like what your priorities are, which is really time saving.*" For drill-down navigation, P5 said "*in*

the context of mobile app, you must be very careful about how much information you bring forwards. It may be too much to display." Also, he suggested that data filtering is very important and basic, and they should be very easy and work for managerial tasks.

Decision-making Process

After understanding what information level is required, where managers use mobile BI the most and what functions they demand, the next question is how mobile BI can impact managerial decision-making. According to Kahneman (2011), there is a dual-process model of human decision-making (i.e. System 1 and System 2), and cognitive biases are a major cause of irrational strategic decision-making: System 1 is fast, effortless, implicit, emotional and slow to learn, such as intuition; System 2 is slow, effortful, explicit, logical, and fast to learn, such as analytic reasoning.

Cognitive biases are more likely to happen in System 1 thinking which relies more on subjective intuition rather than facts and rational reasoning. In this sense, System 2 can moderate or monitor System 1 to reduce biases in decision-making.

In terms of managers' decision-making, managers tend to use System 1 thinking when they have no access to the relevant information for making a decision. However, the System 1 thinking is sometimes unreliable and irrational, which could lead to bad decisions and thus losses for an organization. For example, the decision maker can be overconfident or suffer from memory biases when making a specific decision. With the assistance of mobile BI providing the factual information that the manager needs to make a decision, cognitive biases can be moderated or mitigated through System 2 thinking. For example, P3 could get the relevant data regarding an approval via mobile BI quickly, rather than recalling her impression or memories to respond to the urgent call. As a result, the mobile BI app could help P3 achieve the System 2 thinking in an efficient and effective way.

In short, managers require high-level summarized information from mobile BI, and

their most common use occasion is before or in a meeting. The managers' mobile BI use is mainly aligned with vendor's view. The use of mobile BI can improve managers' decision making, through reducing their cognitive biases. Managers can use 'System 2' evidence from mobile BI to validate 'System 1' decision processes.

Emergent Propositions

On the basis of the above research results and discussion, a number of emergent propositions for future research are identified as below.

Proposition 1: A high level of mobility in work is a motivation for managers to use mobile BI.

Proposition 2: Senior managers require high-level summarized information from mobile BI.

Proposition 3: The most common use of mobile BI is before or in meetings.

Proposition 4: The function of alerts is increasingly popular on mobile BI.

Proposition 5: Mobile BI can improve managers' decision-making, through reducing their cognitive biases. Managers can use 'System 2' evidence with the assistance of mobile BI to validate 'System 1' decision processes.

Proposition 6: Overall, currently there is no significant difference between the vendor's view and managers' actual use of mobile BI.

Conclusion

This paper delivers a preliminary understanding of the managerial use of mobile BI. It investigates the main reasons for managerial adoption of mobile BI and their use patterns. For example, the mobility level at work is an important motivation for managers to use mobile BI. Usefulness and ease of use are two main reasons for managerial use of mobile BI. Senior managers using mobile BI demand high-level information, and the most common use occasion of mobile BI is 'before or in the meetings'. The alerts function is increasingly popular on mobile BI. Furthermore, some

findings have new implications for DSS. For example, mobile BI can improve managers' decision making, by reducing their cognitive biases. Mobile BI enables managers to quickly acquire the factual information when they make decisions. That key piece of information is the evidence to validate the decision process. Also, after comparing the managers' use of mobile BI to the vendor's view, no significant difference is found in this study. This is quite reasonable, considering mobile BI is still at the early stage.

This study contributes to the underexplored area of mobile BI by investigating the managerial use of this new mobile decision support technology from both the managers' and the vendor's perspectives, with theoretical grounds from TTF and UTAUT. This study also posits a series of propositions for future investigation to expand this research topic. Moreover, it contributes to the overall understanding of the role of IS in decision support, and provides a better grounding to guide industry in understanding the business use cases to deliver the mobile BI products that better suit managers' actual needs.

As an exploratory study, there are some limitations with this research. First, due to the small number of interview participants, the findings in this study cannot reliably be applied to wider populations. Nevertheless, all the interview participants are senior managers, and their insights serve as a good foundation for future studies into managerial

use of mobile BI. Second, only one organization was studied. Although this government authority represents similar large-scale decision support cases in many large organizations, there are still some different use cases in other types of organizations and industries. However, it should be noted that care was taken to choose this representative case and interviewees, in order to collect high-quality data that yields more useful insights.

There are a number of possible avenues for future research regarding this research topic. First, this study adopted the case study and semi-structured interviews in the research design. Future research could utilize surveys to collect quantitative data, as mobile BI use grows. Second, the emergent propositions presented above are of significant value for further investigation. Third, the use of mobile BI by middle-level and senior managers demands further studies, to help the industry provide managers at different levels with niche products. Finally, other topics like the continuous use of mobile BI and/or impacts by other emerging technologies on mobile BI are worth investigating.

Acknowledgement

References

Arnott, D. (2010). "Senior executive information behaviors and decision support," *Journal of Decision Systems*, 19(4), pp.465-480.

Arnott, D., and Pervan, G. (2005). "A critical analysis of decision support systems research," *Journal of Information Technology*, 20(2), pp.67-87.

Benbasat, I., Goldstein, D. K., and Mead, M. (1987). "The case research strategy in studies of information systems," *MIS Quarterly,* 11(3), pp.369-386.

Bennett, M. (2015). "The key ingredients for mobile BI success," Retrieved from https://www.forrester.com/report/The+Key+Ingredients+For+Mobile+BI+Success/-/E-RES110501#figure1 on April 28, 2018.

Bi, Q., Zysman, G., and Menkes, H. (2001). "Wireless mobile communications at the start of the 21st century," *IEEE Communications Magazine*, 39(1), pp.110-116.

Bourouis, A., Feham, M., Hossain, M. A., and Zhang, L. (2014). "An intelligent mobile based decision support system for retinal disease diagnosis," *Decision Support Systems*, 59(1), pp.341-350.

Buchana, Y., and Naicker, V. (2014). "The effect of mobile BI on organisational managerial decision-making," *Journal of Applied Business Research*, 30(4), pp.1003-1018.

Chu, Y., and Huang, L. (2005). "Mobile business applications adoption model based on the concepts of task/technology fit," *Proceedings of International Conference on the Services Systems and Services Management 2005*, Shanghai, China.

Dresner Advisory Services. (2015). "Mobile computing/ Mobile business intelligence market study 2015," Retrieved from https://www.tableau.com/sites/default/files/blog/2015_wisdom_of_crowds__mobile_computing__mobile_bi_market_study-_licens....pdf on April 28, 2018.

Gao, S. (2013). "Mobile decision support systems research: A literature analysis," *Journal of Decision Systems*, 22(1), pp.10-27.

Gartner. (2018). Newsroom. Retrieved from http://www.gartner.com/newsroom/archive on April 28, 2018.

Gebauer, J., and Shaw, M.J. (2004). "Success factors and impacts of mobile business applications: Results from a mobile e-procurement study," *International Journal of Electronic Commerce,* 8(3), pp.19-41.

Gebauer, J., Shaw, M. J., and Gribbins, M. L. (2010). "Task-technology fit for mobile information systems," *Journal of Information Technology*, 25(3), pp.259-272.

Goodhue, D. L., and Thompson, R. L. (1995). "Task-technology fit and individual performance," *MIS Quarterly*, 19(2), pp.213-236.

Haghighi, P. D. (2013). "The new era of mobile decision support systems," *Journal of Decision Systems*, 22(1), pp.1-3.

Hou, C. K. (2014). "Exploring the user acceptance of business intelligence systems in Taiwan's electronics industry: Applying the UTAUT model," *International Journal of Internet and Enterprise Management,* 8(3), pp.195-226.

Kahneman, D. (2011). *Thinking, Fast and Slow.* Farrar, Straus and Giroux: New York, USA.

Kautzner, E., Gao, S., Yeoh, W., and Wong, S.F. (2015). "An exploratory study on the factors influencing managers' use of mobile tablets," *Proceedings of the 19th Pacific Asia Conference on Information Systems (PACIS) 2015*, Singapore.

Kotter, J. P. (1999). "What effective general managers really do," *Harvard Business Review*, 77(2), pp.145-155.

Lee, C. C., Cheng, H. K., and Cheng, H. H. (2007). "An empirical study of mobile commerce in insurance industry: Task–technology fit and individual

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differences," *Decision Support Systems*, 43(1), pp.95-110.

Li, K., and Du, T. C. (2012). "Building a targeted mobile advertising system for location-based services," *Decision Support Systems*, 54(1), pp.1-8.

Lock, M. (2015). "Fighting data urgency: Analytics extended to the mobile realm," Retrieved from http://aberdeen.com/research/11491/11491-kb-off-premise-analytics/content.aspx on April 28, 2018.

Mintzberg, H. (1973). *The nature of managerial work.* New York, USA: HarperCollins.

Mintzberg, H. (1990). "The manager's job: Folklore and fact," *Harvard Business Review*, 68(2), pp.163-176.

Moore, J. H., and Chang, M. G. (1980). "Design of decision support systems," *ACM SIGMIS Database*, 12(1-2), pp.8-14.

Nori, M. (2013). "How mobile changes the BI experience," *SAS Global Forum 2013*, Cary, NC.

Parkes, A. (2012). "The effect of task-individual-technology fit on user attitude and performance: An experimental investigation," *Decision Support Systems*, 54(2), pp.997–1009.

Peters, T., Işık, Ö., Tona, O., and Popovič, A. (2016). "How system quality influences mobile BI use: The mediating role of engagement," *International Journal of Information Management,* 36(5), pp.773-783.

Peters, T., Popovič, A., Isik, O., and Weigand, H. (2014). "The role of mobile BI capabilities in mobile BI success," *Proceedings of the 22nd European Conference on Information Systems (ECIS) 2014*, Tel Aviv Israel.

Power, D. J. (2013). "Mobile decision support and business intelligence: An overview," *Journal of Decision Systems*, 22(1), pp.4-9.

Shibl, R., Lawley, M., and Debuse, J. (2013). "Factors influencing decision support

system acceptance," *Decision Support Systems,* 54(2), pp.953-961.

Shin, D. H. (2009). "Towards an understanding of the consumer acceptance of mobile wallet," *Computers in Human Behavior,* 25(6), pp.1343-1354.

Silver, M. S. (1990). "Decision support systems: Directed and nondirected change," *Information Systems Research*, 1(1), pp.47-70.

Sneha, S., and Varshney, U. (2013). "A framework for enabling patient monitoring via mobile ad hoc network," *Decision Support Systems*, 55(1), pp.218-234.

Stanek, S., Namyslo, J., and Drosio, S. (2013). "Developing the functionality of a mobile decision support system," *Journal of Decision Systems*, 22(1), pp.53-68.

Tang, H., Liao, S. S., and Sun, S. X. (2013). "A prediction framework based on contextual data to support mobile personalized marketing," *Decision Support Systems*, 56(1), pp.234-246.

Tona, O., (2015). "Mobile business intelligence usage patterns," *Proceedings of the 21st Americas Conference on Information Systems (AMCIS) 2015*, Puerto Rico.

Tona, O., and Carlsson, S. A. (2013). "The organizing vision of mobile business intelligence," *Proceedings of the 21st European Conference on Information Systems (ECIS) 2013*, Utrecht, Netherlands.

Tona, O., and Carlsson, S. (2014). "The mindfulness and mindlessness in mobile business intelligence adoption," in Strahonja, V., Vrček, N., Plantak Vukovac, D., Barry, C., Lang, M., Linger, H., & Schneider, C. (Eds.), *Information Systems Development: Transforming Organizations and Society through Information Systems (p.8)*, Faculty of Organization and Informatics: Varaždin, Croatia.

Tona, O., and Carlsson, S. (2017). "Enhancing decision-making efficiency

through M-BI use," *Proceedings of the 25th European Conference on Information Systems (ECIS) 2017*, Guimarães, Portugal.

Van der Heijden, H. (2006). "Mobile decision support for in-store purchase decisions," *Decision Support Systems*, 42(2), pp.656-663.

Varshney, U. (2014a). "A model for improving quality of decisions in mobile health," *Decision Support Systems*, 62(1), pp.66-77.

Varshney, U. (2014b). "Mobile health: Four emerging themes of research," *Decision Support Systems*, 66(1), pp.20-35.

Verkooij, K., and Spruit, M. (2013). "Mobile business intelligence: Key considerations for implementations projects," *Journal of Computer Information Systems*, 54(1), pp.23-33.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). "User acceptance of information technology: Toward a unified view," *MIS Quarterly*, 27(3), pp.425-478.

Vishnu, V., Vinny, P., Balaini, N., Modi, M., Radotra, B., and Lal, V. (2017). "Computer algorithm as a supporting tool for clinical decision making on a mobile platform," *Journal of the Neurological Sciences,* 381, pp.751-752.

Xiao, M., Meredith, R., and Gao, S. (2017). "An exploratory study investigating how and why managers use tablets to support managerial decision-making," *Australasian Journal of Information Systems,* 21, pp.1-15.

Yi, M. Y., Jackson, J. D., Park, J. S., and Probst, J. C. (2006). "Understanding information technology acceptance by individual professionals: Toward an integrative view," *Information & Management,* 43(3), pp.350-363.

Yin, R. K. (2014). *Case study research: Design and methods (5th Edition).* SAGE: Los Angeles.

Yuan, Y., Archer, N., Connelly, C.E., and Zheng, W. (2010). "Identifying the ideal fit between mobile work and mobile work support," *Information & Management*, 47(3), pp.125-137.

Appendix 1

Interview Protocol (for users)

Personal basics

Participant name:

1. Gender:

2. Age:
   a.   Under 35 years old *(Gen Y)*
   b.   35 – 50 years old *(Gen X)*
   c.   51 – 69 years old *(Baby Boomers)*

3. Position:

4. Managerial level: (*choose from Card 1*)

Card 1

Senior Manager
Either the head of the business unit or managers who report directly to the head of the business unit.

Middle Manager
Individual who is in an interface position, being managed by more senior managers as well as managing people and resources.

Operations Manager
Responsible for coordinating and directing resources in the business unit, directly related to service delivery.

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5. Length of time on this position:

6. Length of time working in this area:

7. Experience in using mobile IT (e.g. applications on mobile devices):
   a.   Early stage
   b.   Increasing experiences
   c.   Rich and high-level experience

Please use this scale below to respond to questions 8-16:

   1   *Strongly disagree*
   2   *Disagree*
   3   *Somewhat disagree*
   4   *Neither agree or disagree*
   5   *Somewhat agree*
   6   *Agree*
   7   *Strongly agree*

8. Confidence in using mobile IT (e.g. applications on mobile devices):

Work & mobile BI

9. Time flexibility and urgency is critical for my job:

10. Tasks in my job are often related to other organizational units:

11. The level of non-routineness (task variety, difficulty and unpredictability) in my job is high:

12. I often work away from my office and perform the tasks in various locations:

If you have used mobile BI, please respond to the following four statements 13-16:

13. I find using mobile BI helpful for my job:

14. I find the mobile BI system is easy to use:

15. Others' opinions on using mobile BI are important for me to adopt it:

16. I find the organization and its technical infrastructure able to support my use of the mobile BI system:

17. Does the organization encourage you to use mobile BI?

Use of mobile BI

(For questions 18-27, question number with (a) is for users, and (b) is for non-users)

18(a). What is the kind of mobile BI you are using for work?

18(b). Do you know the mobile BI is available in the organization?

19(a). Why do you decide to use this mobile BI?

19(b). Do any of your colleagues use mobile BI?

20(a). How often do you use this mobile BI? Normally, how much time do you use this mobile BI per task/day/week/month?

20(b). If you know the mobile BI is available now, why you don't want to use it?

21(a). Where do you often use mobile BI? (e.g. meeting room, office, commuting)

22(a). What devices do you use for mobile BI? (e.g. smartphones, tablets)

23(a). What tasks do you perform using mobile BI?

24(a). Could you please list three functions you use most? (*See examples in Card 2*)

24(b). What functions/features (*see examples in Card 2*) **do you want or suggest for this mobile BI to support your tasks? What are these tasks?**

Card 2

o Alerts
o Augmented reality
o Collaborative support for group-based analysis
o Dashboard assembly from components
o Data selection; filtering
o Drag-and-drop navigation
o Drill-down navigation
o Guided analysis
o KPI monitoring
o Off-line access
o Real-time data refresh
o Social media analysis (Social BI)
o View charts/reports
o Write-back/transactional integration

Other desired functions not in the list:

25(a). How do you think of this mobile BI? (e.g. interface design, process and battery performance, storage capacity, ongoing maintenance and updates)

25(b). What are your expectations for mobile BI? (e.g. interface design, process and battery performance, storage capacity, ongoing maintenance and updates)

26(a). How do you think of the network connection availability, bandwidth and stability for using mobile BI?

26(b). How do you expect the network connection availability, bandwidth and stability for using mobile BI?

27(a). Do you have any suggestions or expectations for the future mobile BI?

27(b). Do you think you will use mobile BI (if provided) in future?

Appendix 2

Interview Protocol (for the vendor)

1. In your opinion, why do managers use mobile BI?
- o Voluntariness of use *(i.e. mandatory to voluntary)*
- o Ease of use
- o Usefulness
- o Level of mobility in the managerial work *(i.e. working away from offices or at various places)*
- o Time criticality of the work *(i.e. flexibility or urgency)*
- o Interdependence *(i.e. working with other tasks/units)*
- o Non-routineness of the work *(i.e. task variety, difficulty and unpredictability)*
- o Social Influence *(i.e. importance of others' opinions of using mobile BI)*
- o Organizational and technical support
- o *Other reasons or motivations*:

2. Do you have any idea of how people actually use mobile BI?
- o Who are your target users of mobile BI?
- o Is mobile BI only the extension of the BI on PC?
- o Are there any *age* or *gender* differences of your target users in adopting and using mobile BI?
- o Where do they use mobile BI? *(e.g. meeting room, office, commuting)*
- o What devices do they use for mobile BI?
- o What types of tasks do they perform using mobile BI?
- o Could you please list 3 main functions you suppose the users use most?

3. What do you think the future of mobile BI?
- o Will mobile BI be dominant in future?
- o Do you see any trends about mobile BI?

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