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Self-Service BI does it Change the Rule of the Game for BI Systems Designers

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Abstract. Users of Business Intelligence (BI) systems have started to demand more flexible systems in which they could be empowered to serve themselves – self-service BI. In this paper we aim at explaining how such development influences designers of BI solutions and how it impacts the design situation. To say something about this we adapted the PACT (People, Activity, Context, Technology) framework on the BI design situation by conducting semi-structured interviews with vendors and suppliers of BI systems. From the research we found that self-service BI should be seen as a complement rather than a substitute to traditional BI. The concluding remark on the design situation is that designers of BI systems have to consider a more complex design situation where designers need to have increased knowledge about users mental models, decision focus and usage of BI systems in the analysis and design phases for being able to design useful self-service BI systems. The main conclusion from this is that designing for self-service BI is a more demanding design situation for designers of BI solutions.

Keywords: Business Analytics, Business Intelligence, Design, Self-service.

1 Introduction

Data analysis started to be used already in the 1950s, but as technology and the focus of decision making has changed over time, different terminologies (e.g. decision support, executive support) has been suggested, with slightly different meanings [1]. One of the more recent terms is Business Intelligence (BI) evolving in the 1990s [1], and later on “extended” into Business Analytics (BA) [2] and now often referred to as BI&A. However, designers of BI&A solutions often struggles to understand what users of BI wants and needs [3], or more specifically struggling to understand which user needs what information; which information have been produced for a specific user; and whether or not there is a demand or need for the delivered information [4]. Similarly, it can be discussed that users do not know their need meanwhile designers do not understand users' need [5], and users cannot even anticipate what the needs will be [6]. At the same time Big Data has been a fact, as the volume of information in organizations becomes larger, with more variants and increased velocity, the

challenge of distinguishing between ‘wants’ and ‘needs’ have become an even greater challenge [7]. These problems have been exacerbated with the introduction of more self-service BI, where users performing data analysis are expected to adapt the data used for decision support to their needs [8], making decisions more independently and self-determinant [9]. However, the larger amount of available data and technological evolution increases the need for systems which enable flexible usage for decision support and data analysis [8]. In line with this, BI designers must be capable of understanding the organizations better and the needs among their users, and thereafter frame appropriate solutions for the users [2]. From this short introduction the following research questions are suggested: How does self-service BI development influences designers of BI solutions and how does it impacts the design situation?

The rest of the paper is organized as follows. The next section introduces self-service BI solutions by comparing it with traditional BI. Section 3 presents the PACT framework and describes how it is used in this research. Section 4 presents how the research was done, followed by Section 5 that presents and discusses empirical findings. In Section 6 we then present our conclusions and finally in Section 7 contributions and some future research directions are presented.

2 Self-Service BI versus Traditional BI

Self-service technologies were initially created to enable customers to develop and provide services to themselves without direct involvement of the IT department [10]. As the name suggests, the nature of these technologies inherently carry with it openness and flexibility to enable users coming from different backgrounds, using different technologies to create satisfactory services using an uniform technology provided to them. Self-service BI is a derivative of that, which is primarily used by organizational employees based on ad-hoc needs, often without much structure, to make their own decisions. Self-service BI is described by Imhoff and White [9] as a technological option that give users the possibility to modify the system or the content. Baars and Zimmer [11] state that self-service BI highlights flexibility by joining new data sources, increasing the speed of report development and providing new data warehouse methods. It is claimed by for instance Pour [12] that self-service BI is representing one of the most significant trends in the business intelligence field, and as such are a quicker, more simplistic and operative, and much less expensive solution than standard BI solutions. However, Pour [12] also state that self-service BI is not able to serve the same complexity and integration as the case of standard BI solutions, and therefore it could be questioned if it would be able to fully replace standard BI solutions. Abelló et al., [13] gives the view that self-service BI enables non-expert BI users to make well-informed decisions by adding situational data giving a narrow focus on a specific business problem. The data as such are said not being owned and controlled by the decision maker; their search, extraction, integration, and storage for reuse or sharing should be accomplished by decision makers without any intervention by designers or programmers. To sum up, self-service BI are characterized by flexibility, fluidity, openness, and dynamism.

3 Understanding the design situation by using PACT Framework

The basic idea behind the PACT framework, is to use it to collect requirements before designing interactive products [14]. Benyon [14] explains design as a creative process for creating new interactive products, where designers ought to produce various layouts, color schemes, graphics, and a design for the overall structure. The PACT framework can therefore be used to understand the current situation within organizations, to scope potential problems, improvements and to provide the right thinking for designers about design situation for interactive systems. PACT framework is thus useful for both analysis and design phases of interactive systems [14]. The elements (People, Activity, Context, Technology) in the PACT framework can be used by designers to distinguish *Personas*, and to create both *scenarios* and *user stories* in a design situation [14]. In the following sub-sections we discuss the elements in the PACT framework from the perspective of how it can be used to understand design situations when designing self-service BI systems.

3.1 People

By people, we mean decision makers who are users of a BI system. Benyon [14] suggests that people using a system could be presented as *Personas*. The concept of *Persona* has become a widely used method for designers to create user profiles [15]. It is stated that *Persona* should have a name, a background, behavior, attitudes, abilities and motivation [15]. Similarly, Benyon [14] claimed that people might have different *goals*, *needs* and *motivation* when it comes to the usage of technologies. In this context can motivation be related to goals and be explained and defined either to experience goals, end goals or life goals [15]. *Experience goals* refer to the feeling users want to experience during the interaction with a product; *end goals* refer to the users' motivations to accomplish a task; and *life goals* refer to people's long-term desires and motivations. End goals and thus the decision making differs depending on people's roles and at which organizational level they act. Goals at different levels affect which data that has to be gathered [16]. Other categorizations of users are however possible. For instance, *elastic users* are those who are first-time users or power users, but rarely use a product. Meanwhile *real users* are those who use a product more regularly. These user types should be differentiated as designers primarily should meet the needs of *real users* [15]. Similarly, some researchers differentiate the usage in BI systems by categorizing them as either *information consumers* or *information producers* [9, 17], based on different end goals of using the BI systems. Considering users as *Personas* might provide a coherent way of categorizing users, as it has been proven to be an important part of the design process for interactive systems [14, 15, 18].

3.2 Activity

Decision making can shortly be described as an activity consisting of several phases [19-21], where users has to evaluate alternative choices among and then make a

decision. The decision making becomes even more complex if there exists an increased variety of information available, as this increases difficulties in terms of information gathering and information use [22, 23]. In the decision making process, the most important determinant leading to complexity lies with the amount of decision alternatives available [24] and increase in the amount of alternatives which causes a higher degree of complexity. However, decisions can be either rational, irrational or non-rational [25].

Information can be either prepared in beforehand for *expository*, or for *discovery* [26]. Similarly, the exploratory usage can lead to discoveries and decision makers can use exploration without any purpose or goal, and still find valuable discoveries [27]. Discovery requires that decision makers are able to create hypothesis and to validate them, but problem solving through discovery can be a better way of making decisions [19, 27]. More recently, exploratory usage also towards a more continuous approach, where discovery and experimentation with data is becoming more important [1].

Decision making is also depending on temporal aspects. Infrequent activities affect decision makers' abilities to effectively use a BI solution. Time pressure during the usage is also a significant factor when it comes to designing a product, as users may not have a sufficient amount of time to explore the data [20, 28]. However, this is related to the context of the usage, which is discussed next.

3.3 Context

Context is the general environment which surrounds the users during their activities [14]. There are many opinions on where the BI function should be placed within an organization, and how it should operate, but there appears to be 'no single best way' to build an organizational model to support an effective BI solution [4]. Instead, organizations use a combination of different solutions, depending on: the industry they are in, on the business, organizational size, leadership in the organization and level of competence among employees [1, 4, 29]. It is also likely that organizations do not establish new structures, but rather evolve and integrate new solutions into existing ones [1].

The context refers to among things, the nature of control within an organization, for example, whether it is centralized or decentralized. It can be argued that with too much decentralization, users have better support but have less ability to use an information system in a consistent way. Further, IT professionals usually value a system's technical elegance, while users would rather prefer a system which supports their needs [30].

Further, the structure of the organization can also set the stage for the organizational context, and three types of organizational structures are relevant: *special department model*, *top-down model*, and *bottom-up model* [4]. Special department model can be defined as intelligence function works in a special department, often alone in isolation, without using competence existing in other departments and without sharing competence with others [4]. Further, the top-down model can be defined as the intelligence is communicated by people from the top level management and therefore this model works best for companies where the employees have low skills, e.g. in mass production based companies. In contrast to

the top-down model, bottom-up model can be defined as employees from the bottom level of the organization are allowed to access valuable information. It can be suggested that the bottom-up model is common in sales- and marketing-driven organizations indicating that the intelligence function could or should be distributed to the bottom level employees [4]. The discussion on context implies that there exists a need for different technologies in different contexts. However, there is also a need to discuss the technology element in the PACT framework and this is done in the next section.

3.4 Technology

Technology is described by Benyon [14] as hardware and software components in interactive systems. These two components' needs to work together in order to support users' activities, which in the BI solution case is decision making. Moreover, Benyon [14] claims that designers need an understanding on how these components work and how to design something in the best way for users. More specifically, interactive systems should be designed according to various possibilities of inputs, outputs, communications and contents [14].

Within BI, visualization is defined as a process of displaying data for the user [31], and dashboards are often used to present reports as an interactive system. Designers should be aware of screen size, as some information should not be on the dashboard if the screen size is small [14]. In other words, this means that some functions cannot be available on smaller screens. Display sizes in a desktop computer, tablet and Smartphone differs and thus users ability to use certain functionalities differs [32]. The interactive visualization refers to analyzing large amount of data and visualization information. From that follows that a good visualization results in a better decision making [27]. In terms of interactive visualization, there are three categories within visual reasoning: exploratory, supervisory, and routine visualization [27]. However, exploratory is the most interesting among these tasks with the user having no purpose or idea of what will be investigated. Once the discovery has been found, the user can continue to explore the new perspectives. In other words, new discoveries can be achieved when engaging with visualizations [27]. From the discussion of the elements: People, Activity, Context, and Technology in the PACT framework, we were interested in exploring how does self-service BI development influences designers of BI solutions and how does it impacts the design situation, which made us doing a research study, which is shortly presented below.

4 Method

When choosing an appropriate research strategy, initially we discussed the object of analysis and purpose of our study. For our research questions, we found that a explorative study would be appropriate, as we aim at exploring the social and organizational context, as well as understanding how the usage of a new concept [33] (in this case self-service BI) influences the designers and the design situation. Further, we decided to conduct semi-structured interviews [34] enabling us to explore our

research questions more in-depth by asking follow-up questions, and to make sure that all our research items, within the PACT framework, were discussed during the interviews.

Based on Benyon's description of the PACT framework [14], we formulated questions for our interview guide. The design of our interview guide was made in regard to the research question [35] of *how* the designers and the design situation was influenced.

We aimed at interviewing designers since the study aimed at exploring the context of designing self-service BI solutions. The specific selection of informants was based on two criteria; (1) that informants should have knowledge regarding self-service BI and (2) to personally be in contact with users and other designers of BI systems. Our selected informants were thereafter selected from two suppliers who's main business are to deliver BI systems, and one vendor which has been positioned as a leader in user-driven Business Intelligence (i.e. self-service BI). In total, five individual interviews were conducted with experts who possessed experience in design of BI systems and could provide understanding of implications in designers work.

The interviews were recorded and then transcribed before the data were analyzed from the questions in the interview guide and the four elements from the PACT framework. Since we had data from two suppliers and one vendor of BI solutions we had the possibility to compare between different statements. The next section presents the analysis and discusses the findings.

5 Empirical findings and discussion

In this part we present our empirical findings followed by our discussion in relations to previously presented literature.

5.1 People

Our empirical findings indicate that provision of information, when using a traditional BI solution, often fell short in providing decision makers with the information they need. In line with this, several researchers [e.g. 14, 15, 18, 36] have argued that each individual has different needs, goals and motivations, it might thereby be difficult to design a product for various users. From this it can be claimed that users' needs depends on their business role, which is supported by several researchers [1, 4, 16, 19] as the decision focus changes dependent on the job they have. It is thus possible to conclude that business strategy and user's roles in firms are reflected on the end goals among decision makers. We thereby stress that goals within organizations have significant influence on decision maker's requirements on self-service BI.

Decision makers at tactical and operational levels need *current values* as indicators in a BI solution, while decision makers at a strategic level need *target values* as indicators based on the business strategy [16]. This implies that there may exist a problem for designers which they have to consider, namely that the diversity of needs and skills differs and must be identified at every organizational level [19]. A further

implication is that people's roles will vary, implying that users have different styles in decision making [19]. A similar description has also been pointed out by Davenport [1], who has pointed out that designer should design systems which promote decision makers to use their skills for data analysis. Davenport has further suggested that decision maker's skills can be categorized based on their role, emphasizing that they can have roles such as; *business experts, trusted advisors, quantitative analysts, scientists or hackers*. Among these roles, skills for data analysis, knowledge about the business and ability to frame decisions can be found. The distinction of user types is not new, but it is crucial and must be defined correctly when delivering BI systems [4].

Importantly, the findings indicate that usage of self-service BI solutions implies a challenge for designers, demanding increased knowledge about users' end goal, which decision support and thus which data that is needed. Also, there appears to be a concern regarding decision makers' skills. To handle diversity of skills among users, we have found that designers at the vendor organization are using Persona and Mental Models. Thereby, their designers are able to distinguish different types of users dependent on their job roles, different skills and abilities. Meanwhile, the supplier organizations uses other terms to categorize their users, i.e. information consumer and power user [9, 17]. Whatever term used, we thus emphasize that user types should be determined by how users are using BI systems. This might be of relevance, since we have found that users need to have skills and ability to explore data themselves, which implies that decision makers need to assign the appropriate level of self-service that best fits a decision maker.

We have found out that end goals are to make more rational decisions as articulated by Simon [25]. Interestingly, during the interviews we came across the term 'freedom'; as businessmen want to work without having to contact their IT departments, and want to create new analysis based on new data. Our empirical findings indicate that the need for self-service has resulted in decreasing reliance on IT departments, i.e. which can be described as an experience goal. Our informants have however described that decision makers do not necessarily want self-service functionality per se, but more importantly to have support for rational decision making.

Decision makers do however make unsupported decisions which might lead to what could be called irrational decisions. Due to this, decision makers might want and need BI systems which decrease irrational decision making. A conclusion drawn by the informants is that exploration and discovery has become a functional requirement as it is assumed to decrease the amount of irrational decisions. In other words, decision makers end goals might have changed because of self-service BI solutions now are available. It is likely that for instance; technical capabilities, coming with self-service therefore influence the functional requirements in BI systems. It is however questionable whether self-service fulfill such end goals. Users do however use the term 'Big Data' to motivate their need of self-service functionality, which means increased amount of information available and consequently implies increased amount of decision alternatives. One finding is thus that technical capabilities in self-service might influence decision makers to require BI systems, and that the requirements are motivated by changed end goals and experience goals.

We can conclude from our empirical findings that different types of users are significant for designers at vendors and suppliers in order to make better and more useful BI systems. This is also pointed out by many other researchers [e.g. 1, 6, 9, 14, 15, 17, 18]. However, we found a non-coherent use of terms for user types among both scholars and our empirical findings. We thereby suggest that there should be a common terminology among vendors and suppliers to avoid any ambiguities of who the users are in BI systems.

5.2 Activity

In self-service BI, our informants stated that users are expected to use both static and flexible dashboards. The newness in comparison to more traditional approaches is that users are supposed to conduct data analysis themselves by creating assumptions about their business, and verify that these are correct by elaborating with data. Decision makers are then supposed to evaluate alternative choices in terms of their actions and then make a choice [19-21, 25]. The usage of BI solutions can therefore be described as either expository or exploratory usage [26, 27].

In the decision making process, complexity in decision making comes with the amount of available decision alternatives [24]. However, as also found in the literature, BI is only supposed to provide support in identifying the decisions to be made [19]. Moreover, our empirical findings indicate that verification of assumptions is too complex to be supported by static dashboards, and we can thereby state that static dashboards enable some decision support, but with limited functionalities. Further, we have found that designers have to open up the creativeness for users and allow them to find data themselves by providing a personal visualization possibility. Therefore, we can conclude that designers face new design situations in self-service BI development. When evaluating alternative choices with self-service BI, it appears to be more flexible for decision makers. In contrast to all the benefits of self-service, our empirical findings identify a concern that self-service implies that users may select unqualified data sources, which we deem resulting in users requiring more business and technical skills. Self-service therefore implies that designers present whether a data source is qualified, where a data source originates from and how its dimensions are related to each other.

An even further explanation of decision support complexity in BI solutions, is the activity whereby decision makers are 'on the lookout' for information and knowledge needed to support their decisions. In the study we found that traditional BI solutions builds on having so called static reports, while self-service BI enables the users to make business discoveries. This corresponds to earlier research that decision activities can be categorized as exploratory or discovery [26, 27]. We thus can conclude that decision complexity (variety of variables) can be handled better in self-service BI.

We acknowledge that the combined usage of expository usage and discovery usage will provide a more generalizable way of problem-solving and understanding problem domains. It is however important to point out that the self-service approach will not substitute static reports, but rather complement and increase the opportunity to support decision making [26]. Further, as BI solutions nowadays involve increased information gathering about competitors in the market, technical competences,

possible partners, organizational or individual influencers that define and limit the business activities in order to keep the organization business competitive, this increases the amount of alternatives for decision makers [4], and thus the complexity of supporting decisions [22, 23].

In the study we also found that there is a tension between business people and IT people, due to the fact that decision makers have to go IT departments to request new reports. As pointed out by Benyon [14], a significant factor in BI solutions is cooperation, implying that decision activities are completed alone or in relation to work with other people. Similarly, as pointed out by one interviewee, people are likely to go to the colleague nearby rather than contacting IT. Our interpretation is thus that self-service BI might enable the users to complete tasks (i.e. decision making) themselves, but that self-service also might demand that support are provided by other decision makers. This brings us to the social and organizational context.

5.3 Context

Initially, our empirical findings indicate that viability of self-service does not depend on the organizational size, but rather on type of business and structure of the firm. Hence, business type and structure also change how IT departments work. An IT department should not be the primary support for decision makers in a BI solution, as the IT department would be overwhelmed if they supported every single app and dashboard.

The structure of an Intelligence function has been thus explained in our literature review, as organizations might have structure their BI functions accordingly to one or several organizational models, i.e. there is no single best structure for all firms [4]. In line with this, the research indicates that firms, traditionally seen, have structured their BI functions in a top-down approach, where IT departments are in charge of the IT strategies, delivering static dashboards and also acting as gatekeepers for BI users who requests changes. As our results indicate, the self-service approach thus implies, that the structure of the BI function in firms change, and for IT departments, their role evolve in relation to the BI function into management of infrastructure and enabling flexible use of BI solutions, rather than only delivering static reports. The role of IT department are in other words changing and we have found that the new role of IT departments in the BI function is to manage and enable, rather than delivering, in other words IT departments can support decision making by qualifying that decision makers are more independent when using BI solutions.

We do however find it important to point out, that static dashboards will not disappear and large organizations still need a traditional approach as it can fulfill much need of information for decision makers without using self-service. Further, self-service BI should be seen as a complement to the traditional static reports. We thereby emphasize that there is still a need for static reports, especially in large organizations.

Firms can structure the support for BI work in different ways [4]. What is important for BI designer is however that they should consider the social context in where activities (decision making) take place, as it may dictate the acceptability of a design. Firms need a supportive function which can provide help for decision makers

when using BI solutions. In line with the bottom-up model [4], users are more likely to solve problems themselves, but need support and responsible for data security, i.e. there is a need on deciding who has access to which data and when they can gain access [14]. More importantly, despite the security challenge, our interpretation is that firms who wish to use self-service should allow the so called bottom-up structure. All this has some implications on the technology which is discussed next.

5.4 Technology

The research findings show that input and output differs depending on screen's size, which also is supported by Tona and Carlsson [32], who have evaluated the usability on smartphones, tablets and PC/laptops. As pointed out, the use of self-service BI as a technology implies increased flexibility, in order to make explorations and discovery. However, as shown, there is currently a lack of ability to use self-service on mobile devices, but the ability to use self-service at different devices might evolve and thus expand in the future, especially on tablets. The ability to use self-service will probably always be higher on larger screens [27], as the ability for exploratory use increases at larger screen sizes. In other words, it will be easier for a user to investigate new discoveries and new perspectives on data if it is explored on larger screens.

In terms of input and output at one screen, we believe that designers should facilitate the business discovery by giving more "freedom" to the users. Due to the fact that users can have different type of devices, designers have to consider this, but surprisingly the study shows that designers do not consider which device that users will be using in the future. This was explained by the interviewee at the vendor as a result from the fact that their product use responsive design in which the visualization adapt based to a device's screen size.

We summarize the PACT characteristics of self-service BI, and its differences from traditional BI in the table below.

Table 1 Comparison of Traditional and Self-Service BI through the lens of PACT Framework

| Dimensions of PACT Framework | Traditional BI | Self-Service BI |
|------------------------------|---|---|
| People | “Real” users Information consumers | Elastic Users Information producers |
| Activity | Expository and Explanatory | Explorations and Discovery |
| Context | Top Down organizational Model Centralized decision-making in the way that BI usage is predefined | Bottom UP organizational Model Decentralized decision-making allowing users at multiple levels to make decisions |
| Technology | Predefined datamodels | Larger screens Dynamic Dashboards |

In the next section the findings are summarized and we provide some concluding remarks on the research questions: How does self-service BI development influences designers of BI solutions and how does it impacts the design situation?

6 Conclusions

Decision makers' experience goal is to use self-service BI with freedom, without being forced contacting the IT department, while their end goal is to make better decisions. Depending on the decision makers' goals, designers of self-service BI should allow users to choose variables, dimensions and visualizations themselves. The variables and dimensions thus depend on which business role the decision maker has, which can be categorized by their level in the organization. Designers must thus consider that users' requirements differ depending on their role within organizations. Some decision makers have a need for making infrequent decisions, and therefore might have a need for independent data analysis by exploration of new data to make new discoveries, while others fulfill their need for decision support by using static report. So, from the findings that users becomes more of information producers it can be claimed that the designers has to fulfill the possibility to add more data points into the BI solution.

Exploration and thus discovery enable decision makers to consider more decision alternatives. The challenge for designers in such situation is to know which decision makers have sufficient abilities and skills to use self-service, as decision makers are required to have both skills about their business, the technology they use, and the ability to create and validate hypothesis. As self-service implies that BI users' skills are of increasingly varying nature, it demands that various skills and mental models are taken into account by designers. Designers should then consider which level of self-service BI should be used by different decision makers.

Also, in respect to organizational structures, designers need to know that the role played by IT support might have evolved, towards e.g. a bottom-up or special department structure. Designers should acknowledge this, especially as our findings show that there are concerns regarding data quality and data responsibility, particularly if users are supposed to include unverified external data sources. This demonstrates a challenge for designers, as they have to recognize which decision makers will access and use specific data.

Another point worth noting is that self-service BI should be seen as a complement rather than a substitute to traditional BI, and that the varying design opportunities that self-service BI creates, implies several implications as designers have to consider. All in all this make that the design situation changes and it implies that designers needs to have increased knowledge about users mental models, decision focus and usage of BI systems in the analysis and design phases for being able to design useful self-service BI systems

7 Contribution and future work

This paper contributes to existing literature by providing an adapted PACT framework for BI, which aims at improving BI designers understanding and our knowledge of the new design situation in BI systems. The adapted PACT framework for BI systems might be used by designers as guidance in their work, to create Personas, scenarios and user stories in their own design of BI systems. Interestingly,

we have found that designers at the vendor organization are using Persona, whilst suppliers might use notions as e.g. information consumer or power user.

Further research is thus suggested to complement eventual perspectives which designers and users can provide. A study of the like might also result in a better adapted PACT framework for Business Intelligence. It would be worthwhile to study users' perspectives as a longitudinal study, and how decision makers perceive the use of self-service, in order to understand the suitability of activities in certain scenarios. Moreover, a further study could explore whether self-service is required by decision makers based on their life goals, and whether firms should consider incorporating such requirements. From an organizational perspective, another study might be to investigate how organizations support their decision makers by evolving the structure of their Business Intelligence function. Perhaps it would even be useful to create an assessment form, whereby the results would indicate whether the designers should design the dashboards, or if the users themselves should be allowed to create the design, and if so, what potential consequences that could result in.

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