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The role of big data and knowledge management in improving projects and project-based organizations

Anandasivakumar Ekambaram[a]*, Anette Ø. Sørensen[b], Heidi Bull-Berg[a], Nils O.E. Olsson[b]

[a]*SINTEF, S.P Andersens veg 5, 7031 Trondheim, Norway*
[b]*Norwegian University of Science and Technology, Department of Mechanical and Industrial Engineering, 7031 Trondheim, Norway*

Abstract

Knowledge management plays a significant role in organizations; supporting organizations to deal effectively with changes, increasing their productivity and paving the way to development and innovation. Several scientific studies have addressed the relevance of applying knowledge management initiatives to improve projects as well as organizations that conduct projects.

This paper will look at the interaction between knowledge management and big data within the context of projects. In this regard, this paper will discuss, among other things, (1) how big data can contribute to enhance knowledge management in projects and project-based organizations (2) what kind of pitfalls, challenges and opportunities that are associated with the interplay between knowledge management and big data (3) how this interplay can improve projects so that the projects can be carried out effectively and efficiently. These three questions are addressed by taking into consideration some of the important, underlying issues that are essential for ensuring improved decision making and performance in projects and project-based organizations.

This is primarily a conceptual paper with a literature study.

* Corresponding author. Tel.: +47 404 78 174
E-mail address: siva@sintef.no

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1. Introduction

Knowledge management has become an important aspect of modern organizations. Organizations' ability of learning and knowledge sharing can determine their productivity and sustainable competitive advantage [1] [2].

Knowledge management plays a significant role in organizations; supporting organizations to deal effectively with changes, increasing their productivity and paving the way to development and innovation. Several scientific articles have addressed the relevance of applying knowledge management initiatives to improve projects as well as organizations that conduct projects.

This paper will look at knowledge management in the context of projects with a particular focus on the concept of big data. Big data can be considered as an outcome / representation of the current technological capability to capture a huge amount of (real-time) data through different channels – such as monitors, sensors – that can then be analyzed to provide valuable information and knowledge. This paper will look at the interaction between knowledge management and big data within the context of projects. In this regard, this paper will discuss:

1. How big data can contribute to enhance knowledge management in projects and project-based organizations
2. What kind of pitfalls, challenges and opportunities that are associated with the interplay between knowledge management and big data
3. How this interplay can improve projects so that the projects can be carried out effectively and efficiently.

These three questions take into consideration some of the underlying issues that are essential for ensuring improved decision making and human reliability in a dynamic work-environment such as projects. The major assumption here is that obtaining better knowledge will lead to better (more effective) decisions. This is primarily a conceptual paper with a literature study.

In order to address the research questions that are stated above, this paper will first establish a context by looking at the relevance and connection between knowledge management and projects. And then, it will present a working definition / description of knowledge as a stepping stone to look at the aspects of big data. A brief description of big data will then follow and set a starting point of the discussion that will address the research questions.

2. Concepts and theories

In this section, we will present relevant theories and concepts as a framework for the discussion. In this regard, we will look at topics such as knowledge, knowledge management in projects and big data.

2.1. Knowledge

Several definitions of knowledge exist perhaps due to the need for representing the specific context in which they originate. Our intension here is not to present different definitions. However, we shall present a major categorization of knowledge and a working definition that we consider with respect to this paper.

In this regard, we use a categorization presented by Spender [3] that divides knowledge in three major categories:

- Knowledge-as-data: The category tends to suggest that knowledge is considered as an object, and to point out the explicit and objective characteristics of knowledge
- Knowledge-as-meaning: This category deals with reflection and sense-making
- Knowledge-as-practice: This category views knowledge beyond the cognitive spectrum – beyond the sense-making aspect. It incorporates tacit characteristics of knowledge

In this paper, we shall consider the following definition, given by Davenport and Prusak [4]:

"Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms".

In our opinion, the above definition reflects and summarizes the categorization given by Spender [3].

2.2. Knowledge management in projects

Projects are per definition unique. However, they have both unique and known elements. The unique elements provide opportunities for creating new knowledge. The known elements point out the relevance and need for sharing knowledge. These two categories can be considered as knowledge exploration and knowledge exploitation respectively. Hence, project settings are arenas for dealing with ambidexterity [5]. O'Reilly & Tushman [6] and Davis & Brady [7] describe organizational ambidexterity is a form of dynamic project capabilities. Müller et al. [8] link ambidexterity to flexibility and stability in project governance.

Sharing knowledge from one project to other projects have several benefits; for instance, avoiding or reducing *reinvention of the wheel* – reducing time and cost related to creating knowledge from the scratch. In addition to its obvious role in knowledge exploitation, knowledge sharing contributes also to knowledge exploration. Referring to previous studies, Mueller [9] mentions the need to focus on knowledge sharing to obtain wider benefits, including innovation (knowledge exploration): The author says that the flexible configuration of projects provides opportunities to overcome traditional barriers to innovation and organizational change, and be able to respond to requirements from customers in a timely manner. In order to ensure accomplishing these positive effects, project teams need some kind of autonomy to perform their tasks. Knowledge sharing and learning are hence important in this regard. Oyemomi et al. ([10], page 5222), based on their study, consider knowledge sharing as "a key factor for driving innovation as well as the organization's business performance [...]".

2.3. Big data

When describing big data, Olsson & Bull-Berg [11] present – based on previous studies – a common definition of big data. According to them, big data is about large amount of data that require a new way to process them. Traditional databases cannot adequately address issues related to collect, store, process or analyse the huge data sets. Differences between structured data in traditional databases and big data can be described by "the three Vs" [12]:

- Volume: This is the most significant aspect that characterizes Big data – the huge amount / volume. According to Manyika et al. [13], the global data volumes increase by 40 % every year.
- Velocity: Velocity means two things here. The first one is the flow of data – a constant stream of data. The other one is the possibility for making use of real time data.
- Variety: It indicates varying characteristics of the data (unstructured data, or data in different structures) as well as of sources that present these data.

There are other characteristics of big data, and there are other Vs. They are mentioned in Table 1.

Table 1: Technology revolution and the emergence of big data [14]

The Vs	Respective eras
Value	Social and semantic web era
Velocity	The mobile and Web 2.0 era
Veracity	The internet and WEB 1.0 era
Variety	The PC era
Volume	The mainframe era

The Vs point out that that many of the existing tool for analysing data are not appropriate to unleash the potential of big data. Since data from multiple sources, which are mostly of unstructured nature, are hence to be aggregated and analyzed in new contexts, there is a need to develop new solutions to deal effectively with big data.

There has been a rapid development in the area of big data in recent years. The following important developments are worth noting [11]:

- large quantities of data become available, including data from the internet and data based on sensor and tracking technology
- consumers are increasingly exposed to targeted advertising, specially on the internet
- increased pressure for making data available
- access to storage and analysis capabilities at low cost and
- access to IT platforms to put data into context, such as digital maps for presentation of position data, or building information models (BIM)

These developments can lead to ensure effective use of big data in organizational settings.

3. Research method

This paper is primarily based on a literature study – specifically speaking, it is based on a narrative literature study / review. Narrative literature review looks at various studies of a topic, and allows the reviewer to obtain an understanding of various views associated with the topic, and to make a holistic interpretation of the studies by using his / her experience as well as existing theories and models [15] [16].

Another description of narrative literature review is as follows:

> "It can inspire research ideas by identifying gaps or inconsistencies in a body of knowledge, thus helping the researcher to determine or define research questions or hypotheses. […] It can also be helpful in developing conceptual or theoretical frameworks" ([17], page 1).

Since this paper aims to develop more conceptual understanding of the chosen topic, narrative literature study suited well with the aim.

Jahan et al. [18], referring to previous studies, point out that the narrative literature review is more informal compare to systematic literature review, and it does not necessarily require to report more rigorous aspects that characterize structured / systematic literature review – aspects such as research methodology, search term, database that was used, and inclusion as well as exclusion criteria. As a result of this nature, the search related to narrative literature study starts normally from one or more known sources of knowledge, and then based on the available knowledge and information from the existing search-results, further sources of knowledge are identified and relevant knowledge is obtained.

When it comes to this paper, most of the sources (literature) are not earlier than 2015 and they are from international journals. However, some old literature is used to describe basic concepts and theories. The search words consist of big data combined with knowledge management, learning and decision making.

In addition, two of the authors of this paper are involved in guiding a master thesis work that was done at the Norwegian University of Science and Technology in 2016 [19]. The thesis work deals with real-time data-capture in building construction projects, and studied projects conducted in a building construction company in Norway. This involvement contributed to obtain insight and knowledge of application of big data in the building construction sector.

4. Reflection and discussion

Olsson & Bull-Berg [11] describe how big data can be utilized in projects. In this regard, they mention big data's potential in evaluating projects. In particular, several different data sets that illustrate the same phenomenon can be used for triangulation and quality assurance of facts in evaluations. It is however important to consider the potential costs and benefits of using big data compared to the more traditional and (sometimes inaccessible) data sources.

However, the authors point out challenges of applying big data in project evaluation. "One is that big data means a new way to deal with information and may require new use of statistical methods. Traditional statistical issues must be adapted to new types of data. The second challenge is the need for data covering a relatively long time period, typically several years" ([11], page 508). Evaluation of projects can be used to identify more appropriate and

effective decisions (what went wrong? How and why it went wrong?, etc.) and improve decision making process in the future projects and project investments.

Schrage [20] points out a big dilemma that organizations have. On one hand, organizations strive to accomplish robustness an agility. On the other hand, they want to engage all relevant stakeholders actively in their processes. This situation requires greater responsiveness and improved coordination. Schrage characterizes this situation as follows: "More people want to make more-agile decisions more often" [20]. The author points out that real-time situational awareness has been significantly increased as a result of the technological advancement; but, the author is sceptical about the achievement of the operational and managerial ability to act on data-driven information.

Different approaches, tools, and methods are used to act on data-driven information that will improve decision making in organizations; for example:

- Khan & Vorley [21] describe big data text analytics. In this regard, the authors, reflecting on previous studies, say that big data text analytics "has the potential to capture and utilise different sources of explicit and tacit knowledge and produce new depth of knowledge as a basis of more effective decision-making" (page 22).
- Schrage [20] describes a framework of decision rights called RACI (Responsible, Accountable, Consulted, Informed) framework that maps the persons involved in a particular task (and the decisions associated with the task). The author says that this framework will explain and describe authority and accountability for decisions and decision making.

We will now look at the characteristics and applicability of big data from the categorization [3] and definition [4] of knowledge that we have presented earlier.

As we have seen earlier, big data can provide a large amount of relevant data from various sources and contextual information. With respect to Spender's categorization of knowledge, knowledge-as-data points out the obvious connection between managing big data and managing knowledge. The contextual information provided by big data can contribute, at least to a certain extent, to create meaning from the data that are captured and presented by various sources of data. That is, contextual information can be provided by big data, but it does not necessarily mean that big data can ensure the creation of the intended meaning; the user may interpret the data / information in a different or wrong way. Schein [22] presents a classical example of how known terms can be interpreted differently. His study in an organization shows that the word "marketing" meant

- "Product development" to the engineer
- "Studying customers through market research" to the product manager
- "Merchandising" to the sales person, and
- "Constant change in design" to the manufacturing manager.

Different interpretations can occur not only in intra-organizational projects (as the above example points out), but also inter-organizational projects, specially multinational projects where people from different cultures participate. Hence, big data may address the category of knowledge-as-meaning inadequately.

The category knowledge-as-practice can be problematic. As we see it, knowledge-as-data is the category that is highly connected to big data. In order to study the big data in connection with knowledge management, it is natural to look at how human beings create logical meaning in what they think, say and do (knowledge–as-meaning), and how they learn in and through rational, intuitive, impulsive and creative activities that they do (knowledge-as-practice). Usage and benefits of big data do not emerge and function in a vacuum. People who use them (or are supposed to use them) determine the *liveliness* of big data.

According to Davenport & Prusak ([4], page 2), data is "a set of discrete, objective facts about events", and information is "a message, usually in the form of a document or an audible or visible communication". Their definition of knowledge, stated earlier in this paper, suggests that knowledge is the ability to interpret data and information. The new understanding that is resulted from this interpretation will then add to the knowledge base, which in turn helps to interpret and understand new data, information and situations.

In our opinion, knowledge is highly practice-based, and it can be created through reflection, interpretation, action, communication and cooperation. These mechanisms, possibly interacting with one another when knowledge is created, reflect the fluid mix of framed experience, values, contextual information and expert insight that are mentioned in the definition given by Davenport & Prusak [4].

The above description directs us to consider tacit dimension of knowledge. Importance of tacit knowledge is emphasized often in learning and knowledge management literature – for example, Polanyi [23], Nonaka & Takeuchi [24]. In social networks, there can be different kinds of ties between the members of the corresponding networks. Fernie et al. [25] says that strong ties, which represent high degree of trust, lengthy timeframes and close relationships, are ideal for transferring tacit elements of knowledge, whereas weak ties limit knowledge / information sharing. Wenger [26] and Bresnen et al. [27] also mention the importance of the informal nature of social networks in dealing with tacit elements of knowledge. How adequately big data can address and utilize the tacit dimension of knowledge is a major question / challenge. Another major question / challenge is, as we have mentioned earlier, how big data can ensure the creation of the intended meaning. These two questions are interrelated to a certain extent.

Big data is an area of rapid development [28] [29]. In future, development in the field of big data may provide some effective measures to address the challenges that are mentioned above.

Now, we will see a model for knowledge sharing and learning in projects and then discuss the notion of big data with respect to this model.

Several of the knowledge management initiatives and processes focus on both systems and people perspectives. One such model is presented in Figure 1 [30].

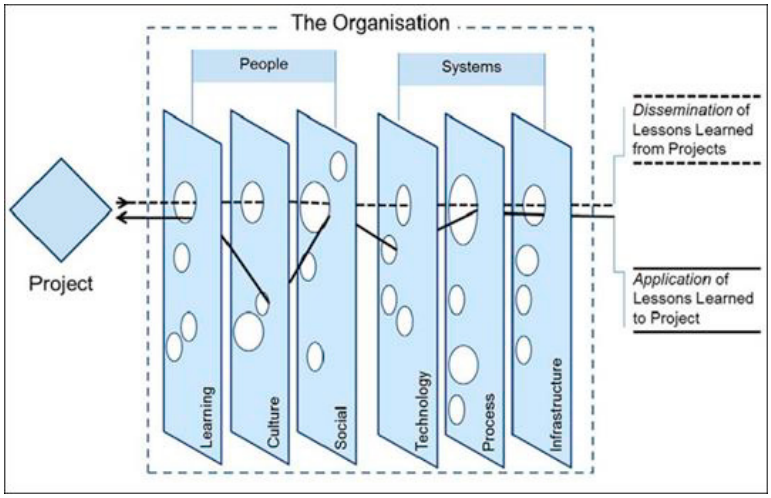

Figure 1: Refined Syllk model ([30], page 318)

The holes in Figure 2 represent possibilities for sharing knowledge – the more and wider the holes, the better chances for sharing knowledge. One can distinguish between a system (or hard) and a people (or soft) approach to learning and knowledge sharing. The system approach typically focuses on knowledge-as-data. A common approach is to create knowledge repositories of knowledge items. Knowledge repositories are electronic databases that are created for access by users. The databases can be filled through collecting and registering knowledge and valuable experiences.

The people approach focuses on human interaction, communication, reflection, sense-making (knowledge-as-meaning), and practice-based issues (knowledge-as-practice). This approach includes, among other things, communities of practice, storytelling and ad-hoc experience transfer (around the watercooler or coffee machine, etc.). Table 2 presents an explanation of the six key aspects that are presented in Figure 1.

The information presented in Table 2 provides a description of what kind of requirements that is needed for effective knowledge sharing / management in project-based organizations. This description can be viewed with respect to big data in order to assess the (potential) role of big data in improving project-based organizations.

Table 2: The six key aspects of knowledge management (Based on [30] and [31])

The six key aspects	Requirements for project learning	Learning instances	Knowledge management practices
Learning (People)	Qualifications, experience, skills	Individual attributes, organizational and individual knowledge	Communities of practice, Stories and lessons through storytelling, Mentoring/coaching
Culture (People)	Values, belief, passion	Examination of routines, work practices, production processes and outputs	Leadership teams (positive, supportive), Link to organizational objectives
Social activities (People)	Communication, teamwork, behavior	Exploration of new ideas through metaphor, analogy and problem solving	Communities of practice, Promoting conversation
Technology (Systems)	Equipment and software	Knowledge storage and transfer system	Knowledge libraries, portals, intranets
Process (Systems)	Planning, running and closing stages of a project	Examination of practices, processes and outputs, blended with new ideas	Knowledge management framework
Infrastructure (Systems)	Support from Project Management Office, Communities of Practice	Knowledge generation, development, storage and transfer	Communal knowledge work areas

The systems perspective of knowledge management includes, among other things, issues related to big data. The people perspective encompasses primarily informal nature of organizations that incorporates issues such as attitudes, behavior, inter-personal relationships, etc. [30]. If big data is combined with or assimilate vital aspects of the people perspective of knowledge management – for instance, combining or assimilating aspects of communities of practice, where professionals within a specific knowledge domain in project management (e.g. handling risks) meet regularly to share their experiences on the specific domain in an informal manner – then it can attain better results. Other practices mentioned in the 4th column of Table 2 can also be considered with respect to the use of big data in project settings. A master-thesis focusing on projects that are done by a building constructing company in Norway [19] also points out the need to take into consideration the people aspects in order to harvest greater benefits of big data.

As a summary, we can say that finding ways to integrate people aspects of knowledge management with big data can produce greater benefits – specially, contributing to make timely and more effective decisions.

5. Concluding remarks

The potential of big date is in the linking of data and the ability to see patterns and trends, providing opportunities to extract new knowledge [11]. This will help to improve planning and execution of projects in the future.

There is also a speculation that big data (big data analytics) may replace knowledge management in organizations in the future [29]. As we see it, dealing effectively with the tacit elements of knowledge, and ensuring the right interpretation of the knowledge that is presented by big data analytics can pose a challenge, at least for the time being. In this regard, it is important to pay adequate attention on the people perspective of knowledge management. Furthermore, Whyte et al. [28] point out the disruptive nature of big data that demands a new way of thinking. This can be seen as a challenge of attitudinal change.

Whatever the future will be, the role of big data is currently very relevant to managing knowledge in organizations. Therefore, it is important to look at and highlight the connection points and gaps between these two topics. In this regard, this paper highlights some of the key connection points and gaps, and emphasizes the importance of addressing the people perspective of knowledge management in the application of big data. This will enable better and timely decisions in dynamic work-environments such as projects.

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