Managing Big Data Analytics Projects: The Challenges of Realizing Value

Jensen, Maria Hofmann; Nielsen, Peter Axel; Persson, John Stouby

Published in:
Proceedings of the 27th European Conference on Information Systems (ECIS)

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

5-15-2019

MANAGING BIG DATA ANALYTICS PROJECTS: THE CHALLENGES OF REALIZING VALUE

Maria Hoffmann Jensen
Aalborg University, mahj@cs.aau.dk

Peter Axel Nielsen
Aalborg University, pan@cs.aau.dk

John Stouby Persson
Aalborg University, john@cs.aau.dk

MANAGING BIG DATA ANALYTICS PROJECTS: THE CHALLENGES OF REALIZING VALUE

Research paper

Jensen, Maria Hoffmann, Vestas Wind Systems A/S, Aarhus, Denmark, mahjn@vestas.com

Nielsen, Peter Axel, Aalborg University, Aalborg, Denmark, pan@cs.aau.dk

Persson, John Stouby, Aalborg University, Aalborg Denmark, john@cs.aau.dk

Abstract

Organizations invest significantly in Big Data Analytics (BDA), but only limited knowledge is available on the challenges faced by these organizations when trying to realize value in such projects. Benefits realization management (BRM) offers a perspective and processes for realizing value from information systems (IS) projects. Yet, limited research has investigated how this can be applied to development processes for BDA projects. We report an in-depth case study of a large organization's BDA development processes and the inherent challenges of realizing value. From our analysis, we found eight necessary activities for realizing value in a BDA process and the challenges pertaining to each activity. These findings extend previous research on value creation in BDA projects with insights from practices in a large organization highly dedicated to exploiting Big Data. The paper discusses these findings as they relate to previous research and concludes with their implications for current BDA projects and future research.

Keywords: Big data analytics, benefits realization management, value realization, case study

1 Introduction

The application of Big Data Analytics (BDA) in driving organizational decision making has attracted much attention over the past few years (Mikalef et al., 2017). More and more companies are focusing their investments on BDA with the aim of deriving valuable insights leading to a competitive edge (Constantiou and Kallinikos, 2015). Within BDA, there has been a significant evolution of techniques and technologies for data storage, analysis, and visualization. However, researchers have paid less attention to whether, and under what conditions the development of BDA solutions produce business value. Other sources to value, than simply those related to technology, such as human skill and knowledge, is a relatively unexplored area of research (Gupta and George, 2016). The orchestration of these resources and their incorporation into strategy and operational thinking, represent areas where value from BDA is relatively unexplored (Gupta and George, 2016). BDA projects differ from IT projects in requiring significant investment in not only data infrastructure and analytic technologies, but also analytical capabilities in form of human capital and strategic positioning in the organization (Grover et al., 2018).

Over the past few years, researchers have stressed the importance of looking into the whole spectrum of aspects in BDA (Constantiou and Kallinikos, 2015; Markus, 2015). While current BDA technologies provide vast possibilities in handling structured and unstructured data, insights from the data do not emerge automatically out of applying tools to data. Rather, insights emerge out of the BDA development process of active engagement between the analyst and business manager. To arrive at meaningful insights, the BDA development project must focus on the development process starting and among other things include the activities to which the BDA provides better decision making. A BDA project needs to incorporate a focus on values that are created and how these relate to the activities which the BDA supports. In BDA development, this happens in the transformation of insight to decision, since it is from the decision that value is created (Sharma et al., 2014).

The type of value that can be realized from BDA is dependent upon the BDA project. Yet, a research focus of BDA to capture and create value has been limited (Sharma et al., 2014; Grover et al., 2018). Very little has been written about why organizations have failed to reach their strategic BDA goals and how value from BDA can be fostered (Grover et al., 2018) The implicit assumption underpinning this is that by applying BDA decision quality gets improved and that the realization of benefits from these insights follows trivially and without effort. Yet research on value in IT projects suggest that to realize benefits from BDA, this need to be managed appropriately (Doherty, 2014). Following Doherty (2014), benefits realization management (BRM) is defined as, "the process of organizing and managing, such that the potential benefits arising from the use of IT are actually realized" (Ward and Elvin, 1999, p. 197). Value is then understood from a benefits perspective, which in turn will be dependent on the BDA project and its specific setting respectively. Doherty (2014) introduces BRM as an approach that by its specific focus on benefits provides better chance of realizing value from BDA. With a similar inclination, we report here from a study on current development activities and challenges for BDA in the company Vestas Wind Systems A/S (Vestas). The study in question has been organized as a case study and we have explicitly addressed the research question:

"What are the challenges of realizing benefits of BDA development projects?

We answer the research question with a case study analysis of the challenges of incorporating benefits realization into BDA development projects in Vestas. This company is an interesting case setting because it has invested significantly in BDA to accelerate its digital capabilities and become data driven. The paper is structured as follows: The next section presents the related research on BDA and BRM. Section 3 outlines the case study approach and in Section 4, we analyze the case company and its challenges respectively. In Section 5 follows a discussion of the findings and we relate these to related research in the field. Finally, Section 6 is the conclusion.

2 Related Research

There are two types of related research in connection with the research question: BDA development projects, and BRM.

2.1 Big Data Analytics Development Projects

The term Big Data first appeared in 1997 when researchers at NASA described the challenges of storing the enormous volume of information generated as a result of a new data intensive type of work (Cox and Ellsworth, 1997). Since the introduction by NASA, the term has transformed to not only comprise data, but also analytical methods, processes, and technologies (Ward and Barker, 2013). BDA is defined as a, "new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high velocity capture, discovery and/or analysis" (Côrte-real et al.,2017, p. 380).

This value extraction may then happen when organizations leverage BDA to drive decision making by framing the right analysis, discover and then act on outputs (Gandomi and Haider, 2015; Grover et al., 2018). The overall process of extracting insights from BDA can be broken down into five stages, (1) acquisition and recording; (2) extraction, cleaning, and annotation; (3) integration, aggregation, and representation; (4) modelling and analysis; and (5) interpretation (Labrinidis and Jagadish, 2012). In this way, BDA projects generally adopt a task-focused approach that focuses on the techniques required to analyze data (Saltz, 2015) and less on the efficiency of the processes (Gandomi and Haider, 2015). Limited research address how to effectively perform BDA projects and how processes effectively can become institutionalized within organizations (Saltz, 2015). Jagadish et al. (2012) approach this from a task-oriented approach. As an example, Jagadish turns to describe the above five stages and then later adds a sixth stage of 'deployment' following interpretation (Labrinidis and Jagadish, 2012). Guo (2013), on the other hand, turns to approach BDA as a workflow with high-level phases including preparation, analysis, reflection, and dissemination. Each of these phases then has a specific series of steps, which can be repeated within its specific phase to deploy an interactive analysis (Guo, 2013). These views, by both Jagadish and Guo, on how to do data science, have not evolved in the past 20 years (Saltz, 2015). The views are similar to the KDD (Knowledge Discovery in Databases) 20 year old process (Fayyad et al, 1996) and the CRISP-DM (Cross industry standard process for data mining) process from the 1990's (Shearer, 2000). None of these models of data science have achieved wide acceptance (Saltz, 2015) with current research now increasingly attending to agile methodologies (Dharmapal and Sikamani, 2016; Larson and Chang, 2016). Grover et al., emphasize how BDA involves developing both data and analytical capabilities and how coevolutionary adaption through "learning by doing" is important in BDA development (Grover et al., 2018).

A survey of BDA projects in 300 companies describes how 55% of BDA projects are not completed and many projects do not meet their objectives (Kelly and Kaskade, 2013). The success of BDA projects is more reliant on the individuals in the organizations than on a defined methodology (Kelly and Kaskade, 2013). Researchers have investigated how to update the so-called outdated process frameworks. According to Larson & Chang, a successful BDA methodology should focus on the information value chain and not on the development of software itself, as is the traditional focus of IT development today (Larson and Chang, 2016). While software and BDA projects may have similar objectives such as trying to understand project requirements, doing analysis, and design (Larson and Chang, 2016), simply applying software methodologies to BDA projects may not result in much value generated for the organization. Special attention needs to be placed on the factors of data quality and accessibility, expectations, and anxiety (Rose et al., 2017). The latter is interesting because only limited BDA research discuss the both social and technical challenges in managing such projects (Saltz, 2015). From these research limitations, we point to the potential of BRM theory to better the realization of value from BDA.

2.2 Benefits Realization Management

Systems in general may fail because developers do not recognize that it is through organizational change, rather than through a technology's functionality per se that benefits are typically realized (Eason, 1988; Mumford, 1995). A concern also important for BDA systems, which in its development implies processes to redesign organizational procedures, behaviors and accommodate and mitigate the risks for organizational consequences. Doherty (2014) proposes the theory of BRM to achieve a more effective relationship between information technologies and the social contexts in which they are intended to operate. BRM is defined as, "the process of organizing and managing, such that the potential benefits arising from the use of IT are actually realized" (Ward and Elvin, 1999, p. 197). BRM compliments

BDA because framing the right analysis, discover and then being able to act upon findings is crucial in realizing value.

BRM can be linked back to the early theorists of information technology and organizational change – in particular Ken Eason (Doherty, 2014). Eason (1988) recognized that it was not possible to design a system to support an activity in an organization that would guarantee to deliver the outcomes of the system specified by the designer. BRM emphatically privileges the attainment of benefits that are meaningful from an organizational perspective. Ward and Daniel (2012) developed a BRM process by studying several IS projects in large organizations across various sectors. They found that some of these were actively trying to manage benefits, while others were not. From their study they gained an understanding of why some projects were more successful than others in delivering benefits. Based on this, they developed a process model for benefits management with five steps and dependencies between these activities. The five steps are: (1) Identify & structure benefits; (2) Plan benefits realization; (3) Execute benefits plan; (4) Review & Evaluate results; and (5) Establish potential for further benefits (Ward and Daniel, 2012). The purpose of the BRM process is to improve the identification of desirable and feasible benefits and moreover, "to ensure that decisions and actions taken over the life of the investment lead to realizing all the feasible benefits" (Ward and Daniel, 2012, p. 80). BRM recognizes that the majority of value from information systems comes from the business change, which it enables in the organization. Organizations will fail in realizing value from IS projects if they do not accommodate and explicate the capabilities of the technology (Ward and Daniel, 2012). The success of an IS project should be measured in relation to its ability to deliver meaningful benefits and not simply to the timely delivery of a technical IS artefact (Doherty et al., 2012). They propose a BRM perspective to systems development success factors (Doherty et al., 2012): (1) identifying goals and objectives to detailed benefits planning; (2) project management to the management of transformation; (3) well-balanced project teams to coherent governance structure; (4) senior management support and commitment to active business leadership; (5) user participation to stakeholder-enabled benefits realization; and (6) rigorous software testing to ongoing benefits review. In contrast to these success factors, numerous studies have also pointed to the challenges in managing the realization of benefits from different types of systems in different types of organizations (Nielsen et al., 2012; Badewi and Shehab, 2016; Pedersen, 2017; Waring et al., 2018). Despite the potential to apply BRM in BDA development projects, we must still investigate the challenges particular to realizing benefits in BDA development projects since BRM is new to BDA and its particular differences.

3 Research Approach

We address the research question on challenges for benefits realization in BDA development projects with a case study to develop better descriptions and explanations of the phenomena being studied (Benbasat et al., 1987). The case study approach is appropriate as it addresses a contemporary phenomenon (BDA projects) in its organizational context (Yin, 2009). Further, it is particularly suited when research and theories are in an early and formative state. The case study utilizes detailed empirical data on how BDA is organized within the case company and the associated challenges for realizing benefits. The case company, Vestas Wind Systems A/S (Vestas), is one of the leading producers of land-based wind turbines for energy production, which for years has invested significantly in BDA to become a digital leader in renewable energy. The challenges of incorporating benefits realization into Vestas' BDA development projects would be important for similar organizations respectively, which makes it a critical case (Flyvbjerg, 2006).

3.1 Case Background

Vestas has responded to a rising demand for digitalization of the renewable energy sector, and thus has purchased the world's third largest commercial supercomputer 'Firestorm' in 2013, quickly followed by the purchase of the supercomputer 'Mindstorm' in 2016. The digitalization of assets and data analytics have become increasingly integrated into the company as enormous volumes of data is generated and fed into the company from the wind turbines. On top of this, Vestas has undergone further expansion with the acquisition of the wind turbine servicing companies Upwind Solutions and Availon to be able to provide service of non-Vestas wind turbines, which posed new challenges in generating, collecting,

and using data from non-Vestas assets. Further expansion to accelerate digitalization occurred in 2018, where Vestas invested in the acquisition of the company Utopus Insights Inc, an energy analytics provider. Furthermore, as the energy sector becomes digitized, the use of data in improving operations of wind farms and other renewable power plants is increasingly important to customers. Vestas collects data from more than 73 GW of turbines under service. Utopus was therefore seen as important to Vestas' strategy to provide customers with digital services. The case study has involved managers and project members concerned with the Utopus post-acquisition project anchored in the Service and Technology Departments. In addition, the case study has also involved a project rooted in the Technology Department only, which concerned the development of a digital platform to enable collaboration of distributed big data services, so that combined big data capabilities can enable value generation in sales tools for Vestas. Common for both projects were the theme of realizing benefits from utilizing BDA.

For the Utopus acquisition, Vestas established eight workstreams to ensure integration and fast deployment of the BDA solutions between Vestas, Utopus, and external customers. An external customer could be an energy company such as Vattenfall. 48 employees from Vestas are direct contributors to the project, where 12 are involved with more than one workstream. The project, however, affects more employees to a lesser degree. Eight employees from Utopus were assigned as contributors to the workstreams where one was assigned to more than one workstream. The workstreams each have their specific focus, which can be a BDA product specifically or of a more generic theme such as "finance" or "communication." For this case study, we have had a specific focus on the workstreams that involved the Technology Department, which is currently involved with BDA. The Technology Department was involved in three workstreams. Two that involved the direct development of an analytic product for external customers and a third workstream concerned with getting data connected from Vestas to Utopus. The workstreams represent a core area in the collaboration between Vestas and Utopus and how this should be handled in the future. This has been a major concern for the Technology Department to ensure data availability and connectivity across the organization. Some of lacking collaboration capabilities could be mitigated by the second project carried out by the Technology Department on its own. This project was staffed with a project owner, a project manager, a product lead, a technical lead, and a project controller. Essentially, the project involved the development of an integration platform for distributed software and data analytics services, so that the quality of the data exposed to the end-user could become a cross-cutting concern for the projects contributing to the platform. Therefore, the intention has been for the platform to ensure that the data interfaces are well-defined and of high quality, thus reducing complexity of working with distributed data analytics.

3.2 Data Collection and Data Analysis

Empirical data were collected through qualitative interviews and through participant observation (Patton, 2002) in several meetings. The qualitative interviews were semi-structured based on an interview guide. The interview guide took a starting point in BDA and benefits realization with questions such as, "What challenges the case participants would experience in BDA projects?" and "How benefits in a BDA project was identified and measured?" The interview guide was intended to encourage the interviewees give a detailed description of the problem area and analysis of the experienced challenges. Further, the participant observation covered several meetings in BDA projects, and the intention was similarly to uncover relevant aspects of how the organizational actors experienced the problem area in question. In addition to following the advice of (Patton, 2002), Soft Systems Methodology (SSM), a social science research method (Checkland and Scholes, 1990; Rose, 1997) was followed to ensure that the qualitative data had a focus with a particular relevance for problem solving. The qualitative interviews and the participant observations were conducted over a period of 6 months and covering 66 encounters, each between 1 to 2 hours, see Table 1. All encounters between the researchers and the organizational actors were documented through audio recordings, observation notes, and meeting minutes.

The data were analyzed using an open coding method to identify the primary concerns. Soft Systems Methodology was used to organize the analysis. The SSM-based analysis led in the first instance to a rich picture to create a visual overview of the problem situation. From this, a brief list of possibly relevant human activity systems was created, and for these human activity systems, root definitions were

formulated, and conceptual models were developed. The most central of these human activity systems and the by far most relevant became the system to benefits realization seen in Figure 1.

Type	*Meeting Count*	*Hours Duration*	*Total Hours*
Data & Analytics Platform Department meetings	16	2	32
Data & Analytics Platform Manager	16	1	16
Senior Data Scientists	12	1½	18
Utopus Project Manager/Head of merger	8	1	8
Utopus Workstream Leads	6	1	6
Utopus Team NY	8	1	8
Total	66	Average: 75 min	88

Table 1: Data Collection

Following the SSM approach (Checkland, 1981; Checkland and Scholes, 1990), a human activity system represents one ideal perspective on the area of concern and provides a systemic way to address the problem situation studied. A human activity system is in this way the result of an open analysis that provides a unique view on the problem situation to ensure that the specific details about the case in its context are elicited in detail. The details are explicated in the activities of the model, and they are further elaborated by what in SSM is called the 'comparison'. In the comparison, the ideal expressed in the activity model is compared with the interpretation of the qualitative data. For each activity in the model, the following questions are answered with the data analysis: (1) How is the activity currently performed? (2) How well is it performed? (3) How is the performance measured? The activities and the three questions serve as a structured organization of the analysis.

The SSM-based analysis was validated in two steps. First, the conceptual model was presented to the organizational actors to validate its relevance and usefulness for the problem situation, its ability to define challenges, as well as its ability to spark the debate about 'what might be changed'. This led to refining some of the names of the activities to give a better fit to the problematic situation from which the conceptual model was build. Second, the conceptual model was validated though a 3½ hour workshop with the data and analytics platform manager and a senior data scientist. This gave rise to long discussions between these two informants about the detailed answers to the three questions for each of the activities and how the model served the problematic situation in the case organization. Additionally, the workshop was also audio recorded as new empirical data. The workshop led to refinement of some of the answers, and, in some cases, to alteration of the answers now based on a more thorough understanding of the problem situation as well. The resulting conceptual models and the comparison was then utilized as a basis for the identification of challenges in each of the 8 activities in the conceptual model.

4 Findings

The conceptual model of activities for the realization of benefits in BDA development projects and the logical dependencies between these activities are outlined in Figure 1. The eight activities comprise tracking benefits from their early identification in the business case to the decision process they should support and the occurrence of organizational change. The conceptual model follows directly from the analysis process described above and is specific to the investigation of the research question in Vestas. The conceptual model was validated by the Director of the Data & Analytics Platform department and a senior data scientist: "…benefits realization, this is exactly that what Vestas needs to get on top of" (Senior Data Scientist). The department director states, "[the model] contributes in asking some very relevant questions about why we do what we do, and I can hear that this is difficult to answer." He continues that the conceptual model is well fitted to the problem situation in the organization. In the following, we account for each of the eight activities in the order outlined in Figure 1 and their inherent challenges (in italic) substantiated by quotes from the interviews or from the final validation.

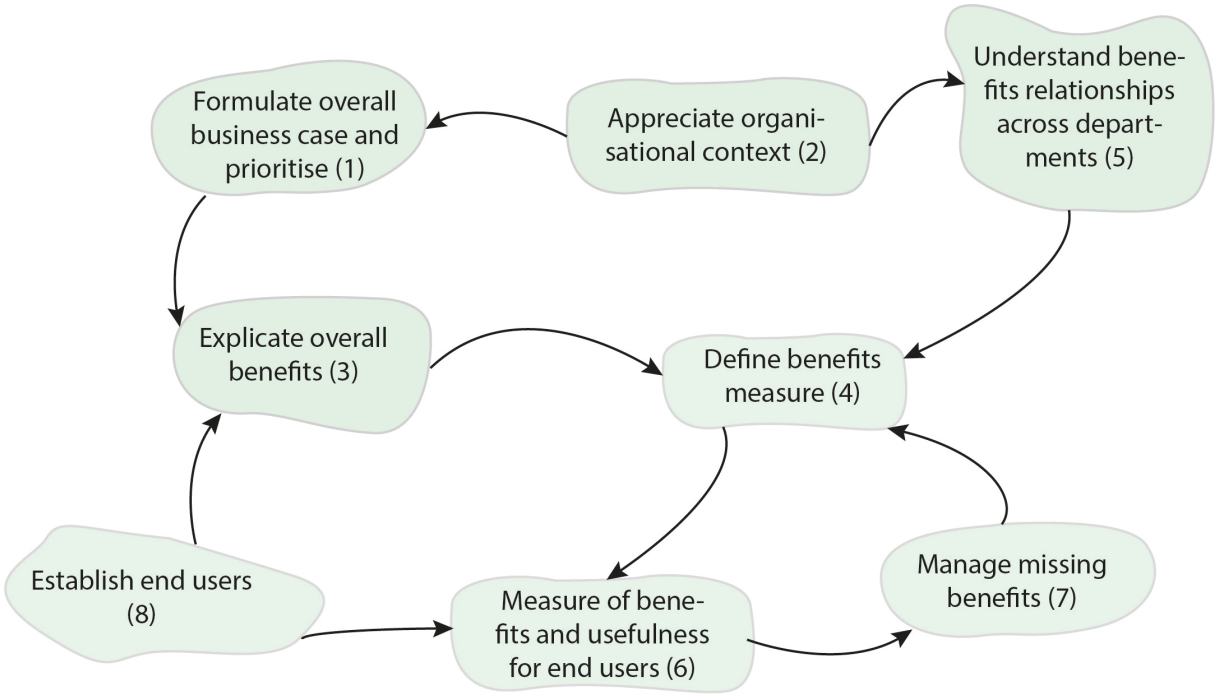

Figure 1: Benefits realization in BDA development projects

4.1 Formulate overall business case and prioritize

Formulating a business case that describe a prospective project and its potential impact on the organization, as guided by a stage-gate model, is a pre-requisite for any BDA development project in Vestas. However, the *inconsistent formulation practices* for business cases inhibited the ability to compare BDA projects with one another, manage them across different departments, and knowledge sharing between the BDA projects. The inconsistency fostered a silo culture of BDA projects, negatively impacting their execution. While any project and its business case had to be approved by a management portfolio board using standard templates for the presentation, the practices behind these were still inconsistent. For IT projects, a dedicated product manager would commonly develop the business case. However, *undefined product management* of BDA projects with no dedicated product manager caused much frustration between the departments involved in the BDA development. The product manager was responsible for formulating the business demand in a business case, which also means responsibility for the BDA development efforts was not wasted. As described by one of the workshop participants, "…for the X project, here he is lucky to have a direct request from product management, so that they take responsibility for the demand" (Department Director). When a direct request from product management was not present for the project, the BDA development team would take the responsibility for the project demand, which was not regarded as their task, "but with project Y… here the BDA developer has a huge problem with getting a product manager to say that this is a good project, so here we take this responsibility" (Department Director). Furthermore, the business cases include *unilateral benefits* referring to a one-sided focus on benefits with a financial measure using the notion of "value capture" measured as either "direct cost" or "performance" impact. Having these standardized impact measures challenged the BDA projects without a direct impact on these but instead provide other benefits. Qualitative or observable benefits were not as highly acknowledged as financial and quantifiable benefits.

4.2 Appreciate organizational context

In Vestas, each department has distinct activities for which it is accountable and must deliver in accordance to. However, BDA activities in the form of requirements engineering, project development, strate-

gizing, and prioritization, was challenged by *undefined boundaries and areas of responsibility*. As explained by the Director of the department, "…it has not been very successful until now [referring to this activity]. And I believe it's due to the fact that we have tried to understand what our role actually means… some departments or individuals believe to have won the claim on certain BDA areas, where we try to enter". This is a recurring challenge, as BDA is regarded as a common capability to apply in the daily work for each department. The Director continues, "we often agree to disagree" about these areas and roles of responsibility, which complicate the collaboration between the departments involved in a BDA project on defining and understanding deliverables, such as user or product requirements. Another challenge in appreciating the organizational context for BDA impacts, is the *bounded organizational KPI's*. When debating how to specify the benefits of BDA, the senior data scientist commented, "…at the moment, those benefits must contribute to some general KPI that have nothing to do with data analytics." As such, the challenge would extend to the implication of defining a business case for BDA in activity #1, where value drivers link to organizational KPI. However, it was found that the organizational KPIs do not acknowledge a BDA contribution.

4.3 Explicate overall benefits

The activity contains the analysis and development of overall benefits from the offtake of the user. A user may be a human receiver, which allows BDA to support actions to be taken and interpreted by a human actor/receiver within the bounds of his/her capabilities. However, a user can also be another system such as, BDA application or a data development platform. The benefits from these types of use may be very different and *defining the users* of the BDA becomes particularly crucial in order be able to explicate the overall benefits. This lack of clarity left some users with a lack of understanding as to why a particular project was developed in the first place, "The product manager/BDA developer has not done his requirement collection sufficiently. He might simply have asked his colleagues sitting next to him" (Department Director). To this statement, the senior data scientist responded: "well that's the way it is. It's because it's political what they work with". Both agree that one must explicate the benefits from the users' standpoint by communicating, interviewing, and providing feedback in the BDA project. However, they do not regard themselves as being solely responsible for this and pointed to the product manager role. The activity of explicating the overall benefits also includes the challenge of *balancing organizational and user level* benefits. As explained by the department director, he would ask product management to clarify the demand from the user of the BDA application and if this user demand in question did not exist explicitly, then the demand could stem from management as a form of control element on organizational behavior. However, he was most likely not able to get an answer to this.

4.4 Define benefits measures

The logical dependency between activity #3 "explicate overall benefits" and #4 "define benefits measures" is evident, as measures must be established from the overall benefits explicated. The measures to be defined are essentially the hard facts on how the organization has changed as a consequence of the benefit that was set out to be achieved. The benefits can also be measured against the organizational KPI's earlier described in activity #2 "appreciate organizational context". Establishing such measures was not applied consequently, which often led to confusion about the impact of the BDA project and points to the challenge of not *establishing consistency and measurability*. No measurement of the change following a BDA project nor was a baseline of the situation prior to the BDA development established for comparison after project closure and realization of the benefits. However, some projects managed to establish measures related to "usefulness" of the BDA analyses for end-users. This had a positive impact on the realization of benefits due to the improved adoption from monitoring usefulness and adjusting if this was found low. Yet, measures from business cases and gate material was typically financial or closely related to financial such as, increase in performance or cost reductions through material or hours. These are by no means obsolete in establishing benefit measures. However, the challenge in not establishing benefits from *understanding affected activities* resulting from the BDA solution prescribes that an organization must extend its benefit focus to not only include hard benefit measures.

4.5 Understand benefits relationships across departments

The analytics process in Vestas, incorporates the activity of understanding the micro environment of the BDA project. However, *maintaining process consistency* across the BDA projects was challenging, "Well that (the process) is also ok, but there is simply no consequence! (not following it)" (Senior Data Scientist). The BDA developer were not conforming to the BDA process and the user, to which the BDA application is designed and who initiated the BDA project, inconsistently apply it to their work. Furthermore, a challenge of *establishing and managing a community* for BDA was evident. As a part of understanding benefits relationships across departments, a community can help connect people across departmental barriers. However, establishing and managing a community where those participating benefit from sharing their knowledge, projects, questions, and answers to others was challenging. The BDA community should potentially ensure deployment of a development process for data analytics. Yet, such a process was not being deployed and no community was established. Finally, in relation to understanding the benefits relationships across departments, there is the challenge of understanding the consequence of *insufficient data quality* for decision making pertaining to benefit dependencies of collecting, storing, and analyzing data to deployment for a user. This challenge was only to a very limited degree accommodated in the cross departmental BDA setting in question.

4.6 Measure of benefits and usefulness for end-users

Several challenges emerged from assessing this activity. As previously stated, benefit measures were rarely defined, which impacts this activity of measuring the benefits and usefulness. The first challenge is the *education of users* in understanding BDA results, taking guided actions from BDA, and in understanding the concept of risks associated with BDA analytics. As stated by the Senior Data Scientist, "…That's what's difficult about analytics…because the user simply does not understand what it is". Educating the users in analytics entails working with their understanding of the risks involved, "They simply don't understand that in analytics 5 is not as such the double of 2.5 in risk percentage of failure detection and costs associated" (Senior Data Scientist). This poor understanding of risk poses a challenge if the user does not take actions guided as intended provided from BDA. Incorporating the mitigation of education into a deployment strategy could accommodate the challenge. Yet, *developing deployment strategies* for BDA is not a pervasive practice, which was confirmed by the Senior Data Scientist, "No I don't believe we do this sufficiently… It becomes a one-man job". He elaborates that not enough BDA project members are involved and there is no clear alignment of responsibilities and understanding of how to deploy, "It is very symptomatically that you somehow just simply forget roll-out…that you just deliver to the next and then it must be their responsibility to roll-out, but they are thinking; "how are we supposed to do that"". However, obtaining documentation of deployment and successive impact measures would be done if a need to demonstrate impact to top management was evident. The department Director commented: "…then you demonstrate success, which you can announce in the organization and then use as a catalyzer for some other (projects)". Thus, using deployment documentation to help gain sponsoring of new BDA projects when needed.

4.7 Manage missing benefits

The activity of managing missing benefits attracted limited attention in the BDA projects, while still being regarded as extremely important. This challenge pertained to moving-on once a project was considered complete, "That's what's sometimes so extremely difficult, getting all the pieces of puzzles in to the project – you simply have to deal with it as you go along" (Senior data scientist). The project management documentation did not provide any *project methodology support* to manage missing benefits. A project is set to close within a given timeframe according to the development hours allocated for the project. Furthermore, the financial aspect of not capitalizing on the project before it is closed did not serve as encouragement to keep them open for managing any missing benefits. Thereby, the whole project model did not support activity #7. The activity also contains the challenge of the *comprehension and ease-of-use tension* for the users' application of BDA, "The analytical part is at a very high level. So just because you have something that has ease-of-use, it can be very difficult to comprehend and apply in real life" (Senior data scientist). Thus, educating the users may also be critical to accommodate

for their inability to understand a BDA solution. Yet, user education may simply be insufficient as it essentially is about understanding, which leads to the challenge of *assessing users' understanding*. Assessing a user's education in simple terms such as passed or acceptable may lead to the previous comprehension challenge. As stated by the Director of the Department: "passed but not necessarily understood" challenges the management of BDA benefits. Improving the users' understanding, enables their necessary change of practice for the realization of benefits. Nevertheless, the users' understanding of BDA is situated in highly specialized professions and is difficult to assess, even over longer periods.

4.8 Establish end-users

Activity #8 involves establishing the end-users, while this group of people or systems may change or simply become obsolete during the lifetime of the BDA solution. The continuous re-establishment of the end-users is emphasized by the senior data scientist, "… this is something you need to revisit all the time as the organization will change as well and maybe your end-users have actually disappeared along the way without it being your fault." The activity of establishing and continuously re-establishing end-users entail *unclear responsibility with dynamic use* as a challenge for this activity not supported in the general project model. Finally, ensuring general awareness and adoption of a BDA product points to the challenge of *organization-wide diffusion* of BDA products, which also links to a continuous re-establishment of users. Some users may find the BDA product themselves, whereas others who could benefit from it may not. A dedicated product manager or BDA community could pervasively direct potential users towards a BDA application they could benefit from to the benefit of the wider organization.

5 Discussion

The aim of this research was to advance knowledge on managing BDA development projects using a BRM perspective. Asking about challenges to realizing benefits of BDA development projects, we conducted a case study of a large organization highly invested in Big Data with 66 encounters over a 6 months period. We analyzed the extensive empirical data using an SSM approach to develop a conceptual model of the necessary activities (cf. Figure 1) each involving 2-3 important challenges in its execution. Each of these activities is related to previous research on respectively BRM and BDA (cf. Table 2).

While both BDA and BRM receives growing attention from IS researchers, limited research has investigated how the areas intersect at the level of projects. We propose the BRM perspective as an important contribution to the call for a broader spectrum of aspects of BDA (Constantiou and Kallinikos, 2015; Markus, 2015) and specifically, the call for research on the management challenges of BDA governance to facilitate the value creation process (Grover et al., 2018). Particularly, with the limited research focus on BDA to capture and create value, understood in BDA development as a transformation of insight to decision (Sharma et al., 2014). BRM research (Doherty, 2014) suggests that appropriate management is needed to realize benefits instead of implicitly assuming that the realization of benefits from BDA insights and decisions follows trivially and without effort. We contribute to the research on BDA development projects by empirically substantiating (cf. Section 4.1-4.8) activities involved in the management needed to realize benefits. These activities are explicitly related (cf. Table 2) to the six factors affecting the successful realization of benefits from systems development projects proposed by Doherty et al. (2012) and the prominent BRM process model by Ward and Daniel (2012). Table 2 also maps the relevant yet fragmented literature on realizing value from BDA development projects (Labrinidis and Jagadish, 2012; Guo, 2013; Kelly and Kaskade, 2013; Gandomi and Haider, 2015; Saltz, 2015; Dharmapal and Sikamani, 2016; Larson and Chang, 2016; Rose et al., 2017).

Space limitations do not allow for a detailed discussion of all the challenges separately. For BRM, most of a discussion will relate the challenges to specifically (Doherty et al., 2012; Ward and Daniel, 2012). Taking activity #7 as exemplary, we see that the challenge of no project methodology support is recognized in (Doherty et al., 2012) as they advocate to review the achieved benefits on-going and after the development project has ended. While (Doherty et al., 2012) emphasize that the need for on-going review they do not suggest that it should be included in the project methodology. The lesson learned from Vestas is, on the other hand that, if it is not in the project methodology, it runs the risk of being forgotten

and a project methodology would then be able to give support with regard to that of 'what' and 'how' questions which need to be answered in order to do it well. The challenge builds on a similar observation in (Ward and Daniel, 2012) that benefits are not always realized despite having been planned. Again, the challenge identified in Vestas suggests that the missing benefits can in part be explained by missing support for a project methodology. It is not that the existing project methodology is not generally supporting, but the challenge persists as most benefits must be realized after the development project has closed. The benefits realization can then be understood as another project, a follow-up project, but it is not necessarily the best organization of BRM activity residing in the business departments and not in the BDA department.

BDA Activities and Challenges	BRM Research	BDA Research
Formulate overall business case and prioritize - Inconsistent formulation practices - Undefined product management - Unilateral benefits	- Detailed benefits planning (Doherty et al., 2012) - Agree on objectives and outline BC (Ward and Daniel, 2012)	- BDA planning phase and requirements engineering (Dharmapal and Sikamani, 2016) - Discovery and scope (Larson and Chang, 2016) - Inaccurate scope of BDA projects as top challenge (Kelly and Kaskade, 2013) - Negotiate business problem (Rose et al., 2017)
Appreciate organizational context - Undefined boundaries and areas of responsibility - Bounded organizational KPIs	- Coherent governance structures (Doherty et al., 2012) - Identify organizational and stakeholder issues for potential project failure (Ward and Daniel, 2012)	- Delivery by answering representative business questions (Larson and Chang, 2016) - Understanding user needs and organizational needs (Kelly and Kaskade, 2013)
Explicate overall benefits - Defining the users - Balancing organizational and user level	- Stakeholder-enabled benefits realization (Doherty et al., 2012) - Identify all potential benefits that could be obtained (Ward and Daniel, 2012)	- Those involved in decision making should be included in development (Gandomi and Haider, 2015) - Understand user-specific cases first (Kelly and Kaskade, 2013)
Define benefits measures - Establishing consistency and measurability - Understanding affected activities	- Detailed benefits planning (Doherty et al., 2012) - Establish benefit ownership, measures, baseline, and expected values (Ward and Daniel, 2012)	- Establish critical success factors and ensure measurability (Saltz, 2015)
Understand benefits' relationships and across departments - Maintaining process consistency - Establishing and managing a community - Insufficient data quality	- Coherent governance structures (Doherty et al., 2012) - Understand IS/IT and business change leads to benefits realization (Ward and Daniel, 2012)	- Planning and stakeholder analysis (Dharmapal and Sikamani, 2016)
Measure of benefits and usefulness for end users - Education of users - Developing deployment strategies	- Active business leadership (Doherty et al., 2012) - Evidence or criteria for obtained benefits realization (Ward and Daniel, 2012)	- Inform the users of the analysis criteria for them to obtain the benefits from it (Labrinidis and Jagadish, 2012). - Value delivery (Larson and Chang, 2016).
Manage missing benefits - Project methodology support - Comprehension and ease-of-use tension - Assessing users' understanding	- Ongoing benefits review (Doherty et al., 2012) - Manage benefits that have not been realized (Ward and Daniel, 2012)	- Deployment stage in development process (Labrinidis and Jagadish, 2012) - Dissemination in the team (Guo, 2013) - Formal change management (Larson and Chang, 2016)
Establish end-users - Unclear responsibility with dynamic use - Organization-wide diffusion	- Management of transformation (Doherty et al., 2012) - Identify unexpected benefits and dis-benefits, provide lessons learned and actions for additional change (Ward and Daniel, 2012)	- Program management and end-user feedback (Larson and Chang, 2016) - People factors – dealing with negative and enthusiastic reactions (Rose et al., 2017)

Table 2: Research on BRM and BDA related to the eight activities

The discussion of activity #7 in the light of existing BDA research relates to (Labrinidis and Jagadish, 2012; Guo, 2013; Larson and Chang, 2016). The activity we have identified in Vestas is in accordance with (Labrinidis and Jagadish, 2012) call for a deployment process of BDA. Yet, what we have seen in addition in the case organization is that deployment is seen as part of the development process and the

case study questions with its challenges that as it is perhaps better to think of it as residing outside the development department, that is in the business department where benefits can be realized. The findings in (Larson and Chang, 2016) that change management is needed is similarly addressing that there is management activity and concern after the development project has ended as they call for formal change management, but they do not relate that explicitly to benefits and value-creation. It also links directly with 'assessing users' understanding' as the case study shows that BDA projects are more complex than most other IS development projects simply because of the complexity of the analytics and how to read and understand analytics results and outcomes. This is only partly dealt with by (Guo, 2013) where the understanding gets addressed as an issue within the team and not across business departments. Hence, (Guo, 2013) does not address the challenge of how business users understand analytics, and they do not relate it directly to benefits and value-creation with BDA.

With activity #7 as exemplary, we suggest that the challenges are of more general importance and needs to be studied in detail in the future. For example, for the three challenges of activity #7 we suggest that the following empirical research questions can address the current dearth of solutions and understanding in the existing research:

- *Project methodology support*:
  How can we support the managing missed benefits specifically when most benefits that are missing are monitored after the development project has ended?
  What is the right balance of what gets addressed during the development project and what gets addressed afterwards?
  How can the missed benefits be measured and monitored efficaciously?
- *Comprehension and ease-of-use tension*:
  How can we balance how easy-to-use a BDA outcome is against other factors such as easy-to-learn, accuracy, robustness, reliability, and required training effort?
  What is the cost of easy-to-use?
  What is the cost of comprehension?
- *Assessing users' understanding*:
  How can we assess the users' understanding of BDA outcomes?
  What is the impact of less understanding of BDA outcomes?
  How do users' understanding relate to benefits and value-creation?
  How can that assessment be fed back to the current and future BDA development projects?

The empirical research questions, we see, as part of a roadmap of future research. Our investigation of realizing value from BDA development projects (and Table 2 as a whole) points to several research opportunities. First, our research is in the terms of Grover et al. (2018) a problem-based investigation of BDA value and more specifically a general starting point for combining research on BDA development projects with research on BRM. We propose that our findings represent an initial understanding of a problematic situation in an area of high practical relevance and investments that IS researchers are predispositioned to impact. Second, the activities and challenges in Table 2 are a concretization of the problematic situation (Checkland and Scholes, 1990) compared to research on BDA value (Grover et al. 2018) but still unexhausted as each activity separately calls for additional research. Such research efforts may adopt engaged problem formulation involving multiple organizations to further enhance the problem dialogue and deliberation for simultaneously increasing richness and relevance of the problem understanding (Nielsen and Persson, 2016). Third, the reported scope of activities and challenges is based on a large organization with significant investments and technical competences in BDA. Other researchers may transfer and revisit the insights summarized in Table 2 to the smaller organizations with low budget investments in BDA solution reported on in other investigations (Rose et al., 2017). Forth, the proposed challenges and overall problematic situation call for problem solving research efforts. Researchers may use Action Research (McKay and Marshall, 2001), Design Science Research (Peffers et al., 2007), and Action Design Research (Sein et al., 2011) to find effective solutions to the challenges for individual or collections of activities. Fifth, future research efforts may assess the usefulness of our conceptual model for evaluating the comprehensiveness of new approaches to value creation in BDA

development projects against the key activities in our critical case (Flyvbjerg, 2006) of a large organization highly dedicated to Big Data. Furthermore, elaboration of the proposed conceptual model may improve its usefulness for evaluating problem solving artefacts for BDA projects resulting from Design Science Research.

Finally, our study provides preliminary implications for the practical management of BDA development projects incorporating BRM. BDA practitioners, who aspire to use BRM in their development processes, can use our conceptual model to prepare for the potential challenges the inherent activities may entail. The conceptual model offers an organizational change perspective stretching beyond the deployment activity as a collection of ongoing activities in the organization to ensure continuous value creation from BDA development projects.

6 Conclusion

We have investigated the challenges to realizing benefits of BDA development projects through a case study of the company Vestas Wind Systems A/S that use Big Data in many decisions and processes. Our research identifies challenges in eight key activities for incorporating BRM in BDA development projects. The activities include tracking benefits from their early identification in the business case to the decision process they should support and hereby the occurrence of the organizational change. We have for each of the activities identified the associated challenges and supported their identification throughout our analysis. We have then summarized the challenges in Table 2 and compared with the existing BRM research and with the existing BDA research. One of the activities has been discussed in more detail and how it specifically relates to the existing research. The contribution of the research is the 19 challenges relating to eight activities. We suggest that these challenges must be addressed in future research and for the one activity discussed in more detail, we have proposed exemplary empirical research questions. Our research may assist BDA mangers incorporate BRM activities into their development process and prepare for the challenges associated with each activity. In this way, our findings extend previous research on managing the value creation from BDA development projects with insights from practice in a large organization highly dedicated to exploiting Big Data. In conclusion, we suggest that our research on challenges should lead to more focused research on this topic.

References

Badewi, A. and E. Shehab. (2016). "The impact of organizational project benefits management governance on ERP project success: Neo-institutional theory perspective." *International Journal of Project Management*, *34*(3), 412–428.

Benbasat, I., D. K. Goldstein and M. Mead. (1987). "The Case Research Strategy in Studies of Information Systems Case Research." *MIS Quarterly*, *11*(3), 369–386.

Checkland, P. (1981). *Systems Thinking, Systems Practice.* Baffins Lane, Chichester: John Wiley & Sons Ltd,.

Checkland, P. and J. Scholes. (1990). *Soft Systems Methodology in Action*. Chichester, West Sussex: John Wiley & Sons Ltd,.

Constantiou, I. D. and J. Kallinikos. (2015). "New games, new rules: Big data and the changing context of strategy." *Journal of Information Technology*, *30*(1), 44–57.

Côrte-real, N., T. Oliveira and P. Ruivo. (2017). "Assessing business value of Big Data Analytics in European firms." *Journal of Business Research*, *70*, 379–390.

Cox, M. and D. Ellsworth. (1997). "Application-controlled demand paging for out-of-core visualization." In: *Proceedings. Visualization '97* (pp. 235–244).

Dharmapal, S. R. and K. T. Sikamani. (2016). "Big data analytics using agile model." *2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT)*, 1088–1091.

Doherty, N. F. (2014). "The role of socio-technical principles in leveraging meaningful benefits from IT investments." *Applied Ergonomics*, *45*(2 Part A), 181–187.

Doherty, N. F., C. Ashurst and J. Peppard. (2012). "Factors affecting the successful realisation of benefits from systems development projects: Findings from three case studies." *Journal of Information Technology, 27(1)*, 1–16.

Eason, K. (1988). *Information Technology and Organisational Change*. London: Taylor & Francis Ltd.
Fayyad, U., G. Piatetsky-Shapiro and S. Padhraic. (1996). "From data mining to knowledge discovery in databases." *AI Magazine*, *17*(3), 37(18).
Flyvbjerg, B. (2006). "Five Misunderstandings About Case-Study Research." *Qualitative Inquiry*, *12(2)*, 219–245.
Gandomi, A. and M. Haider. (2015). "Beyond the hype: Big data concepts, methods, and analytics." *International Journal of Information Management*, *35*(2), 137–144.
Grover, V., R. H. L. Chiang, T. P. Liang and D. Zhang. (2018). "Creating Strategic Business Value from Big Data Analytics: A Research Framework." *Journal of Management Information Systems*, *35*(2), 388–423.
Guo, P. (2013). "Data Science Workflow: Overview and Challenges." Retrieved from https://cacm.acm.org/blogs/blog-cacm/169199-data-science-workflow-overview-and-challenges/fulltext
Gupta, M. and J. F. George. (2016). "Toward the development of a big data analytics capability." *Information & Management*, *53*, 1049–1064.
Kelly, J. . and J. Kaskade. (2013). "CIOS & BIG DATA What Your IT Team Wants You to Know." *Infochimps Whitepaper (2013) 10*.
Labrinidis, A. and H. Jagadish. (2012). "Challenges and Opportunities with Big Data." In: *Proceedings of the VLDB Endowment* (Vol. 5, pp. 2032–2033).
Larson, D. and V. Chang. (2016). "A review and future direction of agile, business intelligence, analytics and data science." *International Journal of Information Management*, *36*(5), 700–710.
Markus, M. L. (2015). "New games, new rules, new scoreboards: the potential consequences of big data." *Journal of Information Technology*, *30*, 58–59.
McKay, J. and P. Marshall. (2001). "The dual imperatives of action research." *Information Technology & People*, *14*(1), 46–59.
Mikalef, P., I. O. Pappas, J. Krogstie and M. Giannakos. (2017). "Big data analytics capabilities: a systematic literature review and research agenda." *Information Systems and E-Business Management*, 1–32.
Mumford, E. (1995). *Effective Systems Design and Requirements Analysis - The ETHICS Approach*. London: MacMillan Press Ltd.
Nielsen, K. M. P., P. A. Nielsen and J. S. Persson. (2012). "It Benefits Management in Local Government: a comparative Case Study." In: *Proceedings of the 20th European Conference on Information Systems*.
Nielsen, P. A. and J. S. Persson. (2016). "Engaged Problem Formulation in IS Research." *Communications of the Association for Information Systems (CAIS)*, *38*(35), 720–737.
Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods, 4th Edition*. Thousands Oaks, California: SAGE Publications, Inc.
Pedersen, K. (2017). "Realizing e-government benefits with minimal capabilities." *Transforming Government: People, Process and Policy*, *11*(2), 262–285.
Peffers, K., T. Tuunanen, M. A. Rothenberger and S. Chatterjee. (2007). "A Design Science Research Methodology for Information Systems Research." *Journal of Management Information Systems*, *24*(3), 45–77.
Rose, J. (1997). "Soft systems methodology as a social science research tool." *Systems Research and Behavioral Science*, *14*(4), 249–258.
Rose, J., M. Berndtsson, G. Mathiason and P. Larsson. (2017). "The Advanced Analytics Jumpstart: Definition, Process Model, Best Practices." *JISTEM - Journal of Information Systems and Technology Management*, *14*(3), 339–360.
Saltz, J. S. (2015). "The need for new processes, methodologies and tools to support big data teams and improve big data project effectiveness." In: *Proceedings - 2015 IEEE International Conference on Big Data, IEEE Big Data 2015* (pp. 2066–2071).
Sein, M. K., O. Henfridsson, S. Purao, M. Rossi and R. Lindgren. (2011). "Action Design Research." *MIS Quarterly*, *35*(1), 37–56.
Sharma, R., S. Mithas and A. Kankanhalli. (2014). "Transforming decision-making processes: A research agenda for understanding the impact of business analytics on organisations." *European Journal of Information Systems*, *23*(4), 433–441.

Shearer, C. (2000). "The CRISP-DM model: The new blueprint for data mining." *Journal of Data Warehousing*, *5*(4), 13–22.

Ward, J. and A. Barker. (2013). "Undefined By Data : A Survey of Big Data Definitions." *ArXiv*.

Ward, J. and E. Daniel. (2012). *Benefits Management*. John Wiley & Sons Ltd,.

Ward, J. and R. Elvin. (1999). "A new framework for managing IT-enabled business change." *Information Systems Journal*, *9*, 197–221.

Waring, T., R. Casey and A. Robson. (2018). "Benefits realisation from IT-enabled innovation: A capability challenge for NHS English acute hospital trusts?" *Information Technology & People*, *31*(3), 618–645.

Yin, R. K. (2009). *Case Study Research: Design and Methods (4th Edition). Applied Social Research Methods Series*. London: SAGE Ltd.