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Abstract

The use of Big Data can hold considerable benefits for organizations, but there is as yet little research on the impacts of Big Data use on key variables such as competitive advantage. The antecedents to Big Data use aiming at competitive advantage are also poorly understood. Drawing from prior research on the ICT-competitiveness link, this research examined the relationship of organizational use of Big Data and competitive advantage – as well as certain hypothesized antecedents to this relationship. Data was collected from a nationwide survey in Japan which was addressed to Big Data users in private companies. The result shows that the competitiveness is influenced by the systematic and extensive use of Big Data in the organization, and top management understanding for Big Data use. Antecedents of systematic and extensive Big Data use were found to be the cross-functional activities of analysts, proactive attitude of users, secured data management, and human resources. Future research should strive to verify these respondent opinions using longitudinal approaches based on objective financial data.

Keywords: Big Data, competitiveness, user, organizational use, Systematic use, Extensive use.

1   INTRODUCTION

When thinking about the relationship of information and communications technology (ICT) and the competitive advantage of organizations, it is not enough to consider how information systems are constructed and developed, or how they are integrated and managed. It is necessary to focus on how the users are utilizing the ICT in their activities. Indeed, user-oriented technologies are recently in the spotlight, such as Big Data, Cloud Computing, and Mobile Computing. This study addresses the relationship between Big Data use and organizational competitive advantage.

Although, in recent years, Big Data has become one trending topic in the business world with increasing interest also from the scientific and engineering community, there is as yet little research regarding the impacts to key variables such as competitive advantage. Furthermore, there is no commonly agreed definition of what is Big Data. In this research, Big Data is defined as follows, by reference to The Ministry of Internal Affairs and Communications of Japan (2014a).

"Big Data is large-scale data with varieties of sources and structures that cannot be processed by conventional methods and that is intended for organizational or societal problem solving."

An example would be multi-sourced unstructured text with location- and sensor-based real-time data in time series, which may be used to understand customer behavior in marketing.

The use of Big Data assumes ICT infrastructure. The information systems division (IS division) tends to undervalue the use processes just as in the operation and maintenance stages compared with the design and implement ones. However, it is the ICT user in business divisions who can create value by utilizing Big Data. More often than not, users distributed throughout the organization are involved in collecting, analyzing, integrating, and interpreting distributed massive data for decision-making and action-taking. The rent-generating use of Big Data should be organizational on the user side in addition to the system management side.

This study is focused on the relationship of organizational use of Big Data and the competitive advantage based on the evaluation by its users in private companies of Japan. We compiled a list of variables and antecedents for competitiveness-oriented Big Data use by learning from prior research on ICT and competitive advantage. Hypotheses were then created and data collected to verify these hypotheses. Our data was 1,363 responses to a survey about the Big Data usage in organizations. The results show that systematic and extensive use of Big Data and top management understanding for it are related with the competitive advantage. The results also show that a number of other variables are crucial for Big Data use in creating competitive advantage. The degrees of systematic and extensive use are positively related with the cross-functional activities of analysts, proactive attitude of users, secured data management, and human resources.

The paper consists of six chapters. After this introduction, the chapter 2 and 3 explain the background of the study and our hypothesis. The chapter 4 and 5 present the method and results. Finally, it is ended by conclusion and limitations in chapter 6.

2   THEORETICAL BACKGROUND

While there is a rapidly accumulating literature on overcoming the technical challenges underlying Big Data, there is as yet limited understanding on how Big Data impacts the core business of organizations. As the background of Big Data use, this chapter describes prior researches about the influence of ICT on the organizational competitive advantage, and theorizes on the possibilities on how Big Data can influence users to create competitive advantage in the organization.

2.1   ICT and competitive advantage

The role of ICT for organizational value has been examined extensively in prior research. For example, it has been found that investing in ICT can, on the average, bring value to the organization (Brynjolffson & Hitt 1996), but that the generation of this value is often dependent on various factors such as attaining sufficient user base (DeLone & McLean 2003, Devaraj & Kohli 2003), organizational restructuring to capture the potential of new ICT (Hammer 1990) or building new skills, competencies, and capabilities around the technology. The form that this benefit takes can be other than monetary, for instance, it can accrue from increased customer satisfaction (Krishnan et al. 1999). One approach to examine the value of ICT to organizations has been to study whether ICT improves the competitive standing of the organization in relation to other organizations, and in particular, whether this competitive advantage gained is sustainable in nature.

As the market environment is ever-changing, it has been argued that attaining sustainable competitive advantage using ICT requires that organizational rigidity is overcome. For example, Kettinger et al. (1994) found that it was crucial to build organizational readiness enabling new strategies, while Mata et al. (1995) underlined the importance of managerial ICT skills and management-level relationships. Powell & Dent-Micallef (1997) and Bhatt & Grover (2005) focus the attention to the human resources of the organization, including the capacity of the employees to form relationships in the organization and to keep learning new skills. Other scholars emphasize the characteristic of ICT as a technology that is tied to the organizational fabric in a complex way. For instance, Bharadwaj (2000) and Piccoli & Ives (2005) show that ICT can form barriers to organizational competitors by meshing with other complementary resources. It seems that using ICT as competitive weapon may require substantial planning and investments to create an organization-wide ICT capability based on lower-level competencies (Peppard & Ward 2004).

Recently, ICT is becoming ubiquitous and present in almost any organizational activity, while ICT services are being purchased and sourced from outside the organization. This commoditization of ICT may lead to the situation where differentiation in the competitive market is increasingly difficult with ICT. An investigation by Chae et al. (2014) found that ICT capability did not contribute to firm performance, and might serve as a warning of such a phenomenon. Therefore, it is an open question as to what degree recent ICT, such as those related to Cloud Computing and Big Data, is contributing to organizational competitive advantage. If indeed a contribution is evident, as discussed above, it is likely that it would be dependent on the valuable use of the data generated by the ICT, rather than the presence of the ICT itself. Big Data extracted from this ICT has the capacity to contribute to learning in the business (user) divisions. Therefore, Big Data shifts the focus back to the human resources of the organization and their capability to process data into knowledge and ultimately into organizational competitive advantage.

2.2   Big Data empowering the ICT user to create competitive advantage

As indicated above, the users in business divisions have long been seen as crucial in attaining ICT-dependent organizational competitive advantage. The role of the users has been seen from various viewpoints, for example, they have been considered important in the adoption and diffusion of systems (Davis et al. 1989, Cooper & Zmud 1990, Goodhue 1995), participating in the development of systems (Barki & Hartwick 1989, 1994), and acting as developers themselves (Galletta & Heckman 1990). Post-adoption of systems, that is their continued use beyond the initial stages of adoption, has also been recognized in the literature (Parthasarathy & Bhattacherjee 1998). Others have examined the generic mechanisms of how to help users derive benefits from the systems in order to increase their performance (Santhanam & Sein 1994, Goodhue 1995).

The conventional concept of "user" emphasized that the main source of potential for the organization was the system which was being used, not the person using the system. However, today's users are often knowledge workers, experts, and managers whose work revolves around information and whose work outcomes result from processing and analyzing information in teams (Brown & Duguid 1991, Nonaka 1994), not as isolated parts of the organizational machine. These users benefit from richness

of communication that allows them to translate their everyday practices and action-based knowing into organizational competence (Orlikowski 2002) and they should be supported by e.g. developing a knowledge-sharing culture, building processes and structures for knowledge sharing, and rewarding the use of knowledge (Lubit 2001). While it is certainly important to examine the gradual diffusion and adoption of Big Data tools in organizations, the true value of Big Data is likely to emerge in this type of knowledge-based work, wherein data is being processed into forms useful for decision-making.

The users as producers of knowledge has been highlighted in connection with the birth of competitive advantage of the organization. For example, Cepeda & Vera (2007) linked organizational knowledge areas to its operational capabilities. The infrastructure and processes facilitating knowledge activities have also been investigated. Gold et al. (2001) found that knowledge infrastructure capability, encompassing the technological and organizational infrastructure, and knowledge process capability, comprising the varied activities of knowledge processing, are linked to organizational effectiveness. According to Magnier-Watanabe & Senoo (2009), time spent on knowledge management activities contribute to the buildup of knowledge assets, which in turn influence competitive advantage. Other scholars, such as Narasimha (2000), Johannessen & Olsen (2003), Adams & Lamont (2003), and Chuang (2004) have also proposed the presence of a link between knowledge and sustainable competitive advantage.

The potential of Big Data in user-initiated knowledge creation is enormous. In particular, Yadav & Pavlou (2014) point out the possibilities of Big Data for marketing activities. Indeed, scholars link marketing information and organizational performance (Souchon et al. 2004, Nakata et al. 2006), and because the amount and quality of this information can be substantially increased via Big Data, this link will likely become more important in the future. The organizational marketing division has long been interested in the use of information systems (Souchon & Diamantopoulos 1996), and in recent years, the importance of ICT skills for staff in the marketing division has been in focus (Brady et al. 2002). The impact of Big Data on organizational sustained competitive advantage may be expected to be realized through knowledge creation activities taking place in the marketing divisions, which is located ideally in terms of access to customer data, and where interest regarding Big Data is already evident.

Recommendations from practical literature regarding Big Data use for competitive advantage stress the abilities and understanding of the management regarding the use of Big Data (LaValle et al. 2011, Klatt et al. 2011, McAfee & Brynjolfsson 2012). It is also argued that the statistical skills to extract information from the data mass should be available (LaValle et al. 2011, McAfee & Brynjolfsson 2012) and that business managers should build a decision-making culture that rewards basing decisions on large data sets (Klatt et al. 2011, McAfee & Brynjolfsson 2012). These practical prescriptions for the use of Big Data for organizational benefits seem familiar, but also indicate that the onus is on business divisions. Through such technologies, the source of competitive advantage may be shifting more to the favour of business divisions, who possess the day-to-day contacts with customers and understanding of the market situation. However, as indicated above, the business divisions should not assume that the technologies work as a silver bullet. As the research of Brynjolfsson et al. (2011) shows, the capabilities for data-driven decision-making need to have been acquired for impacts to firm performance. Moreover, the possibilities of Big Data may only be realized through a significant transformation, which is ultimately dependent on the creativity of organizational members (Fox & Do 2013).

3   MODEL AND HYPOTHESIS

Drawing from prior literature involving ICT and competitive advantage, an organization wishing to derive competitive advantage from Big Data use should prepare a number of resources and structures, some of which are expected to overlap with already known factors from ICT-competitiveness literature. ICT tools are needed (Petter et al. 2013), because the production, processing, analysis and management of Big Data should be set up from technological foundations. Another is personnel assigned to work with Big Data and their skills to use ICT. For example, the diffusion of cloud computing is bringing the tools for users to access vast computational resources and databases both

within and outside the organization, but may require users to learn new skills. Certain organizational arrangements, such as the ease of exchanging information across divisional borders, may promote the benefits of Big Data (Hauptman & Hirji 1999 and Brettel et al. 2011). On the other hand, free exchange of data must be backed up by firm security protocols to ensure that sensitive data is processed safely. Top management understanding (Wade & Hulland 2004) regarding Big Data and IS division power (Chen et al. 2010) may also catalyse the formation of Big Data capabilities that result in organizational benefits.

Considering that this study is in a very early stage on Big Data usage, we hesitated to introduce latent variables, and so the model is built on only observable variables as seen in Table 1.

| Variables / Constructs	Explanation
Competitiveness	Contribution of Big Data to organizational competitive advantage
SystematicBD_Use	Degree to which analysis, utilization, and management of Big Data is systematic, that is, performed in interconnected, well-designed processes
ExtensiveBD_Use	Degree to which utilization of Big Data is extensive, that is, horizontally and vertically diffused in the organization
TM_Understanding	Top management understanding of the importance of Big Data
CrossFunctionalAnlyst	Degree to which the Big Data analysis team operates across organizational divisions
U_ICT_Capabilities	Ability of user divisions to utilize ICT
ISforBD	Information systems available for the analysis and management of Big Data
ISdivPower	The IS division is powerful
U_ProactiveBD_Use	Proactivity of Big Data usage among the users
HRforBD	Ability and headcount of human resources working with Big Data
SecuredDM	Security of data management and utilization

Table 1.   Variables
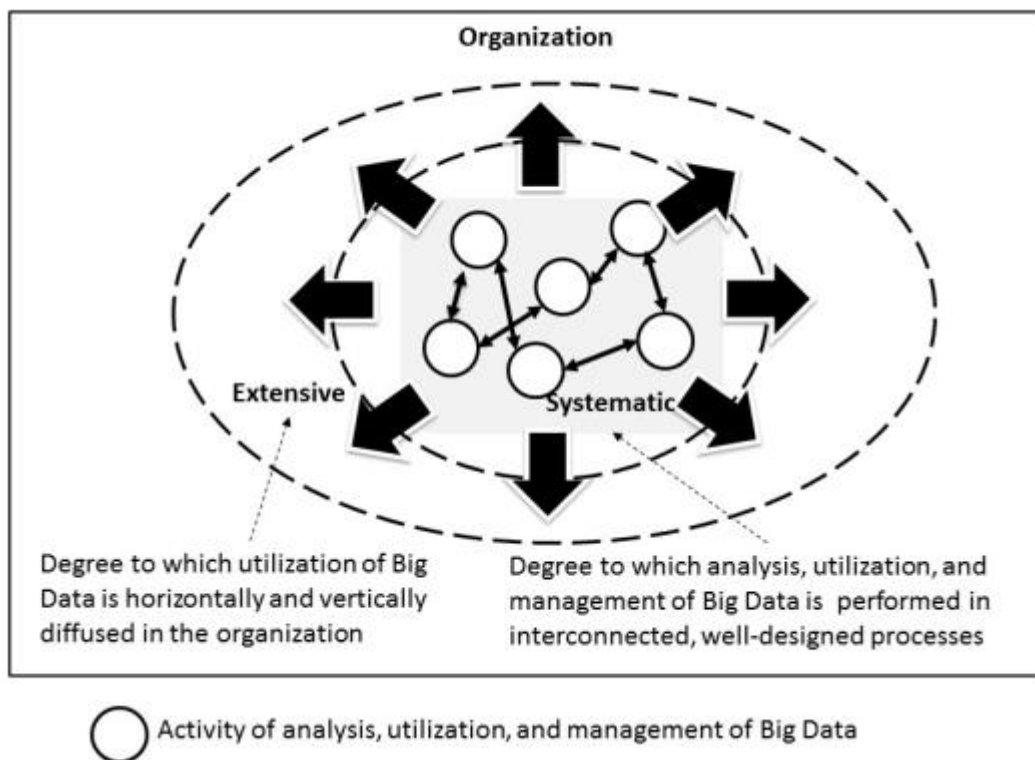
Figure 1.   Extensive and systematic Big Data utilization

This research hypothesized that the organizational use of Big Data for competitive advantage is dependent on whether Big Data is being used in a systematic and extensive manner (Figure 1). In order for Big Data use to have a contribution on the competitive advantage of the organization, it must be collected based on a deliberate plan, integrated, analyzed, and connected to managerial decision-making where it can make a difference in the actions taken by the organization as a whole. On the other hand, as Big Data is heavily reliant on involving the business users, sufficient adoption of these practices may be required throughout the organization for significant payoffs to take place. While it is necessary to involve operational staff, the involvement of management in the utilization of Big Data is also crucial so that use context of data intended for decision-making is properly understood.

Thus, the degree to which the use of Big Data is systematic is likely to influence the organization's competitive advantage. The use of Big Data is also likely to be more extensive in organizations which experience a benefit from Big Data to their competitive advantage, because such organizations would have the chance to exploit more data from different divisions in their decision-making than organizations where Big Data use is more limited. The involvement of top management has also been seen as important for the creation of competitive advantage (Wade & Hulland 2004). Thus, if top management is hesitant toward Big Data, it is doubtful that Big Data use would create competitive advantage.

H1: The more systematic the analysis, utilization, and management of Big Data is, the higher the benefit from Big Data to organizational competitive advantage (SystematicBD_Use ->Competitiveness)

H2: The more extensive the use of Big Data is within the organization, the higher the benefit from Big Data to organizational competitive advantage (ExtensiveBD_Use ->Competitiveness)

H3: The better top management understands the importance of Big Data, the higher the benefit from Big Data to organizational competitive advantage (TM_Understanding ->Competitiveness)

According to Hauptman & Hirji (1999) and Brettel et al. (2011), cross-functional activities contribute to product development efficiency and effectiveness. Therefore, we assume that cross-functional activities are necessary in organizations analyzing, utilizing and managing Big Data systematically.

H4: The more the Big Data analysis team is operating across divisional borders, the more systematic will Big Data use be (CrossFunctionalAnlyst-> SystematicBD_Use)

According to Bharadwaj (2000), IS infrastructure and ICT skills are linked to ICT capability. This leads to the expectation that, to the extent that the ability of users to use information systems is high, and high-quality organizational information systems are provided, it is easier to utilize Big Data in a systematic manner in the organization. In addition, according to Chen et al. (2010), Chief Information Officer's leadership is linked to organizational strategic growth. This suggests that, if the IS division holds significant power, it can be expected that organizational ICT management and ICT governance are well established and enforced, and therefore can contribute to the systematic utilization of Big Data.

H5: The higher the level of user skill in ICT utilization, the more systematic will Big Data use be (U_ICT_Capabilities -> SystematicBD_Use)

H6: The better information systems are provided for the analysis and management of Big Data, the more systematic will Big Data use be (ISforBD -> SystematicBD_Use)

H7: The more powerful the IS division is, the more systematic will Big Data use be (ISdivPower -> SystematicBD_Use)

As pointed out by DeLone and McLean (2003), user satisfaction and intentions to use are crucial to adoption of systems. Similarly, it can be expected that the attitude of users toward Big Data is connected to the widespread utilization of Big Data in the organization. If the users' attitude toward Big Data is positive, the utilization possibilities of Big Data can be more extensive. Human resources are also needed for extending the scale of utilization. However, doubts regarding the confidentiality of

information can be a factor that can inhibit the utilization of Big Data. If data can be managed securely, this can help promulgate the utilization of Big Data.

H8: The more proactive the utilization of Big Data by the users, the more extensive the use of Big Data will be in the organization (U_ProactiveBD_Use -> ExtensiveBD_Use)

H9: The higher the ability and greater the number of Big Data human resources, the more extensive the use of Big Data will be in the organization (HRforBD -> ExtensiveBD_Use)

H10: The more safely data is managed and utilized, the more extensive the use of Big Data will be in the organization (SecuredDM -> ExtensiveBD_Use)

The analysis and management of Big Data occurs because information systems infrastructure is available. According to Bharadwaj (2000), IS infrastructure and ICT skills are linked to ICT capability. Similarly, since the infrastructure is expected to provide a beneficial environment for promoting the use of Big Data, ICT infrastructure and the ability to use information systems are connected to how extensively Big Data is used in the organization. In addition, according to Chen et al. (2010), Chief Information Officer's leadership is linked to organizational strategic growth. Inferring from it, the degree to which the IS division is powerful is impacting the strength of ICT management and governance, and thereby can increase the extent of Big Data use in the organization.

H11: The higher the skills to use ICT in the user divisions, the more extensive the use of Big Data will be in the organization (U_ICT_Capabilities -> ExtensiveBD_Use)

H12: The better information systems are provided for the analysis and management of Big Data, the more extensive the use of Big Data will be in the organization (ISforBD -> ExtensiveBD_Use)

H13: The more powerful the IS division is, the more extensive the use of Big Data will be in the organization (ISdivPower -> ExtensiveBD_Use)

4   METHOD

The Ministry of Internal Affairs and Communications of Japan commissioned a committee, of which one of the authors is a member, to conduct questionnaire surveys in order to collect data for building a training curriculum on Big Data usage in "Promoting the development of advanced ICT human resources" (The Ministry of Internal Affairs and Communications of Japan 2014b). The questionnaire consists of 41 questions related to knowledge about and current utilization of Big Data, the necessary skills to use Big Data, and the respondents' opinions on which courses would be needed in a Big Data -oriented training curriculum, in addition to background information on the respondents and their organization. This research concentrates on analyzing the data extracted from this questionnaire from the perspective of the utilization of Big Data in organizations.

Big Data was explained as follows to the recipients of the survey invitation.

"Large-scale data that has become possible and easy to create, collect, and store by the advancement of ICT. Such data is not limited to rapidly accumulating data e.g. derived from web page access logs or GPS sensors, or unstructured data that is difficult to store and analyze by older database software e.g. SNS logs or video files, but can also signify bulky data that is already present in databases but which is particularly time-consuming to process, e.g. product purchase histories and usage histories."

The survey took place in October 2012, and was focused on the online subscribers of two well-known business magazines in Japan, "Nikkei Business Online" and "Nikkei Digital Marketing", both owned by Nikkei Business Publications, inc. Nikkei Business Online is a major business magazine with approximately 1,700,000 subscribers at the time. Nikkei Digital Marketing is a magazine, which often features Big Data, and had 4,600 subscribers. A random sample of 6,134 people from Nikkei Business Online and 2,611 people from Nikkei Digital Marketing was selected, and an email was sent to this group to ask for their cooperation in responding to the web-based questionnaire. Double subscription to both magazines was eliminated. The number of respondents was 3,024.

The study was interested in the relationship between the user of Big Data and competitiveness in organizations. Therefore, respondents corresponding to all three of the following profiles were selected as the sample:

- Respondents affiliated to a private company, and
- Respondents currently engaged in the use, analysis, management, or decision-making related to Big Data, and
- Respondents having no missing values in any of the 11 data items as outlined in the model above.

Firm Size	User Div.	IS Div.	Total
< 20	135	13	148
< 100	137	71	208
< 300	136	44	180
< 500	70	39	109
< 1000	96	66	162
>=1000	383	173	556
Total	957	406	1363

Table 2.   Sample by Firm Size and Division

Variable	Mean	S.D.	Cronbachα
Competitiveness	2.962	1.089	0.869
SystematicBD_Use	2.316	1.135	0.851
ExtensiveBD_Use	2.455	0.917	0.870
TM_Understanding	2.941	1.145	0.862
CrossFunctionalAnlyst	2.328	1.152	0.852
U_ICT_Capabilities	2.569	1.068	0.859
ISforBD	2.301	1.082	0.852
ISdivPower	2.908	1.145	0.878
U_ProactiveBD_Use	2.624	1.108	0.858
HRforBD	2.200	0.922	0.873
SecuredDM	2.863	0.889	0.876

Table 3.   Summary Statistics and Cronbach alpha

The screening resulted in 1,363 respondents corresponding to all the above criteria. A gift card worth 500 Japanese yen was offered as reward to all respondents. As all data was recorded anonymously, the email addresses of the respondents were not recorded together with the survey data.

Table 2 shows the distribution of our final sample with respect to user/IS division and company size. As large companies are defined as those with 500 employees or more, the sample of these companies is 718. Companies with a fewer number of employees are defined as small and medium-sized companies, the sample of which is 645. The number of respondents affiliated to organizational IS divisions were 406, and those affiliated to user divisions (non-IS divisions) were 957, respectively (see Table 2).

Five-point Likert scale was used for the variables introduced in the model above. As the questionnaire has one question corresponding to a variable on the list, the value of each variable originates from the

response of one question. Summary Statistics and Cronbach alpha are presented in Table 3, and correlation matrix is in Table 4. As can be seen in Table 3, scale reliability was measured with the Cronbach alpha coefficient and all coefficients were greater than .7, indicating that reliability is acceptable.

	1	2	3	4	5	6	7	8	9	10	11
1.Competitiveness	1.000	0.436	0.343	0.351	0.421	0.341	0.446	0.204	0.373	0.224	0.260
2.SystematicBD_Use	0.436	1.000	0.350	0.525	0.796	0.520	0.776	0.337	0.565	0.329	0.269
3.ExtensiveBD_Use	0.343	0.350	1.000	0.262	0.318	0.323	0.338	0.137	0.311	0.648	0.391
4.TM_Understanding	0.351	0.525	0.262	1.000	0.553	0.484	0.517	0.369	0.551	0.182	0.188
5.CrossFunctional Anlyst	0.421	0.796	0.318	0.553	1.000	0.533	0.723	0.323	0.580	0.320	0.246
6.U_ICT_Capabilities	0.341	0.520	0.323	0.484	0.533	1.000	0.538	0.357	0.596	0.295	0.267
7.ISforBD	0.446	0.776	0.338	0.517	0.723	0.538	1.000	0.329	0.540	0.333	0.293
8.ISdivPower	0.204	0.337	0.137	0.369	0.323	0.357	0.329	1.000	0.312	0.081	0.119
9.U_ProactiveBD_use	0.373	0.565	0.311	0.551	0.580	0.596	0.540	0.312	1.000	0.257	0.224
10.HRforBD	0.224	0.329	0.648	0.182	0.320	0.295	0.333	0.081	0.257	1.000	0.394
11.SecuredDM	0.260	0.269	0.391	0.188	0.246	0.267	0.293	0.119	0.224	0.394	1.000

Table 4.   Correlation

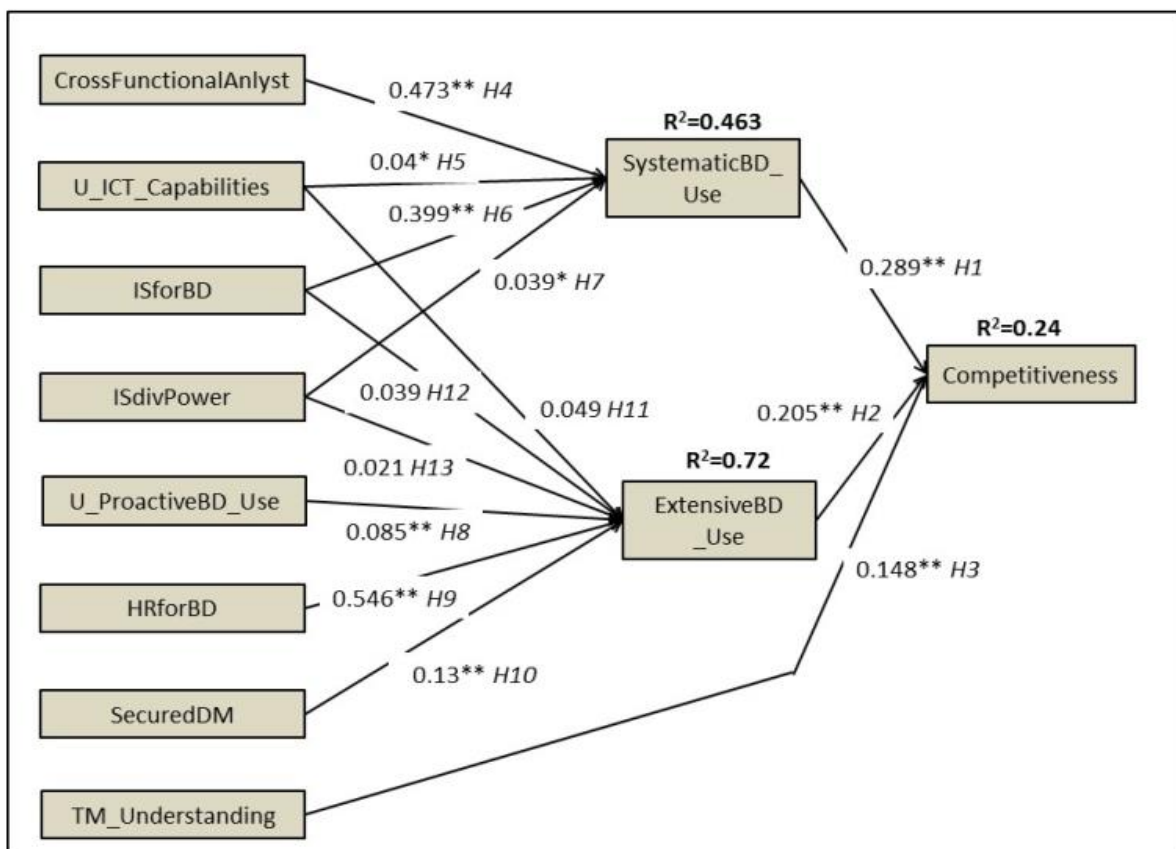*Figure 2.   Path Analysis Results (p< 0.05, ** p< 0.01, GFI=0.988, AGFI=0.943, CFI=0.989, REMSEA=0.64)*

5   RESULTS

Structural equation modelling by IBM SPSS AMOS version 2.0 was used to estimate the causal relationships in the hypotheses. Figure 2 depicts the results. The four measurement indexes fit well with the goodness of fit (GFI) index = .988, adjusted goodness of fit (AGFI) index = .943, comparative fit index (CFI) = .989, and root mean squared error of approximation (RMSEA) = .064. R-square values for Competitiveness, SystematicBD_Use, and ExtensiveBD_Use are 0.24, 0.463, and 0.72, respectively.

As summarized in Figure 2, all the hypothesized path coefficients except H11, H12, and H13 are significant.

- In support of H1, H2, and H3, the more systematic the analysis, utilization and management of Big Data, the more extensive the utilization of Big Data in the organization, and the higher the top management understanding of the importance of Big Data use, the higher the contribution of Big Data to organizational competitive advantage.
- In support of H4, H5, H6, and H7, the more cross-functionally the Big Data analysis team is operating, the higher the user division ICT skills, the better information systems are provided for the analysis and management of Big Data, and the more powerful the IS division is, the more systematic is the analysis, utilization and management of Big Data.
- In support of H8, H9, and H10, the more proactive the user divisions are in the use of Big Data, the higher the ability and greater the number of Big Data human resources, and the more securely data is being managed and used, the more extensive the utilization of Big Data will be in the organization.
- However, none of H11, H12, or H13 is supported. Therefore, the degree of extensive use of Big Data in the organization is not significantly related with user ability to utilize ICT, the information systems for the analysis and management of Big Data, and the power of IS divisions.

The appendix presents the path coefficients and R-squared value of the respondents by the size of their affiliated companies and by the affiliation to the user division or the IS division. Some differences in the results are seen when company size and affiliation to user/IS division vary, but most of the path coefficients and R-squared values tended to be similar.

6   CONCLUSION, LIMITATIONS, AND FURTHER RESEARCH

The rapid advancement of technologies capable of generating and processing large amounts of data is having a profound impact on societies and organizations. Users of ICT have become an important competitive force for organizations as the profitable use of data is increasingly demanded in value-creation. Data and information have become critical, underlining the users of Big Data in creating new knowledge and opportunities for organizations.

Drawing on prior research, ICT and organizational competitive advantage are linked in complex ways (e.g. Petter et al. 2013). Therefore, utilizing Big Data for competitive advantage would likewise depend on several antecedents, some of them similar as found for the link between ICT and competitiveness, some perhaps new. In this research, we examine the link between Big Data use and competitive advantage by assuming that this relationship is dependent on several hypothesized variables, which were selected partly based on prior literature, and partly based on the researchers' intuition. We analyzed the survey responses of employees who are involved with Big Data activities in their organizations and succeeded obtaining evidence as to the link between Big Data and competitive advantage, as well as the existence of several antecedents. The results may be interpreted as follows.

Firstly, we divided the use of Big Data into systematic and extensive use of Big Data in the organization, and found that both the degree of how systematic and how extensive the usage of Big Data is in the organization are linked to competitive advantage using Big Data (H1 and H2). Further,

the responses indicate that management involvement and understanding also was connected to competitive advantage using Big Data (H3).

Regarding the antecedent factors which were connected with systematic Big Data use, the cross-functional activities of employees who are tasked with analyzing Big Data was found to be one antecedent (H4). Moreover, the availability of information systems for Big Data processing, the ICT use abilities of users, and the power of the IS division all had a positive effect on the organizational use of Big Data (H5, H6, and H7). Naturally, the use of Big Data requires the presence of technology and user ICT abilities. A powerful IS division may also contribute to the effective harnessing of these elements.

Regarding antecedents to the extensive use of Big Data, the positive attitudes of the users, the sufficiency of human resources, and the secure management of data were found to have an influence on the extent of Big Data use (H8, H9, and H10). These can be considered to be according to expectations. However, while user ICT skills did have some correlation with the extent of Big Data use, this was not strongly evident from the data (H11). Moreover, the presence of information systems for Big Data did not appear to have an influence on the extent of Big Data use (H12). Combined with H8, it appears that the information systems by themselves have little impact on the extent of use. Rather, the role of the user appears to be important. This is also suggested by the finding that the power of the IS division was also not connected with the extent of use (H13).

A few differences can be seen in the results when company size and affiliated division are varied as in the Appendix table. Although the reasons in the differences are not clear, some of them might be attributed to the factor that such divisions are not clear in the case of small and medium-sized enterprises, and the users of Big Data are at the same time on the side of the ICT supplier in the case of the IS division.

The above results should be taken with full awareness of the limitations of this research. First, as the definition of Big Data has not been fixed in the scientific community, there were limits as to how well measures used to investigate the use of Big Data could be based on constructs in prior literature. This research relied on related literature e.g. on ICT and competitive advantage in establishing the research model, and adopted constructs which seemed likely to have importance for Big Data in particular. Future research in this vein should strive to establish a definition for Big Data and embed it in the corpus of literature of ICT role in competitive advantage. Second, each variable was measured using a single question in the survey form. Future research is recommended to use more wide-ranging data to construct factors to gain more robust understanding of the relationships of these variables. Third, the data used was limited to a one-time snapshot of the subjective opinions of the respondents. For example, financial data that could be used to confirm whether profit or competitive advantage was gained as a result of Big Data was not collected. There was also no possibility to obtain longitudinal data to account for the gradual accumulation of benefits to organizations. Moreover, as Big Data is a relatively new trend in business, this survey can be assumed to show data of organizations which are early adopters of Big Data. In the future, a long-term and concurrently a more ambitious scheme for data collection is necessary.

This research resulted in suggesting – and obtaining exploratory evidence in support of – antecedents for the use of Big Data for organizational competitive advantage. While it is too early to draw recommendations for organizations considering to adopt Big Data, it appears that Big Data must be used in a systematic way at several organizational levels in order to reap significant organizational benefits from it. This research also suggests that many familiar antecedents contribute to the creation of competitiveness via Big Data. Future research should use constructs and data that can more objectively and rigorously collect evidence on the presence of these antecedents. An approach to form a link between Big Data use and the competitive advantage of organizations is important to demonstrate the potential benefits of this technology to decision-makers.

7   ACKNOWLEDGEMENTS

APPENDIX

Hypothesis	N=1363 P.C.	N=1363 P	Large Enterprise N=718 P.C.	Large Enterprise N=718 P	Small&Medium Enterprise N=645 P.C.	Small&Medium Enterprise N=645 P	User Div. N=957 P.C.	User Div. N=957 P	IS Div. N=406 P.C.	IS Div. N=406 P
1.Competitiveness← SystematicBD_Use	0.289	***	0.324	***	0.268	***	0.26	***	0.366	***
2.Competitiveness← ExtensiveBD_Use	0.205	***	0.236	***	0.174	***	0.197	***	0.228	***
3.Competitiveness← TM_Understanding	0.148	***	0.109	0.004	0.175	***	0.14	***	0.152	0.001
4.SystematicBD_Use← CrossFunctionalAnlyst	0.473	***	0.478	***	0.459	***	0.435	***	0.569	***
5.SystematicBD_Use← U_ICT_Capabilities	0.04	0.026	0.064	0.013	0.016	0.522	0.056	0.011	-0.004	0.886
6.SystematicBD_Use← ISforBD	0.399	***	0.374	***	0.427	***	0.416	***	0.358	***
7.SystematicBD_Use← ISdivPower	0.039	0.013	0.034	0.11	0.047	0.045	0.036	0.069	0.055	0.027
8.ExtensiveBD_Use← U_ProactiveBD_Use	0.085	0.001	0.087	0.015	0.076	0.047	0.073	0.02	0.133	0.006
9.ExtensiveBD_Use← HRforBD	0.546	***	0.53	***	0.565	***	0.552	***	0.515	***
10.ExtensiveBD_Use← SecuredDM	0.13	***	0.152	***	0.104	0.001	0.127	***	0.149	***
11.ExtensiveBD_Use← U_ICT_Capabilities	0.049	0.069	0.025	0.502	0.078	0.043	0.067	0.039	0.006	0.9
12.ExtensiveBD_Use← ISforBD	0.039	0.132	0.061	0.095	0.025	0.488	0.042	0.168	0.036	0.453
13.ExtensiveBD_Use← ISdivPower	0.021	0.337	0.006	0.825	0.043	0.177	0.002	0.943	0.041	0.276
ExtensiveBD_Use R²	0.463		0.47		0.459		0.456		0.484	
SystematicBD_Use R²	0.72		0.711		0.715		0.706		0.763	
Competitiveness R²	0.239		0.276		0.211		0.202		0.345	
GFI, AGFI, CFI, REMSEA	0.988, 0.943, 0.989, 0.064		0.986, 0.933. 0.988, 0.067		0.986, 0.932, 0.988, 0.64		0.988, 0.945, 0.99, 0.06		0.978, 0.896, 0.983, 0.82	

Path coefficients (P.C.) and R² by firm size and division (P=probability)

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