Learning vs. bridging of Big Data for innovation development in the Smart Grid

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Abstract

This paper provides input on the use of information from Big Data analytics for innovation development in a Smart Grid cooperation. This research should show an approach on how to handle Big Data after analytics have filtered relevant information for an organizations. Thus, the research investigates the further processing of information from Big Data that can become knowledge and that can be used for innovation development. For this purpose, it has to be found out if project partners in the Smart Grid learn or bridge new knowledge from Big Data. The research aims at understanding innovation development between different actors in the Smart Grid and is therefore of great relevance in order to promote energy transition.

Keywords

Big Data, Smart Grid, innovation cooperation, learning, knowledge bridging.

Introduction

The future energy system aims to integrate decentralized and renewable energy, new actor structures and collaborations as well as innovative business models in the system to reach internationally agreed energy targets. To make these changes happen in the so-called Smart Grid concept, all technical components should be connected in the system for improving today’s currently inefficient and polluting energy supply. The Smart Grid is a two way communication of power and information exchange between all actors and assets (Giordano et al., 2011), which requires an increasing integration of information and communication technology (ICT) in the system. However, the large quantity of data that is generated by sensors and machines leads to challenges in the handling and processing for further use. Big Data analytics come into play here to convert mass data into useful information for organizations. The new information will not only be used as a memory and computer resources, but also for developing innovation in an organization. Although the technical possibilities to generate, process and store Big Data will be largely feasible in the near future, the dealing with a huge amount of information that occurred from Big Data is still far behind from a social point of view. Thus, the generation of knowledge from these new information hardly plays a role in today’s literature. This paper aims to take a socio-technical perspective on how organizations could handle information developed from Big Data and use it for innovation creation. This process from information to knowledge and finally to cooperative innovation development can be shaped either by learning or knowledge bridging processes. This research focus on how to handle this information for innovation development from a socio-technical perspective.

Big Data in the Smart Grid

Today, a social change to an information society can be recognized in which ICT is taking a dominant role. Although the importance of information and knowledge was already seen in the 1960s in the wake of increasing economic importance, today's significance has been created in particular through an easy access and exchange of information via the Internet. This change leads to a comprehensive upheaval in many areas of life and is particularly evident in the energy sector, where ICT is seen as an enabler for the Smart Grid (Koch and Rauh, 2017). In the Smart Grid, Big Data will be generated through the increasing connection of different technical components in the network. Five main characteristics can be assigned to Big Data in the Smart Grid (Zhu et al., 2015). First of all, Big Data in the Smart Grid is associated with (1) a high volume of...
data, (2) velocity that indicates the speed of data transmission and generation, (3) variety that describes diverse types of data and (4) veracity, which depicts the challenges that a large amount of data is often less trustworthy in its quality and accuracy. Lastly, a characteristic of Big Data in Smart Grids implies the extraction of (5) valuable data from the large quantity of information (Zhu et al., 2015). As such Big Data cannot be processed at one organization, the processing takes place in many locations. In order to dynamically shift work between these locations, it is necessary that actors in the Smart Grid have agile processes (Mohindra et al., 2013). Smart Grid actors use Big Data Analytics to convert the mass data generated in the Smart Grid into descriptive, prescriptive and predictive information, which cannot be done with conventional business intelligence programs (Jain, 2017). The aim of organizations is to use this new information to enhance business processes, to assist decision making or to use the information for innovation development. Big Data analytics should therefore process mass data developed in the Smart Grid to filter only useful information for an organization. Although Big Data analytics help an organization to gain relevant information, it is still questionable how to further handle these newly obtained information. Big Data analytics therefore reach its limits when regarding the further use of information for innovation development in an organization. Thus, in particular, the people in the organization are responsible for using the prepared information, creating knowledge and further establishing innovation with these information. This innovation development often takes place in the form of a cooperation, such as projects.

From technical Big Data to knowledge

Big Data is not only processed and transferred between technical systems, but the information from Big Data analytics is also used at the people working in an organization or other involved actors. The “Data, Information, Knowledge and Wisdom (DIKW) pyramid” developed by Ackoff in 1989 is used in this paper, because the transition from information produced by Big Data analytics to knowledge, which can be used in organizations for innovation development, is not yet fully explored. The DIKW model shows very well the distinction of data to information, knowledge and wisdom and justifies that information from analytics do not automatically mean knowledge that can be used for innovation development in an organization. Thus, information have to be first integrated through processes, such as learning, to become knowledge. This knowledge can be exchanged between organizations to develop innovations. However, it should be noted that the boundaries between the layers are sometimes blurred and a clear differentiation is not always easy to make in practice. Thus, in a cooperation information but also knowledge can be exchanged.

The DIKW pyramid shows the way from simple data existence, to the development of information, the creation of knowledge and lastly the achievement of wisdom. First of all, data are signals, numerical values, or words that are created through measurements or observations and which have no meaning at all. Only when they are bound into a context, data become information that can be useful, organized and structured. The raised information can be used to create knowledge by giving them a meaning. Knowledge is contextual synthesized and can be developed by learning processes. Wisdom is the understanding and integration of knowledge that is actionable for an organization (Ackoff, 1989).

Integrating valuable information from Big Data

To harvest and integrate information that is valuable for an organization is a challenging task. As already mentioned, Big Data is produced by many different actors in the Smart Grid. Especially due to growing interconnections between all actors in the Smart Grid, the importance to get new information beyond one’s own organizational border gets all the more important. Since most innovation do not originate in own
organization but within a cooperation, this research focuses on how to handle information from Big Data analytics between different actors in the Smart Grid to acquire knowledge, which will be exchanged for innovation development. However, the integration of information from Big Data in a Smart Grid for innovation development in organizations has not yet been concretely defined. Therefore, it must first be generally discussed how organizations learn or bridge knowledge from Big Data.

**Inter-organizational learning as an approach for handling Big Data**

Big Data has raised the complexity of integrating knowledge and changed the architecture of learning significantly. Learning turned from a process of information transaction into a matter of communication between heterogeneous actors (Gerybadze, 2004). Learning from Big Data means in this context that e.g. distribution network operators no longer only have to process their own data, but also use information from transmission network operators, flexibility providers, electrical vehicles or other actors in the energy market. Actors therefore have to be able to handle more as well as different kind of information that derived from Big Data. Three main forms of learning have been established, namely individual, inter-organizational and organizational learning (Sövell and Birkenshaw, 2007). Although the Smart Grid intends the coordination and knowledge transfer between different organizations in the system, it has to be first break down the learning process and distinguished between individual, organizational and inter-organizational learning to decide which form is necessary for collaboration in Smart Grid cooperation.

Next to economic and management interest in the early 1960s and late 1980s, organizational learning also took place in social science where empirical research has been conducted in this field. However, until today there is no consensus about what organizational learning actually is, thus, a definition that comprises the diverse intentions of organizational learning is not available in existing literature (Ellström, 2010). The following overview shows how existing literature describes organizational learning. In the literature, organizational learning is often equated with individual learning (Huber, 1991; Simon, 1991). Studies that emphasis on an individual level of learning in organizations often defend its focus with basic theoretical concepts, such as the concept of absorptive capacity (Cohen and Levinthal, 1990) or the Baddeley’s model of working memory (Baddeley and Hitch 1974), which can only be used by individuals. Also, authors like Tsai assume that learning of information depends on the absorptive capacity of an organization as well as on its access to corporate knowledge (Tsai, 2001). Organizational learning is therefore conveyed by learning through individuals and intends to be an interaction between the cognition and action of them (Ellström, 2010). Next to the individual level of analysis, other studies highlight the collective matter when taking about organizational learning (e.g. Cross and Israelit 2009). The place of learning is here the group in the form of a team, which is responsible for integrating new knowledge in an organization (Watkins and Marsick 1993). Advocates of this intention assume that organizational learning is not only the sum of each individuals learning, but it is more than that and therefore different than individuals learning. Senge explained in his study that the team is the basic level of learning processes (Senge, 1990) and it is more related to cognition, interaction, feedback, discussion and reflection in the team (Edmondson 2002).

Another level of analysis is the level of inter-organizational learning, which developed in the course of a rethinking of organization. Previous research often treated organizations as an autonomous system with closed borders (Ellström, 2010). This view changed through the interest in new organizational forms, like joint ventures, project work, innovation networks, multinational cooperation etc. These new forms of organizations brings in new conditions of competition and collaboration that influences the way organizations learn and should be therefore considered in upcoming analysis (Ellström, 2010). Currently, only a handful studies exist that deal with an inter-organizational level of learning. Thus, it is not well known what it means when learning takes place in an (international) collaboration between organizations. However, the approach of inter-organizational learning could become an important concept for the investigation of integrating knowledge from Big Data in organizations of the Smart Grid. However, it is not sure how inter-organizational learning indeed takes place as well as which mechanism control inter-organizational learning. Moreover, it should be taken into account that innovation development could be an interplay between different forms of learning. Crossan et al. is also convinced that organizational learning is not only limited to one level, but is a collaboration between many levels and can be therefore seen as a multilevel process (Crossan et al., 1999). This suggest to take the individual as well as organizational perspective into account in order to explain organizational learning from Big Data in Smart Grids.
Knowledge bridging as an approach for handling Big Data

Although the term learning is often used in the context of innovation development, the concept should not be taken for granted to describe the integration of new knowledge that occurred from Big Data. As stated above, the energy system is evolving towards new, ever-changing actor structures, increasing dependencies of organizational relations and technologies, and the emergence of Big Data that has to be handled in this changing environment of the Smart Grid. This means for actors in the Smart Grid that learning from distributed and specialized mass data gets more complex and demanding. Due to different fields of expertise, knowledge in the Smart Grid is often very specific and deeply integrated in the individuals but also in the different organizations. In the light of these circumstances, it is questionable to what extent a high amount of information that developed from Big Data can be learned by organizations.

An approach to handle this great amount of information for innovation development in a cooperation could be knowledge bridging. The concept of knowledge bridging intends that the knowledge integration between different organizations take place without learning. Thus, only the most relevant information will be transferred and integrated to fill in the knowledge gaps, which is necessary for innovation development. Kieser and Grunwald have investigated the appearance of knowledge bridging, which they call “Transactive Organizational Learning (TOI)”. According to the authors, TOI enables an expert in an innovation cooperation to use the knowledge from other experts without passing on its own knowledge to them (Kieser and Grunwald, 2007). Mattes defines knowledge bridging as a means for building a bridge between two individuals who stay single experts in their particular area. In contrast to learning, they do not share a common knowledge base, but bridge the relevant knowledge for the development of innovation (Mattes, 2010). The following figure 2 shows the differences between learning and bridging knowledge between two organizations.

![Figure 2: Own intention of learning and knowledge bridging between organizations](image)

Research gaps and future work

Although the terms have a widespread acceptance of notion, there still does not exist an agreement about what inter-organizational learning as well as knowledge bridging really is, how it arises and to which extent it develops in a cooperation (Argote 2011). The research in the field of learning between organizations as well as bridging knowledge is therefore still limited and not yet transferred to the new circumstances of a new actor structure, new technical and organizational dependencies and the emergence of Big Data in the Smart Grid. Studies therefore often explain conditions, but do not explain underlying mechanism of knowledge integration and its processes in the form of learning or bridging knowledge (Mattes, 2010). Due to the growing importance of integrating information from other organization, further investigations in the field of inter-organizational learning should be conducted that take the new circumstances of the Smart Grid into account. The research gaps lead to the question of how organizations could handle knowledge derived from Big Data and use it for innovation creation. Against this background, the EU Horizon 2020 project TDX-ASSIST will be used to investigate knowledge integration between different organizational groups. Thus, the way Smart Grid project actors learn or bridge knowledge should be investigated. The project TDX-ASSIST aims to create new ICT tools and techniques to enhance scalable and safe information...
systems and data transfer between transmission and distribution system operators. A data platform will be developed, which should integrate Big Data from different components of the energy system. Thus, the handling of information from Big Data between different organizations plays a key role in the project.

This research starts where Big Data Analytics leave off. Therefore, Big Data analytics are of little use if information is not understood or exchanged by the people of an organization and joint innovations cannot be developed. Thus, the further procedure with information from Big Data analytics shall be investigated in this research. This should answer the question of how the newly acquired technical information can best be used to generate new knowledge for innovation development. In-depth qualitative interviews will be used to find out whether actors in the Smart Grid bridge or learn new knowledge that occurred from Big Data as well as to what extent they do so. The research work should provide input for future research in the field of organizational learning and knowledge bridging, which is changing through new organizational forms.

REFERENCES