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Big Data Analytics and Strategic Decision Making: A Study of Select ICT Companies

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Abstract

Present day enterprises are generating massive business data, mainly due to digitalization or digital transformation of their business processes. These business data have multi-structured data formats. These include structured, semi-structured and unstructured data formats. Thus, frequent innovations and developments in emerging technologies are desired to handle such voluminous, rapid and complex data formats. Big data analytics (BDA) technology is one such innovation in recent years, which is extensively used for handling and meaningfully interpreting multi-structured data. It helps establish a data-driven ecosystem for efficiently managing today's dynamic business environment and the associated decision-making. It further facilitates the decision-making process to be more data-driven and automated with lesser influence of the management team in a business enterprise's day-to-day activities. This research study aims to identify the role of big data analytics technology in the process of decision-making for an enterprise, specifically in the context of strategic decision-making. This research establishes a linkage between big data analytics technology and strategic decision-making process, assuming that the big data analytics technology deployed in an enterprise results in the development of organizational capabilities and attributes, which will further influence the strategic decision-making processes and capabilities. This assumption can be tested using longitudinal and cross-sectional studies. However, the present attempt will confine to cross-sectional study and identification of the attributes of strategic decision-making, which were found to be moderate to highly influenced by the capabilities developed due to the emerging technologies like big data analytics and its deployment in an organization. It has helped to understand the role of technology in influencing complex

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business processes like strategic decision-making and thus helps motivate enterprises to adopt big data analytics technology to solve their multifaceted problems.

Keywords: Big data analytics, strategic decision making, big data, and big data analytics capabilities.

1. Introduction:

Emerging technologies used for business modernization have led to massive process disruptions and higher stakeholder expectations from the businesses. Information Communication Technology (ICT) enables these modern technologies to manage today's dynamic business environment, which is highly volatile and unpredictable. Due to this reason, an enterprise is required to tune its core strategies and related decision-making (strategic decision-making) capabilities continuously. The role of strategic decision-making has been evident as critical, with the make or break of companies in a short span of time, mainly due to oversight of a threat (yahoo vs. google) or under-sighting of an opportunity (Kodak vs. digital technologies). Hence, it is prudent for any business organization to handle its decision-making process more intelligently, i.e., by using IT-enabled processes. Big data analytics(BDA) technology offers the desired attributes needed to achieve it. In practice also, BDA has helped businesses with more insightful and authenticated facts by using artificial intelligence (AI) and data analytics technologies.

This paper is aimed to highlight how big data analytics technology implementation leads to enhancement of business operations capabilities, which further strengthens the strategic decision-making capabilities of the organization. It helps understand the parameters of big data analytics technology-based capabilities and their role in influencing operational efficiency. It will also relieve the business executives and key managers from day-to-day operational decision making thereby impacting the organizational growth and efficiency.

As an emerging technology, big data analytics has emerged as a game changer in how organizations make decisions and use big data characteristics to achieve their business objectives. Therefore, it would be apt to understand the impact of big data analytics technology on strategic decision making.

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2. Background/ Scope of the Study:

The term Big Data Analytics (BDA) is derived from a combination of 'big data' and 'data analytics' technologies. It involves understanding big data technologies, which are further characterized based on the 4Vs, i.e., Volume, Velocity, Variety and Veracity. A few of definitions of BDA technology adopted from various sources are:

Big data analytics has been defined by De Mauro *et al*((De Mauro et al., 2018) as having "six components - data generation, data acquisition, data storage, advanced data analytics, data visualization, and decision-making for value-creation, its typical tools, techniques and technologies, and its main domains of application". Whereas Riccardo *et al* identified the complexity of business data and the big data analytics capabilities to handle it that it can be "used to describe datasets so complex that they cannot be managed or analyzed using traditional data analysis software" (Riccardo et al., 2018). Also, it has been defined as a process "to analyze the large data volumes to capture value for the businesses and employees" (Batistič & van der Laken, 2019). As identified by Gupta & George (Gupta & George, 2016), big data analytics-based capabilities impact an organization's performance. Hence, it is evident that big data analytics is a technology driven by multiple systematic processes to enhance and measure the dynamic capabilities of an organisation.

The operational management in an organisation involves the day-to-day activities, and related decisions, which generally get delayed due to the process of management team concurrence. One of the significant factors for this delay is the process of checks to align it with their strategic aims and objectives. Strategic decision-making helps identify the fulfillment of needs by undertaking guidelines from the enterprise's business strategy.

Quinn (Quinn, 1989) defined strategic decision-making as "an incremental and interdependent process shaped by a variety of contextual influences arising from past events, present scenarios, and future perspective assumptions". It is also defined as "a synthesis of bounded rationality and political perspectives" (Kinange & Patil, 2020). Thus, the role of strategic decision-making in an organization is to manage and guide the operational activities and their execution.

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The attributes used for the impact analysis utilizing the dynamic capabilities theory (DCT) as defined by Teece et al. (Teece et al., 1997), are based on the concept of modern organisation capabilities and the need for an agile business system with resilient processes to meet the need of external competitive business environment. These all can be achieved by having a dynamic capability of the organisation, which must be able to meet the changing needs of the business. Besides, the resource-based view (RBV), as defined by Wernerfelt (1984) derived from the fact as "resources and products are two sides of the same coin" (Wernerfelt, 1984), has helped in classifying the resource of an organisation into tangible and intangible assets.
Based on the analysis of the literature, following methods of classification of BDA capabilities can be identified.

Business analytics capabilities framework (BACF): It is the relationship between business analytics capabilities and organizational capabilities. It identified sixteen capabilities (Cosic et al., 2015) that must be developed and acquired by an organization to adopt and implement the technology innovation. It used the Delphi technique-based capabilities identification, which results in three sub-categories identification such as technology, organization, and people.

Process-oriented dynamic capabilities (PDC): Kim et al. (2011) attempted to identify the firm's ability to improve, adapt, reconfigure, renew, or refresh its business processes better than its competition. In this, a firm's competence was considered in three essential business processes, i.e., their ability to perform integration/connectivity, connecting parties for communication, information sharing; cost efficiency; and capitalization of business intelligence/learning, like bringing insights into the process. It was derived by validating the performance of the firm using eleven constructs, which were identified to understand BDA based capabilities.

Big data analytics capabilities (BDAC): Gupta & George defined BDAC as "the ability of a firm to deploy technology and talent to capture, store effectively and analyze data towards the generation of insight." These capabilities were classified as tangible, human skill and intangible(Gupta & George, 2016; Kiron et al., 2014).

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Strategic decision-making is a well-researched area, and a few of its aspects are discussed below:

Elbanna (Elbanna, 2006) stated that strategic decision-making is divided into content and process research. The approach of content research is widely accepted and covered and is more into strategic content. In comparison, process research talks about the rationality of the decision-making process along with a behavioural aspect of the organization at large. Some of the process-based constructs for strategic decision-making capabilities, as identified by the researchers are procedural rationality and political behavior.

An aspect of decision-making, the role of political behaviour among decision-makers, has long been recognized (Wilson, 2003), and hence it contributes to the strategic decision-making for an organisation and holds significant influence in the process of decision making. Also, on inspecting the constructs of BDA technology with strategic decision-making, the role of an intangible attribute of BDA technology, which pertained to the organization culture and data culture aspects of BDA technology, was found to be relevant and considered for further analysis.

2.1. Research Objectives:

The following two research objectives acted as motivation for research:

1. To identify the significance of big data analytics capabilities attributes towards organisational strategic decision-making capabilities enhancement.
2. To identify the relationship between big data analytics capabilities (BDAC) attributes such as data & technology, people and organization with strategic decision-making capabilities (SDMC) attributes such as procedural rationality (PR) and political behavior (PB) as perceived by the big data analytics practitioners in Delhi/NCR region.

2.2. Hypothesis:

The following hypothesis have been formulated based on the literature review and research objectives:

H11: Big data analytics capabilities - data and technology (BDAC_DT) is positively associated with the strategic decision-making capabilities - political behavior (SDM_PB)

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H12: Big data analytics capabilities - data and technology (BDAC_DT) is positively associated with the strategic decision-making capabilities - procedural rationality (SDMC_PR)

H21: Big data analytics capabilities - organisation (BDAC_ORG) is positively associated with the strategic decision-making capabilities - political behavior (SDM_PB)

H22: Big data analytics capabilities - organisation (BDAC_ORG) is positively associated with the decision-making capabilities - procedural rationality (SDMC_PR)

H31: Big data analytics capabilities - people (BDAC_PEOP) is positively associated with the strategic decision-making capabilities - political behavior (SDM_PB)

H32: Big data analytics capabilities- people (BDAC_PEOP) is positively associated with the strategic decision-making capabilities - procedural rationality (SDMC_PR)

3. Research Methodology:

The theoretical concepts show that big data analytics is increasingly becoming pivotal to strategic decision-making and innovation management (Chen et al., 2012). In addition, big data analytics provide the characteristics that support the firm performance based on the capabilities developed using the business process implementation (Gupta & George, 2016). This exploratory research involves a multi-domain cross-sectional study of big data analytics capabilities along with the strategic decision-making capabilities of an enterprise. Thus, the survey-based data collection was aptly used along with the quantitative analysis techniques for the proposed hypothesis testing and validation.

A total of Ninety-Nine (99) experts in big data analytics from enterprises in leading positions in digital-related industries were identified and surveyed from a total of 250 identified organizations from multiple business domains in the Delhi/NCR area. The respondents were in senior profiles and had an understanding of both big data analytics technology and strategic decision-making aspects of their respective organizations. The study included a structured questionnaire survey with closed-ended and pre-specified response alternatives. The appropriateness validity of the questionnaire was assessed using a seven-point Likert scale to get the respondent's views on these and reduce response bias. Big data analytics capabilities (BDAC) and strategic decision-making capabilities (SDMC) were measured with a scale ranging from strongly agree to strongly disagree.

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4. Data collection and analysis:

The survey instrument, with closed-ended questions, was developed using the research questions. Constructs of big data analytics capabilities as identified by Gupta & George (2016) as tangible, people and intangible as well as the strategic decision-making capabilities as identified by Dean Jr. & Sharfman (Dean Jr. & Sharfman, 1996), the cross-sectional survey based measurable high-order constructs of SDMC as procedural rationality and political behavior, were used in the questionnaire for testing. These parameters and variables are shown in Figure 1 below:

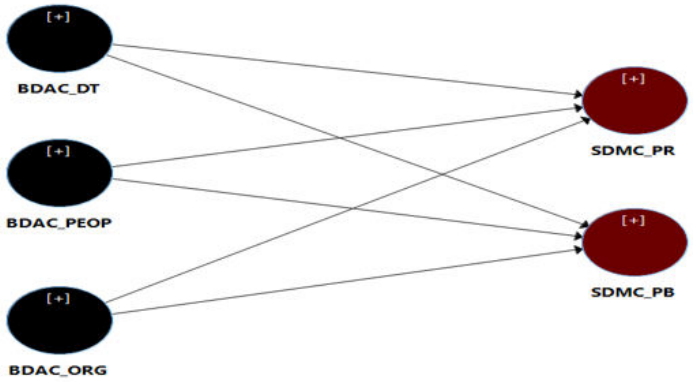

Figure 1: Constructs for the BDAC and SDMC

On further analysis of the attributes of strategic decision-making-based capabilities, the second order constructs were found to be relevant. The questions were designed to measure the impact of the data-technology, people and organization on the procedural rationality and organizational behavior attributes.

The questionnaire thus designed has 37 (28 for BDAC and 9 for SDMC) construct measurement questions as referred in appendix-A and shown in Figure 2 below:

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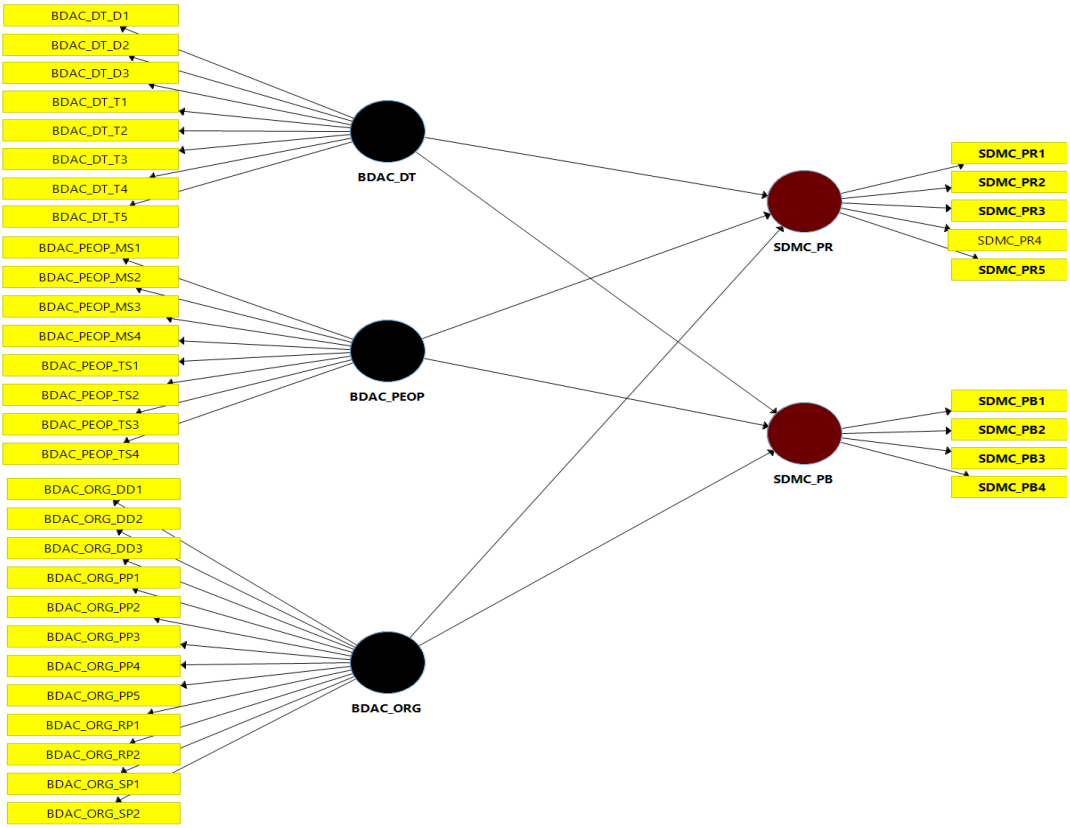

Figure 2: Questionnaire-based constructs-parameters of BDAC and SDMC

4.1. Data collection:

The questionnaire design, testing and administration of the survey were done in digital mode, using social media and the website of the firms who have experience and expertise in big data analytics implementation. This process of reference-based identification helped confirmation of the respondents holding expertise in big data analytics. It also helped in understanding their role in the organisation besides the credibility authentication of respondents and reference, besides the emerging technology enabled organization.

4.2. Data Analysis

It is an exploratory research from diverse information systems (IS) and decision-making disciplines. For such interdisciplinary research in IS domain, structured equation modeling (SEM) is viewed as the most appropriate analytical tool. Also, it involves the questionnaire technique to collect the data using the survey method. It is a statistical technique for testing and estimating causal relationships among multiple independent (exogenous) and dependent (endogenous) constructs (Gefen et al., 2000).

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In the domain of information systems, the use of structural equation modeling (SEM) with latent variables is widespread (Urbach & Ahlemann, 2010). Thus, to establish a causal relationship among the variables of BDA and SDM, structured equation modeling is the most appropriate statistical analysis technique to validate an exploratory research model.

As identified by Urbach & Ahlemann (Urbach & Ahlemann, 2010), the articles published in Management Information Systems Quarterly (MISQ) and Information Systems Research (ISR) for the period 1998 to 2008, the PLS algorithm is a component-based approach for testing SEM models and it is a popular statistical algorithm of the SEM technique. For an exploratory study with the estimation of causal relation, PLS-SEM is recommended and shows apt analysis results. Therefore, to assess the hypotheses, PLS-SEM was used. It uses systematic and comprehensive analysis to assess both measurement and structural models, taking measurement error into account.

To check for the indicator to latent variable relation: Hair et al(Hair et al., 2011) stated that for the reflective latent variables, the reliability and validity should be thoroughly checked when the indicators are highly correlated and interchangeable. For Big Data Analytics capabilities (BDAC), an exogenous latent variable with all 28 indicators has shown positive moderate to high correlation coefficients. All the correlated coefficient values between (0.3 to 0.7) were marked as moderate and (0.7 to 1.0) as high. Hence, the latent construct was marked as reflective. For strategic decision-making capabilities (SDMC), an endogenous latent variable, all nine (9) indicators have shown moderate to high correlation.

Convergent validity: To check the convergent validity of the latent variable Average Variance Extracted (AVE) has been evaluated. The AVE values of all five latent variables are more significant than the minimum acceptable value of 0.500, as shown in Table 1. Hence, the outer model (measurement) confirmed convergent validity.

Table 1 Convergent validity and reliability using the SmartPLS tool

	Cronbach's Alpha (CA>0.700)	Dijkstra-Henseler's (pA>0.700)	Composite Reliability (CR >0.700)	AVE (>0.500)

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BDAC_DT	0.925	0.929	0.939	0.658
BDAC_ORG	0.958	0.960	0.963	0.687
BDAC_PEOP	0.925	0.961	0.965	0.775
SDMC_PB	0.886	0.890	0.922	0.746
SDMC_PR	0.891	0.914	0.922	0.706

Discriminant validity: To conceptually test the existence of similar latent variables, the discriminant validity is used by the heterotrait-monotrait (HTMT) ratio (Henseler et al., 2015). Therefore, the heterotrait correlations should be smaller than monotrait correlations, or the HTMT ratio should be below 1.0. The HTMT values are shown in Table 2.

Table 2 Discriminant validity using the SmartPLS tool

	BDAC_DT	BDAC_ORG	BDAC_PEOP	SDMC_PB	SDMC_PR
BDAC_DT	0.811				
BDAC_ORG	0.784	0.829			
BDAC_PEOP	0.833	0.891	0.880		
SDMC_PB	0.568	0.803	0.684	0.864	
SDMC_PR	0.555	0.791	0.705	0.853	0.840

Structural model assessment:

The PLS algorithm and Bootstrapping analysis were used to validate the t-test significance and further to determine the significance of the hypotheses. As the results show that all the R2 values are over 0.1. Hence, the predictive capability is established. Further, Q2 demonstrates the predictive relevance. Finally, the significance of predicting the constructs is shown in Table 3:

Table 3 Structural model analysis with a test of significance and P-value

	β	Std. Dev.	t-stat (>1.96)	Sig(P) (<0.05)
BDAC_DT -> SDMC_PB	0.133	0.103	1.369	0.171
BDAC_DT -> SDMC_PR	0.216	0.195	1.817	0.067
BDAC_ORG -> SDMC_PB	0.973	0.187	5.188	0.000
BDAC_ORG -> SDMC_PR	0.840	0.198	4.245	0.000
BDAC_PEOP -> SDMC_PB	0.070	0.195	0.332	0.740

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BDAC_PEOP -> SDMC_PR	0.123	0.226	0.607	0.544

The hypotheses are tested to ascertain their significance and validity:

H11: While evaluating whether Big data analytics capabilities - data and technology (BDAC_DT) is positively associated with the strategic decision-making capabilities - political behavior (SDM_PB). The result revealed that BDAC_DT has not had a significant impact on SDMC_PB (β =0.133, t= 1.369, p=0.171). Hence, H11 is not supported.

H12: While evaluating whether Big data analytics capabilities - data and technology (BDAC_DT) is positively associated with the strategic decision-making capabilities - procedural rationality (SDMC_PR). The result revealed that BDAC_DT has not had a significant impact on SDMC_PR (β =0.195, t= 1.817, p=0.065). Hence, H12 is not supported

H21: While evaluating whether Big data analytics capabilities - organisation (BDAC_ORG) is positively associated with the strategic decision-making capabilities - political behavior (SDM_PB). The result revealed that BDAC_ORG has a significant impact on SDMC_PB (β =0.187, t= 5.188, p=0.000). Hence, H12 is supported

H22: While evaluating whether Big data analytics capabilities - organisation (BDAC_ORG) is positively associated with the decision-making capabilities - procedural rationality (SDMC_PR). The result revealed that BDAC_ORG has a significant impact on SDMC_PR (β =0.198, t= 4.245, p=0.000). Hence, H22 is supported

H31: While evaluating whether Big data analytics capabilities - people (BDAC_PEOP) is positively associated with the strategic decision-making capabilities - political behavior (SDM_PB). The result revealed that BDAC_ORG has a significant impact on SDMC_PB (β =0.195, t= 0.332, p=0.745). Hence, H31 is not supported

H32: While evaluating whether Big data analytics capabilities- people (BDAC_PEOP) is positively associated with the strategic decision-making capabilities - procedural rationality (SDMC_PR). The result revealed that BDAC_PEOP has not have any significant impact on SDMC_PR (β =0.226, t= 0.607, p=0.544). Hence, H32 is not supported

Hence, overall the high-order constructs are showing moderate to high impact of BDAC-ORG over the other two constructs of data and technology besides people are also not getting any impact on SDMC with parameter of procedural rationality and political behaviors.

5. Conclusions:

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This paper has advanced a comprehensive view on the multi-utility model of ICT technologies implementation with an innovative implementation of big data analytics in an organisation. The relations between the big data analytics implementation and strategic decision-making capabilities have been investigated through the lens of dynamic capabilities and by an exploratory methodology based on a survey with leading experts at Delhi/NCR's firms in ICT sector. Firstly, the research helped in understanding the Big data analytics as a technology(Chen et al., 2012), besides its implementation-based capabilities. Secondly, the findings further enhance the opportunity for capabilities enhancement across the organisation and specifically to the core competencies of an organization. Thirdly, this research contributes to the works on dynamic capabilities (Teece, 2007). It confirms the need for a continuous orchestration of capabilities by addressing the role of big data analytics and their positive impact on firms' strategic capabilities development. Lastly, this research offers a practical implication to identify the ICT implementation effects by means of measuring the capabilities enhancement at the strategic level. The big data analytics capabilities have shown an influence on the strategic decision-making capabilities of an organization as moderate to high.

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Appendix A - Questionnaire:

Questionnaire									
Constructs Measure Item	Question	**Options**							
Big Data Analytics capabilities (BDAC)									
BDACD	Data	Please select any one option							
BDACD1	Access to very large, unstructured, or fast-moving data for analysis	o	o	o	o	o	o	o	
BDACD2	Integrate data from multiple sources into a data warehouse for easy access	o	o	o	o	o	o	o	
BDACD3	Integrate external data with internal to facilitate analysis of business environment	o	o	o	o	o	o	o	
BDACT	Technology:	1	2	3	4	5	6	7	
BDACT1	Explored or adopted parallel computing approaches (e.g., Hadoop) to big data processing	o	o	o	o	o	o	o	
BDACT2	Explored or adopted different data visualization tools	o	o	o	o	o	o	o	
BDACT3	Explored or adopted new forms of databases such as Not Only SQL(NoSQL)	o	o	o	o	o	o	o	
BDACT4	Explored or adopted cloud-based services for processing data and performing analytics	o	o	o	o	o	o	o	
BDACT5	Explored or adopted open-source software for big data analytics (BDA)	o	o	o	o	o	o	o	
BDACP	People:								
BDACPM	Managerial skills:	1	2	3	4	5	6	7	
BDACPM1	BDA managers are able to understand the business need of other functional managers, suppliers, and customers to determine opportunities that big data might bring to our business.	o	o	o	o	o	o	o	
BDACPM2	BDA managers are able to coordinate big data-related activities in ways that support other functional managers, suppliers, and customers	o	o	o	o	o	o	o	
BDACPM3	BDA managers are able to understand and evaluate the output extracted from big data	o	o	o	o	o	o	o	
BDACPM4	BDA' managers are able to understand where to apply big data	o	o	o	o	o	o	o	
BDACPT	Technical skills:	1	2	3	4	5	6	7	
BDACPT1	BDA staff has the right skills to accomplish their jobs successfully	o	o	o	o	o	o	o	
BDACPT2	BDA staff is well trained	o	o	o	o	o	o	o	
BDACPT3	BDA training to our own employees is provided	o	o	o	o	o	o	o	
BDACPT4	BDA staff has suitable education to fulfill their jobs	o	o	o	o	o	o	o	
BDACO	Organization:								
BDACOD	Data-driven culture:	1	2	3	4	5	6	7	
BDACOD1	Decisions are based on data rather than on instinct	o	o	o	o	o	o	o	
BDACOD2	Willing to override our own intuition when data contradict our viewpoints	o	o	o	o	o	o	o	
BDACOD3	Continuously coach our employees to make decisions based on data Process	o	o	o	o	o	o	o	
BDACOS	Structural practices:	1	2	3	4	5	6	7	

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BDACOS1	Identified key IT and non-IT decision makers to have the responsibility regarding data ownership, value analysis and cost management.	o	o	o	o	o	o	o
BDACOS2	Use steering committees to oversee and assess data values and costs	o	o	o	o	o	o	o
BDACOR	Relational practices:	1	2	3	4	5	6	7
BDACOR1	Educate users and non-IT managers regarding storage utilization and costs	o	o	o	o	o	o	o
BDACOR2	Develop communications regarding policy effectiveness and user needs	o	o	o	o	o	o	o
BDACOP	Procedural practices:	1	2	3	4	5	6	7
BDACOP1	Setting retention policies (e.g. time to live) of data	o	o	o	o	o	o	o
BDACOP2	Backup routines	o	o	o	o	o	o	o
BDACOP3	Establishing/monitoring access (e.g. user access) to data	o	o	o	o	o	o	o
BDACOP4	Classifying data according to value	o	o	o	o	o	o	o
BDACOP5	Monitoring costs versus value of data	o	o	o	o	o	o	o
Strategic decision-making capabilities (SDMC)								
SDMPR	Procedural Rationality	1	2	3	4	5	6	7
SDMPR1	How extensively did the group look for information in making this decision? (1-Not at all, 7 - extensively)	o	o	o	o	o	o	o
SDMPR2	How extensively did the group analyze relevant information before making a decision? (1-Not at all, 7 - extensively)	o	o	o	o	o	o	o
SDMPR3	How important were quantitative analytic techniques in making the decision? (1 - not at all important, 7 - very important)	o	o	o	o	o	o	o
SDMPR4	How would you describe the process that had the most influence on the group's decision? (1 mostly intuitive, 7 most analytical)	o	o	o	o	o	o	o
SDMPR5	In general, how effective was the group at focusing its attention on crucial information and ignoring irrelevant information? (1 = not at all effective, 7 = very effective)	o	o	o	o	o	o	o
SDMPB	Political Behavior:	1	2	3	4	5	6	7
SDMPB1	Were group members primarily concerned with their own goals, or with the goals of organisation? (1 = own goal completely, 7 = organizational goals completely)	o	o	o	o	o	o	o
SDMPB2	To what extent were people open with each other about their interests and preferences in the decisions? (1 Not at all, 7 = completely)	o	o	o	o	o	o	o
SDMPB3	To what extent was the decision affected by the use of power and influence among group members? (1 Not at all, 7 completely)	o	o	o	o	o	o	o
SDMPB4	To what extent was the decision affected by negotiation among group members? (1 Not at all, 7 completely)	o	o	o	o	o	o	o