MOBILE BUSINESS INTELLIGENCE: KEY CONSIDERATIONS FOR IMPLEMENTATIONS PROJECTS

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ABSTRACT

The new generation of mobile devices, such as smartphones and tablets, is enabling employees to access business insights anytime, anywhere. This trend in Business Intelligence (BI) is popularized under the term mobile BI. Various studies indicate a strong increase in the adoption of this technology. However, mobile BI implementations remain unexplored and unsupported by implementation methods. By devising a Mobile BI Implementation (MOBII) framework, this study aims to fill in this research gap. A systematic literature review revealed the following major implementation themes: (1) value creation, (2) application deployment, (3) information security, (4) workforce mobilization, (5) information delivery and (6) device management. Moreover, expert interviews revealed twenty key considerations, which are also included in the framework. Using a single case study the MOBII framework was successfully evaluated and its practical applicability was demonstrated by adapting an actively used BI implementation method.

KEYWORDS: business intelligence, mobile business applications, implementation methods

INTRODUCTION:
TOWARDS IMPLEMENTING MOBILE BI

Business Intelligence (BI) solutions deliver employees accurate and useful business insights in order to support effective decision-making [29]. Traditional BI solutions deliver these business insights, like performance scorecards, via web-based portals or desktop applications to employees. Hence, it allows employees to make fact-based decisions when having access to their desktops or laptops [47]. However, business decisions are made continuously and no matter the location [12]. The new generation of mobile devices (especially smartphones and tablets) enable software vendors to align BI with the anytime, anywhere nature of decision-making [26]. This way of delivering the BI service is popularized under the term 'mobile BI'. Recent surveys indicate a strong trend of organizations willing to adopt mobile BI in the near future (see [6], [43], [8]). This study defines mobile BI as:

> *"The capability that enables the mobile workforce to gain business insights through information analysis using applications optimized for mobile devices."*

Definition: Mobile Business Intelligence

Adoptions of Information Systems (IS) are realized by executing implementation projects. Various software vendors claim that mobile BI implementation projects are rather straightforward and simplistic processes. For example, the state-ment 'build once, deploy anywhere' is often used in promotional material. However, this only concerns the development aspect of the implementation and not any other managerial aspects. In order to avoid project failure, implementation methods are developed to support project managers in managing BI adoptions effectively (for example the BI roadmap [34] or the Business Dimensional Lifecycle [25]). Such implementation methods provide a stepwise description of activities, deliverables and key considerations. Key considerations describe the most important aspects that a project manager should take into account for the realization of an effective BI solution. However, because the implementation projects of mobile BI remain relatively unexplored, no implementation method is yet capable to support project managers who are facing a mobile BI implementation. One could state that a 'mobile BI ready' implementation method is currently lacking in literature.

This is a critical issue as the quality of the implementation approach determines the success of technology adoption [52]. Basole [4] adds that solely adopting mobile solutions does not lead to actual benefits for businesses; a tailored implementation method is required to realize these benefits.

In order to address these issues, this study aims to propose a mobile BI implementation (MOBII) framework. The framework will address the current issues by representing the major implications of mobile BI implementations. As such, it will allow the adaptation of traditional implementation methods. Moreover, the framework will support project managers directly by providing them with a high-level overview of all key considerations to oversee the mobile BI implementation. While the scientific contribution of this study can be ascribed to the theoretical and empirical exploration of mobile BI implementations, the final deliverable makes this study of practical relevance.

This study adopts the design science approach in order to devise the MOBII framework. It uses primarily qualitative research techniques to accomplish this. The following section will provide more detail on the operationalization of the research method and its rationale. Section 3 and 4 discuss the results of the research activities. Section 5 provides a description of the final MOBII framework, which will be evaluated in section 6. The framework application and evaluation is presented in section 7 and 8. The conclusion, limitations and implications will be discussed in section 9.

DESIGN:
A FOUR-STEP RESEARCH APPROACH

Design Science aims at solving practical issues by developing so-called artifacts (such as methods or frameworks) [23]. This approach was adopted because it is strongly aligned with the objective of this study (to develop a MOBII framework to support project managers and stimulate effective mobile BI

implementations). In operational terms, this study follows a four-step approach in an effort to address the research objective. First step is a literature review, followed by expert interview and a case evaluation and finally a practical demonstration.

Literature review

Hevner et al. [23] state that evaluating prior research provides a fundamental starting point for the development of design science artifacts. Hence, a logical first step was to conduct a Systematic Literature Review (SLR). Okoli and Schabram [36] developed a guide to conduct a SLR in the IS research domain. The aim of the SLR was to identify the major implementation themes of mobile BI. Because little scientific literature is available on the topic of mobile BI, this review also had to draw upon the closely related topic of 'mobile business applications'. The first fifty search results retrieved from Google Scholar were considered in the SLR; subsequently the title and abstract of the resulting articles were reviewed. Articles that passed all of the SLR steps were analyzed in order to identify the implementation themes that were described by them. One criterion for the identification of a theme was that it had to be discussed by at least four scientific articles.

Expert interviews

The implementation themes found in literature provided a good starting point for a more detailed analysis (the identification of key considerations). For this second step, two approaches were considered: a qualitative and quantitative approach. When a research domain is still relatively unexplored, such as the mobile BI domain, a qualitative approach is favored [24] because it is more open and receptive to new and unexpected information. More specifically, expert interviews were used for this step because it allows the generation of a theory about phenomena by capturing both process knowledge and context knowledge [32]. Moreover, experts represent a wider group of people and thus enable the researcher to capture comprehensive information within a short period using limited resources [19].

The expert selection was based upon two selection criteria. First, experts should have effective knowledge on BI. Second, they should be actively involved in mobile initiatives. Having this experience would allow experts to make sound judgments on the convergence of these two disciplines. During the interviews, experts were asked to name the most important aspects of mobile BI implementations per major implementation theme. This approach was chosen in order to elicit the top-of-the-mind aspects and avoiding choice bias [27]. The interview content was analyzed by grouping the closely related statements per implementation theme. A minimum of three experts needed to refer to a particular consideration in order to be included in the MOBII framework. The rationale behind this threshold was that it would exclude very specific considerations, but keep enough detail to keep the results meaningful.

Case evaluation

Both the implementation themes and key considerations were incorporated into the MOBII framework. Vaishnavi and Kuechler [48] state that the final research artifact has to be evaluated once it has been constructed. In the third step, this evaluation was conducted by comparing the MOBII framework to a real life implementation case. A case study approach is eligible because the MOBII framework is based on a contemporary phenomenon and focuses on managerial and organizational issues [35]. The approach for conducting a descriptive case study was adopted from Yin [21]. More specifically, a disconfirmatory [5] case study setting was chosen, as this allows the use of a single case while safeguarding external validity.

To overcome the remaining threats to validity several case study tactics were adopted from Yin [21]. First, to safeguard construct validity, the case study report was reviewed by the key informants and the key concepts were agreed upon at the start of each interview. Internal validity was safeguarded by analyzing multiple sources of evidence. Finally, a case study protocol was developed to ensure reliability.

To achieve a convincing disconfirmation it is essential to select a typical case (a single case that is representative of a large number of other cases) [54] with a high probability of confirming the theory. A "*theory that can be shown to fail in a setting where it is most likely to hold can be quite decisively disconfirmed*" [31]. To adhere to this criterion the following three selection criteria were set. First, the mobile BI implementation should embrace software from a popular mobile BI vendor. This will exclude the cases with custom build software that will likely be atypical. Second, the case company should already have a traditional BI solution in place. This implies that the mobile BI implementation is probably an enhancement project and less likely a redefinition. Third, an external partner should execute the mobile BI implementation. Such partners have established best practices and extensive experience with these projects. Another criterion was that the case study had to have a retrospective nature. This latter criterion allows the researcher to gain an in-depth understanding of a case in which the researcher has little control [56]. Additionally, this allowed the investigation of a lengthy process in a relatively short period of time [49].

Practical demonstration

The main purpose of the fourth and last step was to demonstrate the utility, quality, and efficacy of the research artifact, as required by Hevner et al. [23]. Because the MOBII framework aims to extend the scope of traditional BI implementation methods, this had to be demonstrated in practice. The organization Deloitte Consulting BV provided an actively used BI implementation method, called the Enterprise Information Management (EIM) method. The demonstration was operationalized by adapting the EIM method in order to include support for mobile BI. A second round of practitioner interviews was used to assess the completeness and correctness of the adapted EIM method and to assess the MOBII framework itself. Practitioners that conformed to the target group of framework were used for this final round evaluation interviews.

RESULTS: MAJOR IMPLEMENTATION THEMES IN MOBILE BI

This section presents the findings of the first research activity. As stated in section 2.1 a SLR in the domains of mobile business applications and mobile BI was conducted in order to identify the major implementation themes. Table 1 lists the number of articles that passed the subsequent steps of the SLR. The table shows that 26 of the 87 considered articles were used for the identification of the implementation themes.

The first column of table 2 lists the six implementation themes found in the relevant literature. These implementation themes were not explicitly referred to, but were found by interpretation of the researcher. Each of them is discussed by at least four scientific articles, which are presented in the second and third column of table 2.

The following paragraphs will provide background on the implementation themes listed in table 2.

TABLE 1: The Systematic Literature Review (SLR) pipeline in this research

	Mobile business applications	*Mobile BI*
Considered	50 (of 1390 search results)	37 (of 37 search results)
Left after title review	27 (-23)	24 (-13)
Left after abstract review	19 (-8)	18 (-6)
Accessible	16 (-3)	14 (-4)
Retrieved from author	16 (+0)	15 (+1)
Relevant and used	14 (-2)	12 (-3)

TABLE 2: Categorization of literature

	Mobile business applications	*Mobile BI*
Value creation	[3] [10]	[15] [42]
Application deployment	[11] [21] [13]	[1] [37]
Information security	[22] [47] [51]	[39] [1] [38] [28]
Workforce mobilization	[20] [4] [47] [40] [46]	[15] [53]
Content delivery	[14]	[42] [37] [16] [26] [17]
Device management	[41] [11] [47]	[45]

Theme: Value creation

A broadly discussed implementation matter is how mobile business applications like mobile BI create business value. Yet, the tangible and intangible benefits of mobile business applications remain poorly understood and relatively unexplored [3]. Various attempts have been made to identify the contributions of mobile business applications [15]. In Basole's [3] effort to understand value opportunities of mobile business applications, found that adopting this generally leads to the following six benefits.

One benefit is the improved access capabilities, which refers to the ability of employees to connect anytime and anywhere to the company's back-end systems. Another benefit is cost savings; this can be achieved by enrolling mobile devices instead of expensive workstations to employees. Additionally, accuracy will be higher, as end-users will type data directly into the device instead of via paper. Moreover, productivity will be increased, as better access allows end-users to respond faster and provide more accurate and up to date information. Another benefit is the increased organizational responsiveness, as truly mobile organizations have the ability to react faster on market conditions because information is provided instantly. Finally, more control can be gained by having access to the status and whereabouts of the full workforce and processes. With respect to the organizational responsiveness aspect, Chen and Nath [10] claim that the business value increases when data is more time sensitive and when the user more mobile. This is also supported by [42].

Theme: Application deployment

Another important implementation theme is the way in which mobile BI applications can be deployed. Mobile BI vendors have developed various kinds of deployment frameworks to deliver mobile BI solutions. The main reason for this is the incompatibility between the various mobile operating systems and desktop operating systems [1]. Mobile BI vendors provide frameworks that range from native mobile application configurators (for example MicroStrategy) to rendering components for mobile web reporting (for example Qlikview) [44]. Additionally, vendors also differ in which deployment method they support per operating system. Some vendors are committed to a web only offering for all mobile operating systems, while other vendors aim to support most mobile operating systems natively.

Dresner's [18] survey study reveals that most vendors support a native deployment for Apple's iOS and Google's Android, while for RIM's Blackberry and Microsoft's Windows Mobile a web deployment is provided the most. Hence, it is evident that there is no consensus among BI vendors about the most suitable method. Rasmussen et al. [37] provides more detail on pros and cons of the two main deployments. He states that native applications tend to be very responsive. Moreover, they have access to the specific hardware features on the mobile device (for example GPS, push-notifications, camera, accelerometer, etc.). Particularly relevant for mobile BI is the capability to store data locally. This enables users to have offline access to their cached BI reports.

With respect to web applications, Clevenger [11] states that, while traditional websites can be viewed on mobile devices it is important to acknowledge that mobile devices are fundamentally different from stationary workstations. The user experience of traditional websites should be improved and designed with the mobile user in mind. Most web applications leverage HTML and CSS technology to optimize the mobile user experience. The biggest advantage of web applications is that they are compatible with all mobile web browsers. This reduces the cost for the deployment, which is especially relevant for BI vendors who do not need to build a dedicated framework for each mobile operating system. However, a web application requires a permanent internet connection and web applications do not have access to all specific hardware features on the mobile device.

There is also a hybrid approach to deploy mobile applications. This technique can have two forms. Web applications that utilize HTML5 to use the native hardware features or native applications that use the web protocol to display content. For the former, HTML5 enables developers to build platform independent applications, which reduces the required development effort [13]. However, the HTML5 standard is not yet widely adopted. Especially, more advanced capabilities such as offline access, multimedia, and security are currently incompatible with all mobile operating systems.

Theme: Information security

Securing information that is processed by mobile BI solutions is the third major implementation theme. This is the case because the introduction of mobile business applications and mobile devices add to the already complex security needs of organizations [47]. The computing power available in mobile devices today introduces security threats on all three information security dimensions: confidentiality, integrity, and availability. Specifically for mobile BI, information security is a widely discussed theme. Haller et al. [22] state that information security becomes crucial when confidential information is retrieved outside the firewall(s) of an organization. Because mobile BI, typically, accesses sensitive information from outside the premises [39] makes information security a real concern [1].

The four most occurring examples of direct information security threats are: a mobile device is stolen or lost, confidential data is transferred via a compromised wireless hub, the application on the mobile devices is compromised and mobile BI servers exposed to the internet are subject to existing web-threats. Kuntze et al. [28] devoted a full study to the information security aspect of mobile BI and state that an attacker may have two goals for an attack: To gain unauthorized access to company data (industrial espionage) or to manipulate BI data (sabotage). Hence, it is neither advisable nor feasible to make all BI content mobile [38].

Mobile devices, as opposed to traditional workstations, introduce multiple distinct security aspects. The high chance of theft or loss requires that direct physical attack vectors must be considered. Additionally, mobile devices can operate in hostile environments in which even the end-user cannot be considered trustworthy (in the case were a malicious user is operating it). An additional constraint is that different stakeholders (including network operators, service providers) have influence on the operations of the device. Kuntze et al. [28] provides nine non-exhaustive but common attack scenarios for mobile BI applications. He also introduces a set of rules that must be introduced in order to address these security treats. However, these scenarios are based on native deployments, whereas Unhelkar [47] states that, each distinct type of mobile deployment has unique security characteristics. Another important aspect is that current enterprise IT infrastructures are protected with perimeter security models. This implies that the network is protected from perpetrators by using firewalls and intrusion detection solutions. Walter et al. [51] states that the perimeter model is not adequate for securing mobile business applications. Mobile business applications require application-level security mechanisms.

Theme: Workforce mobilization

Mobilizing the workforce in a suitable manner is the fourth implementation theme. Offices where mobile knowledge workers only visit on occasion, is actually closer to reality than generally thought [47]. Currently, most BI solutions do not support the mobile workforce that performs activities while moving on and off the premises [15]. Not supporting this group is an issue for organizations that have specialists and executives, which are mobile on or outside the premises [46].

Extending the work of Zetie [57], Basole [4] provides seven typical profiles of employees and their degree of mobility. Site wanderers and road warriors have the lowest percentage of time at their desk; however, they are not the primary target group for mobile BI. Simon [40] states mobile BI initiatives start typically at the executive level because their time is the most valuable. The

survey study of Dresner [18] confirms this; he states that this is the case because this group will create executive commitment for a wider mobile BI implementation. Another important aspect is that while technology enables the distribution of information, the users themselves need to integrate it into their work processes [53]. Therefore, only the right set of users will provide the greatest value [20].

Theme: Information delivery

The information delivery aspect of mobile BI is fifth major implementation matter. Stipić and Bronzin [42] state that mobile and traditional BI applications have access to the same information, but strongly differ in how and what information they should present. Mobile devices have two major constraints that play a role in information delivery. The first constraint is that the screen real estate of mobile devices does not allow the same amount of information to be displayed effectively. Second, a mouse is absent; this inhibits the end-user from accurate and quick scrolling through large quantities of information.

Instead, mobile BI should focus on the presentation of key information in a visually attractive manner. Rasmussen et al. [37] state that mobile dashboards have to be developed using ingenious ways to deliver the same intelligent information on a smaller screen size. Moreover, dashboards should be transformed to mobile devices selectively. Dashboards that include multiple independent components will be easier to redesign for small screen sizes than dashboards that include dependent components. Diallo et al. [16] state that in order to give the mobile workforce adequate support, a fully context aware mobile BI solution is required. De Heer et al. [14] further elaborate upon the context awareness of mobile business applications. They state that context is very relevant for mobile business applications because it continuously changes for a mobile user. Current mobile business applications predominantly use spatial information (location) to make the content more relevant.

Theme: Device management

Managing mobile devices is required for the use of mobile business applications is therefore the last implementation theme. When organizations embrace mobile business applications, they increase their reliance on mobile devices. Hence, it becomes essential to ensure the productivity of those devices [30].

Expanding existing management services to include mobile device is not an easy task [7]. One constraint is that the IT organization has a need to manage mobile devices in a unified way [41]. Moreover, it can take significant time for the IT organization to be ready to deliver the mobile business applications [47]. Standardization of mobile devices can be a main advantage because it typically yields low cost for deployment, maintenance, support, and administration. Unhelkar [47] even claims that any effective mobile business strategy embraces standardization. A logical question for these strategies is "*Which devices should we support?*"[33]. Contradictory to pursuing standardization, is the trend of letting employees bring their own device (BYOD). This diminishes the need for the IT organization to certify and procure mobile devices. Instead, the IT organizations must create a sustainable framework for the development of mobile business applications and should adopt tools like mobile device management (MDM) to keep some visibility and control [11]. Moreover, BYOD policies need to be established in order to govern

the use of mobile devices and to communicate the guidelines for acceptable use, responsibilities, and penalties [2]. According to Weldon [55], MDM solutions are key enablers for the adoption of mobile devices in the organization. Trivedi and Unhelkar [45] state that devices supported by MDM solutions can be used for key processes, including decision support, because they ensure the performance and security of mobile devices.

RESULTS: KEY CONSIDERATIONS IN MOBILE BI IMPLEMENTATIONS

Because the implementation themes presented in the former section are partially based on the more general 'mobile business application' domain, it is not valid to make direct inferences for the specific domain of mobile BI. However, the implementation themes provide a good starting point for subsequent expert interviews, which were used to elicit the key considerations typical to mobile BI implementations. Table 3 lists the seven experts who were interviewed in this study because they adhered to the selection criteria defined in section 2.

The following paragraphs formulate the synthesis of related expert statements, which were found per theme. A requirement for a consideration to be included in the MOBII framework was that the considerations had to be important and typical for mobile BI implementations. The tasks and phases (included in the BI roadmap [34]) for which the considerations are the most relevant will be described. Each considerations is coded with a CN notation, the experts are coded with EN as listed in Table 3.

Value creation considerations

With respect to the value creation theme, a key consideration elicited during the expert interviews was that, mobile BI increases the efficiency and effectiveness of mobile processes (C1). Experts evidently state that employees who have access to supportive information anytime, anywhere can work more efficiently and effectively (E1; E3; E4; E6). In addition, it was identified that mobile BI increases employee satisfaction (C2). Experts stated that the ease of use and relevance ensures mobile initiatives are welcomed by employees (E2; E5; E6). Furthermore, mobile BI increases customer satisfaction (C3). According to experts, this is particularly noticeable in customer facing processes such as sales, because it allows on-the-fly support and quick and accurate

decisions (E1; E3; E5). Moreover, mobile BI increases the organizational responsiveness (C4). By leveraging sensitive data, mobile BI can enable a more responsive organization. However, experts state that this benefit is definitely not always present (E1; E3; E5). Additionally, mobile BI can be deployed as a competitive differentiator (C5). Experts acknowledge that mobile BI allows companies to differentiate towards employees/customers/markets (E1; E2; E5). Currently, the need for a quantified business case is suppressed by the hype surrounding mobile BI (C6). This is consideration is supported by but not included in the framework because the experts also state that the hype will soon make way for more rational adoption decisions. All value creation considerations are relevant for the business case assessment task within the justification phase.

Application deployment consideration

With respect to the application deployment theme, there was a strong indication that compatibility with traditional BI solutions is leading for the selection of the mobile BI vendor (C7). Experts do not think that a traditional BI vendor will be set aside quickly, just for the benefit of mobile BI vendor support due to the financial implications (E1; E3; E4). Second, web deployments are considered the most efficient (C8). Such deployments allow organizations rapidly and costs effectively deploy mobile BI to a broad audience (E3; E5; E6). Finally, the native mobile BI deployment is favored from an end-user perspective for now (C9). The high usability standard and advanced capabilities of the native approach are very appealing to end-users (E1; E2; E4; E5; E6). Using advanced HTML5 capabilities in mobile BI applications is still too immature (C10). While this is supported by expert, this consideration is mainly relevant for software vendors who deliver the deployment frameworks. Hence, this consideration is not included in the framework.

The application deployment considerations are particularly relevant for the enterprise infrastructure evaluation task within the planning phase.

Information security consideration

The expert interviews revealed that, information security is the biggest risk in mobile BI projects (C11). Experts' state that this is so important for mobile BI that is the first hurdle of any

TABLE 3: Expert profiles regarding the elicitation of the considerations specific to mobile BI

No.	Role	Type of branch	Knowledge/Experience
E1	Senior manager BI	Technology consultancy	More than 10 years of experience in BI and member of a mobile BI community.
E2	Project manager	Mobile development	Multiple years of experience as a project manager for mobile development projects.
E3	Mobile BI consultant	Technology consultancy	Extensive experience with mobile BI implementations in multiple organizations.
E4	Strategic Product Manager	Supply chain Solutions	Experience with the operationalization of mobile strategies, especially mobile CRM and mobile ERP
E5	Chief Research Officer	BI consultancy	Authority in BI with extensive expertise on the mobile BI market.
E6	Innovation consultant	IT services	Initiator of the enterprise mobility initiative within his company
E7	Senior consultant	Risk consultancy	Multiple years of experience as mobile security consultant

implementation project (E2; E3; E5; E6) and should therefore be covered in the business case assessment. Second considerations is that the most important security measure is to cache or store as little BI data on mobile devices as possible (C12). Experts evidently agree that putting as little sensitive information as possible on the device mitigates most information security risks (E1; E2; E4; E5; E6; E7). However, this security requirement can affect functional requirements and is therefore relevant during in the business analysis task. Finally, creating security awareness among mobile BI end-users is key to mitigate information security risks (C13). Expert state that having security protocols and procedures is only effective when the end-users know why they are important and how and when they should initiate them (E1; E3; E7). Designing these protocols is typically relevant during the design and deploy phase.

Workforce mobilization consideration

With respect to the workforce mobilization theme, it was found that mobile BI should be rolled top-down in an organization (C14). Experts state this is typically where it should start because the people at the top of the organizational hierarchy can act as project sponsors and would benefit the most since their time is the most expensive (E1; E3; E5). In addition, it is less feasible to deploy mobile BI for operational workers (C15). Mobile devices, generally, considered too expensive and fragile for employees working in these operational positions and here they typically do not deliver a fast return on investment (E3; E4; E5).Therefore it is key to identify the appropriate stakeholders during the business analysis interviews.

Information delivery consideration

The first consideration for the information delivery theme is that mobile BI users require information that is more relevant for their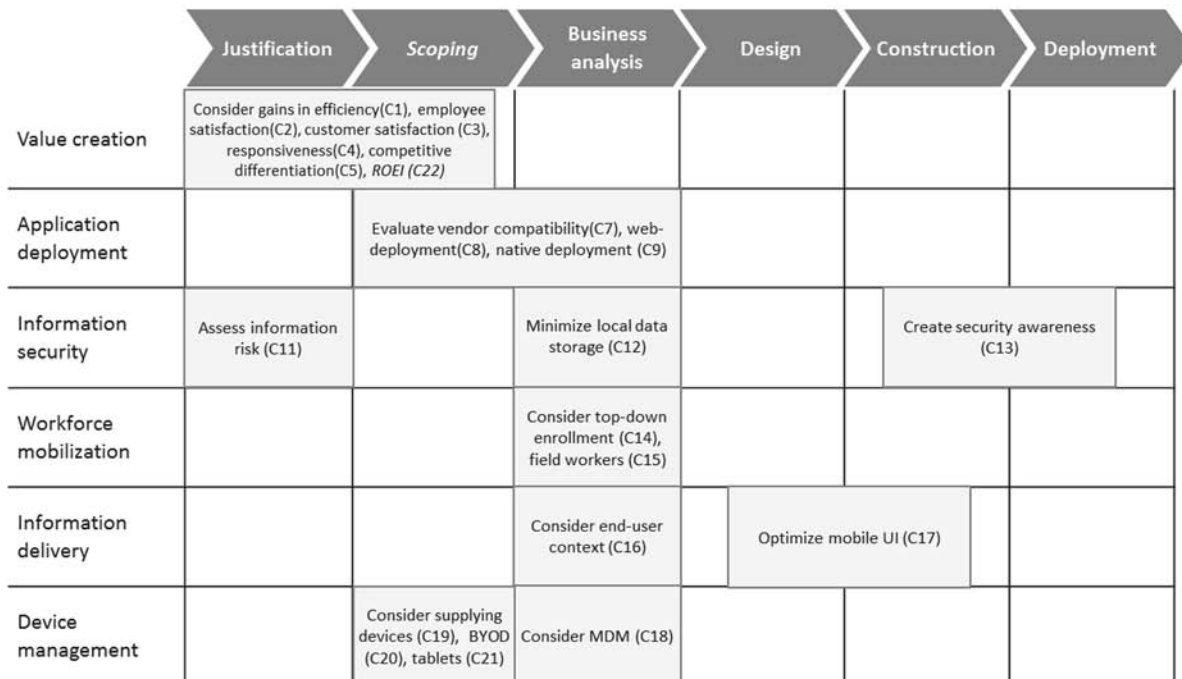 context (C16). The information need of mobile users is different because of both device restrictions and the context of the end-user (E1; E3; E5; E6). This aspect should be considered during the requirements interviews in the business analysis. In addition, the user interface and navigation design of traditional BI applications should be redefined for mobile usage (C17) particularly, due to the hardware particularities of mobile devices (E1; E3; E4; E5). This aspect becomes important during the design and construction phase of the mobile BI implementations.

Device management consideration

The expert interviews revealed that with respect to device management, offline access to mobile BI reports requires the use of MDM software (C18). Experts state that when a mobile device stores information belonging to an organization, it requires managing and protecting the information (E1; E6; E7). This requirement should be taken into account during the business analysis. Second, the most straightforward mobile BI deployment is on company-supplied devices (C19). Standardization gives the organization more control and requires less effort (E3; E6; E5). Alternatively, projects have to deal with the BYOD phenomenon (C20). Although, standardization is preferred, the current reality in organizations is that employees bring their own devices. This cannot be neglected and should be managed (E1; E3; E7). Finally, tablets are the most favorable device for mobile BI (C21). The screen size of tablet devices is perfect for data exploration, whereas a smartphone is considered too small for most purposes (E1; E3; E5; E6). Note that the latter three considerations are particularly relevant for the enterprise infrastructure evaluation in the planning phase, because in this step the as is situation is assessed.

DELIVERABLE: THE MOBII FRAMEWORK

Figure 1 depicts the final artifact of this study, the MOBII framework. It depicts a high-level overview of results of this

	Justification	Scoping	Business analysis	Design	Construction	Deployment
Value creation	Consider gains in efficiency(C1), employee satisfaction(C2), customer satisfaction (C3), responsiveness(C4), competitive differentiation(C5), ROEI (C22)					
Application deployment		Evaluate vendor compatibility(C7), web-deployment(C8), native deployment (C9)				
Information security	Assess information risk (C11)		Minimize local data storage (C12)		Create security awareness (C13)	
Workforce mobilization			Consider top-down enrollment (C14), field workers (C15)			
Information delivery			Consider end-user context (C16)	Optimize mobile UI (C17)		
Device management		Consider supplying devices (C19), BYOD (C20), tablets (C21)	Consider MDM (C18)			

FIGURE 1: The Mobile Business Intelligence Implementation (MOBII) framework

study as described in sections 3 and 4. More specifically, the vertical dimension depicts the implementation themes identified during the literature study. In addition, the cells in the MOBII framework include short referrals to the key considerations found during the expert interviews. The horizontal dimension represents the subsequent phases of BI implementation projects. More specifically, the phasing of the BI roadmap by Moss and Atre [34] was adopted for this. Mainly because the BI roadmap compared to other methods provides a high-level overview, which is applicable for this framework. The key considerations are allocated to the phases for which they are the most relevant.

As described in the introduction, the objective of devising the MOBII framework is twofold. First, it aims to provide project managers who are facing mobile BI implementations a high-level overview of the most important implications. This should support them in overseeing such projects. Secondly, the MOBII framework content should be used to adapt traditional BI implementation methods that are not 'mobile BI ready'. The adequateness in which the MOBII framework addresses these objectives will be evaluated in section 7 and 8. First, the key considerations included in this framework will be evaluated in a real life case.

EVALUATION:
A MOBILE BI IMPLEMENTATION IN PRACTICE

As defined in chapter 2, a case study was conducted in order to evaluate the MOBII framework. A Dutch mortgage advisory company was selected for this purpose.

The company established over 100 mortgage shops in the Netherlands and the headquarters is staffed with about 40 FTE. One or more managers who may have some staff employed run each individual shop. The company recently completed a successful mobile BI implementation and was willing to cooperate with this study. With respect to the case study selection criteria, the company adopted the mobile BI software of Qlikview, which

is a popular (mobile) BI vendor. It also had a traditional Qlikview BI solution in place prior to the initiation of the mobile BI project. Moreover, an external implementation partner executed the implementation. As such, all case selection criteria were met. The case study information was gathered by interviewing the responsible project manager. To ensure construct validity, during the interviews, the purpose of the interview was clearly communicated and the key concepts were elucidated. By also analyzing the delivered mobile BI application and other evidence such as videos and websites related to the project, the treats to internal validity were mitigated.

Before the initiation of the mobile BI implementation, the established traditional BI solution allowed the companies staff to get updates on the aggregated business performance, consumer behavior and market conditions. The BI solution integrates six internal (including a CRM system) as well as external (including the land register) data sources to provide these business insights. The shop managers were informed about their status towards the business objectives during bi-monthly performance meetings at the company headquarters. In the envisaged situation, the shop managers would have an iPad that would allow them to get these business insights anytime, anywhere.

By discussing the implementation project with the project manager in a chronological structure it became apparent that all of the key considerations included in the MOBII framework were also major aspects that where faced by the project manager in this case. Two additional key considerations were explicitly articulated.

First, increasing the penetration rate of BI was a key aspect for the business justification. It allowed the organization to leverage the investment of the traditional BI solution. As such, one could label this a return on existing investment (ROEI) [9]. Hence, the following key consideration was added to the framework: Mobile BI delivers a ROEI by increasing the penetration rate of BI (C22).
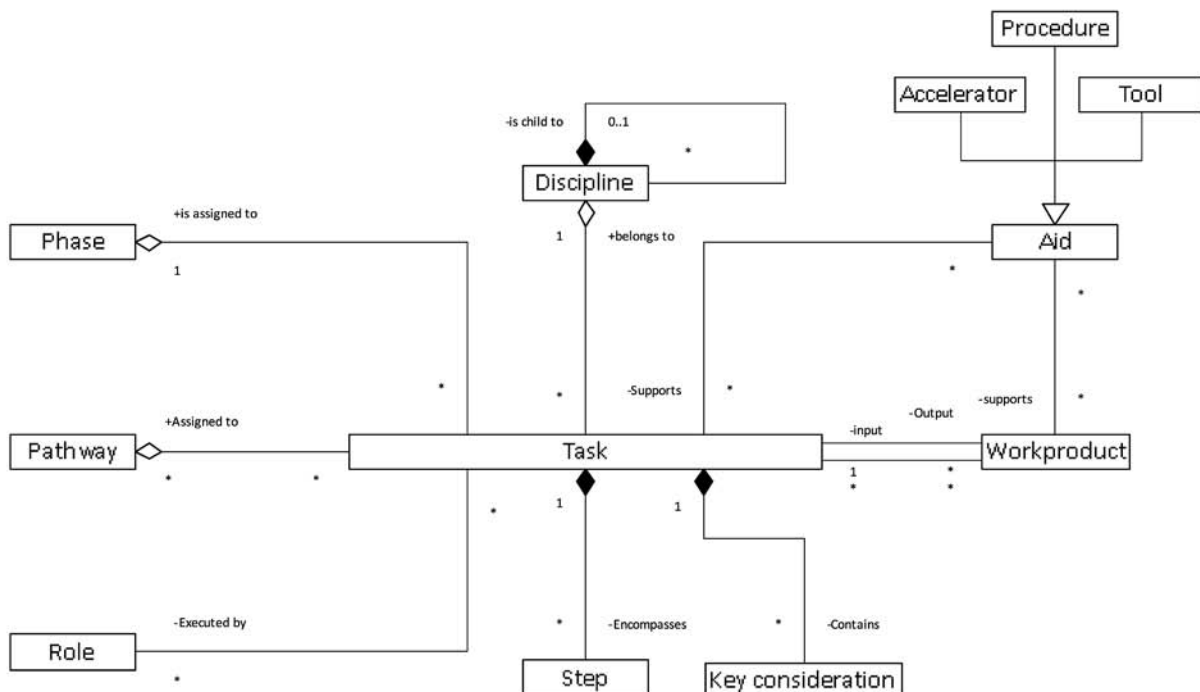
FIGURE 2: UML class diagram of the EIM method architecture

The second finding was that the data model of the traditional BI solution had to be adapted during the design phase. This was done to reduce the license cost of Qlikview's special license agreement. This is a vendor specific aspect and does not apply to most mobile BI vendors. Hence, this consideration is not typical and, therefore, not included in the framework. Another notable finding is that the business value considerations C1 and C2 were not identified until the evaluation phase. This is where the benefit of the MOBII framework becomes obvious. Project managers responsible for future implementation projects will not have problems with the justification because they will have insights in the business value opportunities beforehand. With respect to the information security consideration, C11 was not identified in the first phase of the project. This could have led to the abandonment of the project if a less safe deployment method was embraced in the planning phase while the company has strict security requirements. In such a scenario, it would not have been faced unit late in the project that the envisaged situation opposes an unacceptable information security risk.

DEMONSTRATION: ADAPTING A TRADITIONAL BI IMPLEMENTATION METHOD

In order to demonstrate the practical applicability of the MOBII framework, a proprietary BI implementation method was adapted. Deloitte's Enterprise Information Management (EIM) method was used for this purpose.

The BI pathway in this method specifies Deloitte's proven approach for delivering BI implementation services. It consists of six phases: vision, plan, design, build, deliver and operate and nine disciplines. Figure 2 depicts a UML class diagram of the EIM architecture. This figure illustrates that each pathway is a sub-set of relevant tasks for a certain EIM project (in this case a BI implementation). Moreover, a task belongs to a certain phase and a (sub) discipline. The latter is a high-level grouping of related tasks across phases. In addition, a task is assigned to one or more roles. Work products are the result of a completed task and aids (tool, procedure, and accelerator) assist in the execution of a task or delivery of a work product. There is also a 'key consideration' element, which provides additional guidance for accomplishing a task. This element is particularly relevant for this study.

The MOBII framework described in section 4 includes twenty key considerations. To embed the MOBII framework into the EIM method, each key considerations is mapped to a task in the EIM method. The mapping resulted in a dataset, which contains one record for each key consideration and indicates to which EIM tasks it is mapped. Table 4 presents an excerpt of this spreadsheet.

Table 5 summarizes the number of mappings per phase, per discipline. While methods can be adapted by insertion, editing or removal of method fragments [50], these method adaptions only prescribe the insertion of new key considerations. None of the existing key considerations were edited or removed. As illustrated in table 5, the plan, design, and build phase are impacted the most,

TABLE 4: Mapping of key considerations (excerpt)

Source location		Mapping location		
Key consideration		Phase	Discipline	EIM Task
The most important security measure is to cash or store as little BI data on mobile devices as possible (C12)	→	Design	Technology — application security	Develop Production Application Security Design
Mobile BI users require information that is more relevant for their context (C16)	→	Plan	Information management — Business Intelligence	Define Business Intelligence Reporting Requirements
Offline access to mobile BI reports requires MDM software (C18)	→	Vision	Information management — Information governance	Design Information Governance Processes
Tablets are the most favorable device for mobile BI (C21)	→	Design	Technology — Infrastructure	Define Physical Infrastructure

TABLE 5: Overview of the key consideration mappings per EIM phase and discipline

EIM Disciplines	Vision	Plan	Design	Build	Deliver	Operate
Project management						
Quality management						
Process and application						
Organizational change management						
Information management	2	5				
Development		1	2			
Technology			4	1		
Deployment						
Value		5				

TABLE 6: Practitioner profiles regarding the evaluation of the MOBII framework

No.	Role	Type of branch	Knowledge/Experience
P1	Manager BI	BI consultancy	Extensive experience with EIM projects and EIM method champion
P2	Manager BI	BI consultancy	Extensive experience with EIM projects
P3	Senior Manager BI	BI consultancy	Extensive experience with EIM projects and member within a mobile BI community

(a total 19 method adaptations are allocated here). This does not fully correspond to the phases of the MOBII framework, because the activities in the EIM method are distributed in a somewhat different manner.

PRACTITIONER EVALUATION

The final iteration of this study was the practitioner evaluation. Three interviews were conducted in order to evaluate the MOBII framework and the adapted EIM method. The interviews were conducted with practitioners that conform to the target audience of the framework. More specifically, the interviewees were project managers within the BI service line of a consulting firm.

The interviews revealed that the practitioners recognized the value of the MOBII framework: "*it provides insights in the anchor points that need a careful thought*" (P1). Moreover, the practitioners found the high-level approach useful: "*the framework highlights the most important aspects; this is currently missing in the EIM method*" (P2), "*The MOBII framework serves as a guide that provides insights in the key takeaways and concerns per phase*" (P3).

With respect to the correctness of the MOBII framework, some minor adjustments were suggested. First, by spreading the considerations over more than one phase in MOBII framework, the limitation of selecting only one phase is overcome. Second, C13 should be partially moved to the construction phase, because in this phase the consideration is also relevant. Finally, the naming of the second phase should be changed to 'scoping' instead of 'planning', this label is considered more appropriate. With respect to the EIM method adaptation, most of the mappings were considered adequate. Nevertheless, some minor optimizations were identified: First, C17 should be mapped to the 'Develop User Interface, Wireframes and Schematics' task instead of the 'Develop Business Intelligence Reports' task. Second, C18 should be mapped to 'Design Information Governance Processes' task instead of the 'Develop Production Application Security Design' task. These suggestions were followed and are already processed into tables 4, 5 and figure 1.

DISCUSSION, CONCLUSION, AND FUTURE WORK

While this study aims to address the research objective in a systematic and valid way, the results are also subject to some limitations.

First, it is possible that the interviewed experts have had a certain subjective bias or influence on the results. Moreover, the research setting (funding, resources, and geographic location) also yielded in some limitations. The latter constraint particularly influenced the expert selection process because it resulted in a non-internationally diverse expert group.

Furthermore, the goal of this research was to support project managers in order to stimulate effective mobile BI implementations. The practitioner evaluation indeed revealed that project managers acknowledge this support. However, the actual impact on the effectiveness of mobile BI implementations is not proven. When this framework is applied to a number of implementations this limitation can be overcome by statistical analysis.

This study reveals that mobile BI implementations are not as straight forward as they may seem. Mobile BI introduces various key considerations during the consecutive phase of a BI implementation as represented in the MOBII framework. These key considerations represent the full set of managerial aspects typical for mobile BI implementations. Hence, traditional BI implementation methods should embed these key considerations to include support for mobile BI. This will support project managers who are facing such projects and will ultimately stimulate the effective and broad adoption of this technology. Several recommendations can be derived from this conclusion. First, while mobile BI vendors will say otherwise, organizations who are considering the adoption of mobile BI should not underestimate the managerial implications of such implementations. Second, companies should use the MOBII framework to update their proprietary BI implementation methods. If the demonstrated way of doing this is not possible, the framework can also serve as a direct reference for project managers because it provides a high-level overview of the most important implications.

This study also revealed a number of opportunities for future work. While this study builds upon the trend of mobile BI, several more BI trends can benefit from the approach that was used in this study. Examples are constructing a 'Big data' implementation framework or a 'cloud BI' implementation framework. Besides the research opportunities from the BI point of view, there are also opportunities from the mobile business point of view. The mobile business research discipline will benefit from the research on closely related mobile business applications such as mobile CRM, mobile ERP and mobile SCM. By doing so, mobile business research will greatly stimulate the mobile evolution in organizations. Ultimately, resulting in releasing employees from duties at their desk and enable them to establish a truly mobile workplace.

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