Characteristics of consulting firms associated with the diffusion of big data analytics

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Received 14 April 2020
Revised 17 July 2020
Accepted 27 July 2020

Abstract

Purpose – This study investigates the characteristics of business and management consulting firms (firm size, international affiliation and scope of operation) affecting the adoption rate (i.e. recency of adopting big data analytics (BDA) as a new idea) and usage level of BDA. Ten critical areas of BDA application to business and management consulting were investigated, (1) Human Resource Management; (2) Risk Management; (3) Financial Advisory Services; (4) Innovation and Strategy; (5) Brand Building and Product Positioning; (6) Market Research/Diagnostic Studies; (7) Scenario-Based Planning/Business Simulation; (8) Information Technology; (9) Internal Control/Internal Audit; and (10) Taxation and Tax Management.

Design/methodology/approach – Survey data was obtained through a structured questionnaire from one hundred and eighteen (118) consultants in Nigeria from diverse consulting firm settings in terms of size, international affiliation and scope of operation (Big 4/non-Big 4 firms). Data was analyzed using descriptive statistics, cluster analysis, multivariate analysis of variance (MANOVA), multivariate discriminant analysis and multivariable logistic regression.

Findings – Whereas organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of BDA, two attributes (international affiliation and scope of operation) significantly explain BDA usage level. Internationally affiliated consulting firms are more likely to record higher usage level of BDA than local firms. Also, the usage level of BDA by the Big 4 accounting/consulting firms is expected to be higher in comparison to non-Big 4 firms.

Practical implications – Contrary to common knowledge that firm size is positively associated with the adoption of an innovation, the study found no evidence to support this claim in respect of the diffusion of BDA. Overall, it appears that the scope of operation is the strongest organizational factor affecting the diffusion of BDA among consulting firms.

Originality/value – The study contributes to knowledge by exposing the factors promoting the uptake of BDA in a developing country. The originality of the current study stems from the consideration that it is the first, to the researchers' knowledge, to investigate the application of BDA by consulting firms in the Nigerian context. The study adds to literature on management accounting in the digital economy.

Keywords Big data, Big data analytics, Business consulting, Management consulting, Management accounting in the digital economy, Organizational characteristics

Paper type Research paper

1. Introduction

The remit of business and management consulting practice is to apply technical competence to solve clients' business problems. In performing this onerous task, consultants will have to

JEL Classification — D22, G30, O16

Journal of Asian Business and Economic Studies
Vol. 28 No. 4, 2021
pp. 281-302
Emerald Publishing Limited
2515-964X
DOI 10.1108/JABES-03-2020-0018

analyze data relevant to the problem at hand with a view to deriving insights that shape strategies for organizational competitiveness. Disruptive technologies, including big data and big data analytics (BDA), have been gaining momentum in recent times as innovations helpful for unearthing unobservable intelligence buried in the myriads of structured and unstructured data generated within and outside organizations (Ernst and Young, 2014). Predictably, modern-day business enterprises are taking keener interests in BDA because data is becoming the basis for competition (Chartered Global Management Accountants, CGMA, 2013).

Big data refers to high-volume, high-velocity and high-variety data, which requires advanced and innovative processing techniques for enhanced insight and decision-making (Chen *et al.*, 2012; Warren *et al.*, 2015; Jiang and Chai, 2016). Peterson (2016, p. 1) simplifies the concept of big data by referring to it as " the collection of large amounts of data from places like web-browsing data trails, social network communications, sensor and surveillance data that is stored in computer clouds then searched for patterns, new revelations and insights." Big data has six main characteristics of: volume (amount of records and information); variety (the different forms of data ranging from structured to unstructured data); velocity (the speed at which data is created and processed); veracity (the reliability of data); value; and complexity (Mohammadpoor and Torabi, 2019). Due to these characteristics, big data cannot be processed using conventional data-processing methods, thus requiring BDA. BDA involves the in-depth analysis of both structured and unstructured data to obtain insightful information that could lead to making informed decision.Whereas literature suggests the rising importance of big data in the field of business and management consulting (Schneider *et al.*, 2015; Tras, 2015; Warren *et al.*, 2015; CB Insights, 2018), it is surprising that little research attention has been accorded to application of BDA in the business and management consulting context. Consulting firms wanting to remain competitive cannot afford to be complacent about how disruptive technologies including BDA are redefining the manner of doing business – the need for consultants to employ BDA to better service their clients has never been more pressing. However, as crucial as the deployment of BDA may seem, and *in spite* of how forward-thinking consultants may be eager about utilizing BDA to revolutionize their consulting practices, the characteristics of consulting firms may exert on the rate of spread of BDA as an innovation. Although studies have shown that organizational variables affect the diffusion of an innovation (e.g. Feldstein and Glasgow, 2008; Aarons *et al.*, 2011; Wisdom *et al.*, 2014), little is known on the extent to which the characteristics of consulting firms may influence the propagation of BDA. Diffusion of BDA, within the context of this study, refers to the spread of BDA with respect to its adoption rate (recency of adopting BDA as a new idea) and usage level. Therefore, the objectives of the current study are to: (1) examine the extent to which organizational characteristics determine the adoption rate of BDA and (2) evaluate the organizational characteristics affecting usage level of BDA among consulting firms.

The characteristics of consulting firms investigated were: size, international affiliation (i.e. linkage with a network of international consulting firms) and scope of operation (Big 4/non-Big 4 dichotomy). Acknowledging that scope of operation as per the Big 4 accounting/consulting firms versus other consulting firms (regarded as the "non-Big 4") is the most popular method for dichotomizing accounting/consulting firms (Guenther and Willenborg, 1999; Mitton, 2002; Smart and Zutter, 2003; Gul *et al.*, 2009), the study moved beyond this omnibus classification to disaggregate consulting firms into sizes and international affiliation in order to establish the specific impact of these firm attributes on innovation adoption. For instance, the non-Big 4 consulting firms vary in size. Whereas some non-Big 4 firms may belong to a network of international accounting/consulting firms, others (say indigenous firms) may not. This distinction is deemed crucial to gain a deeper understanding of specific organizational characteristics exerting on the diffusion of BDA.

Results from the analysis of data obtained from one hundred and eighteen (118) consultants in Nigeria from diverse consulting firm settings suggest that organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of BDA. Further, two attributes (international affiliation and scope of operation) significantly explain BDA usage level. Internationally affiliated consulting firms are likely to record higher usage level of BDA than local firms. Also, the usage level of BDA by Big 4 accounting/consulting firms is expected to be higher in comparison to the non-Big 4 firms. Contrary to common knowledge that firm size positively affects the adoption of innovation, the study found no evidence that size is strongly associated with the diffusion of BDA. Overall, it appears that the scope of operation is the strongest factor affecting the diffusion of BDA among consulting firms.

The study contributes to knowledge by exposing the factors promoting the uptake of BDA in a developing country. The originality of the current study stems from the consideration that it is the first, to the researchers' knowledge, to investigate the application of BDA by consulting firms in the Nigerian context. The study adds to literature on management accounting in the digital economy. The remainder of the paper is organized into four sections (Section 2 to 5). Section 2 covers literature review, while Section 3 explains the methodology adopted for the study. Section 4 presents result and discussion of findings. The paper is concluded in Section 5.

2. Literature review

2.1 Application of big data analytics in business and management consulting practice

BDA is a relatively new concept in the information technology field (McAfee and Brynjolfsson, 2012; Frizzo-Barker *et al.*, 2016), belonging to the class of disruptive innovations. BDA is gaining prominence (Koseleva and Ropaite, 2017; Mohammadpoor and Torabi, 2019), especially the analysis of semistructured and unstructured data (Russom, 2011). BDA qualifies as an innovation going by Rogers' (2003) postulation. An innovation, according to Rogers (2003, p. 12), is "an idea, practice, or project that is perceived as new by an individual or other unit of adoption." Although an innovation may have been invented a long time ago, if individuals in a location, place or organization perceives it as new, then it may be construed as an innovation for them.

Whereas the analysis of data to improve organizational effectiveness has been a long-standing phenomenon, the analysis of large volume of data, particularly semistructured and unstructured data (i.e. BDA), is increasingly becoming popular and could be regarded as an innovation. BDA has therefore been conceived and researched as an innovation (e.g. Davenport, 2014; Koseleva and Ropaite, 2017; Mohammadpoor and Torabi, 2019). According to Koseleva and Ropaite (2017), the first science research on the topic of big data was done in 1974. However, the extent of research in the area has been rapidly increasing during the last ten years (Koseleva and Ropaite, 2017). Prior studies have applied the innovation diffusion theory to explain the adoption of technology (e.g. Dooley, 1999; Stuart, 2000; Medlin, 2001; Sahin, 2006).

BDA could be applied in various areas of consulting, including but not limited to: human resource consulting, risk consulting, financial advisory services, innovation and strategy consulting, brand building and product positioning, market research/diagnostic studies, scenario-based planning/business simulation, information technology consulting, internal control/internal audit consulting and taxation and tax management consulting, among others. Insight from BDA can guide product design that appeals to customers' purchasing power (Jørgensen and Messner, 2010; Spenner and Freeman, 2012). With respect to innovation and strategy consulting, insights from BDA could shape competitive strategies (Chartered Global Management Accountants, CGMA, 2013). The deployment of BDA could

enhance the quality of work done by internal or external auditors (Griffin and Wright, 2015). The application of BDA can substantially assist in the quality and quantity of audit evidence amassed by auditors upon which audit opinion is based. In relation to financial advisory service, consulting firms could leverage on BDA in advising clients to make better investment decisions that will ensure consistent returns (Fanning and Grant, 2013). BDA can be used to assess the business' short-term and long-term viability through market research (Khade, 2016). Big data and business analytics can be applied for purposes such as employee performance appraisal, design of reward system and prediction of employee turnover (Wislow, 2017; Vulpen, 2018). When applied in the context of risk management, BDA can be used to profile customers for creditworthiness based on analysis of their credit history (Baesens *et al.*, 2013).

2.2 Organizational characteristics affecting the diffusion of big data analytics

BDA involves the rigorous examination of large and varied data sets (i.e. big data) to uncover previously unobservable trends, sentiments and other insightful information that could lead to making informed decision. Considering that consulting firms differ in size, affiliation/connection to network of other consulting firms operating beyond national boundaries and scope of operation, these characteristics may affect the quality of consultancy services offered and, by extension, level of competence in BDA. This stems from the argument that while some consulting firms may be more familiar with BDA because of their presence in jurisdictions where BDA thrives (e.g. developed countries), other firms operating in terrains where BDA is latterly gathering impetus may be less familiar with the methodology of analyzing avalanche of data to extract actionable intelligence. Thus, expertise in BDA may be expectedly heterogeneous among consulting firms. Literature suggests that organizational characteristics affect the adoption of innovation (e.g. Rogers, 2003; Sahin, 2006; Aarons *et al.*, 2011; Wisdom, *et al.*, 2014). Given that BDA is becoming widespread, the knowledge and resources available to consulting firms, with respect to their attributes, may affect the adoption rate of BDA. It is therefore hypothesized that:

H1. Organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of BDA by consulting firms.

The size of a consulting firm may affect the level of BDA usage. Studies have shown that organizational size is positively related to innovativeness (e.g. Graham and Logan, 2004; Godin *et al.*, 2008). Large consulting firms may have the resources, expertise and structure to considerably apply BDA in comparison to medium- or small-sized firms (Mendel *et al.*, 2008). As big organizations have more absorptive capacity (i.e. ability to recognize new information, assimilate it and invest on it) to accommodate the vagaries of BDA, it may be expected that:

H2a. Large-sized consulting firms will record higher usage rate of BDA than small-sized firms.

A firm's connection to a network of other consulting firms operating beyond national boundaries may affect the usage level of BDA. Studies have shown that members linked in a social system have a tendency to adopt an innovation (e.g. Valente, 1996; Frambach and Schillewaert, 2002; Rogers, 2003; Greenhalgh *et al.*, 2004; Feldstein and Glasgow, 2008; Mendel *et al.*, 2008; Oldenburg and Glanz, 2008; Mitchell *et al.*, 2010; Aarons *et al.*, 2011). Thus, earlier adopters of an innovation are more highly interconnected in the social system than later adopters.

Firms operating transnationally operate in more competitive markets and face greater competitive pressures. As a result, entities with international presence may be more open to innovation to cope with competition (Quesado and Rodrigues, 2009; Quesado *et al.*, 2016).

The utilization of BDA may therefore be associated with the internationalization of organizations. Entities affiliated with foreign consulting firms have the tendency to extensively apply BDA because the practice of deploying BDA to improve the quality of consultancy service may emanate from the culture of organizations in their network. Social network and linkages among internationally connected organizations within the same system promote the uptake of the behavior of those organizations (Solomons and Spross, 2011; Abdo and Aldrugi, 2012; Wisdom *et al.*, 2014). In sum, consulting firms affiliated to other foreign firms would have higher propensity to apply BDA in comparison to local firms. Therefore,

H2b. Internationally affiliated consulting firms are likely to witness higher usage rate of BDA than local firms.

The Big 4 accounting/consulting firms have always stood apart from other "non-Big 4" consulting firms in terms of size, reputation, reach, resources and scope of operation (Dopuch and Simunic, 1980; Khurana and Raman 2004; Behn *et al.*, 2008; Government Accountability Office, GAO, 2008; Lawrence *et al.*, 2011), and this perhaps explains the general notion that the Big 4 provide superior assurance engagement services than the non-Big 4. Furthermore, it has been argued that accounting firm size is synonymous to service quality (DeAngelo, 1981), because big accounting/consulting firms have the wherewithal to provide robust training and execute standardized methodologies. The consideration that larger accounting firms have greater reputations to protect (Dopuch and Simunic, 1980) may cause them to be more scrupulous in providing quality services.

The Big 4 accounting/consulting firms have wider scope of operation globally and enjoy more presence in the international scene than the non-Big 4 (Okaro and Okafor, 2013), including regimes where BDA is more preponderant say developed countries. Against the backdrop that prior knowledge and existing skill base promote the diffusion of innovation (Frambach and Schillewaert, 2002; Feldstein and Glasgow, 2008), the Big 4 may be more competent in BDA. Argued from another standpoint, the Big 4 are bigger and more connected internationally than the non-Big 4. Considering on one hand, that fast adopters of innovation are more highly interconnected in the social system than later adopters and, on the other hand, that firm size is positively correlated with the propensity to adopt an innovation, the Big 4 may be expected to evolve more innovative means to improve the quality of their services, including the extensive usage of BDA. Hence:

H2c. The Big 4 accounting/consulting firms will have higher usage rate of BDA than the non-Big 4 firms.

3. Methodology

3.1 Population and sample selection

The population of the study is comprised of all business and management consulting firms in Nigeria, but the study focused on top-ranking firms providing diverse consulting services. After scrutinizing the directory of registered consulting firms from five different online sources (1) https://www.businesslist.com.ng; (2) http://www.jarushub.com/ranking-worlds-top-consulting-firms-by-categories-2016/; (3) https://www.consultingcase101.com/list-of-consulting-firms-in-lagos-nigeria; (4) https://www.nairaland.com/2481274/list-top-management-consulting-companies; and (5) https://www.nigerianinfopedia.com/best-consulting-firms-nigeria-top-10], top twenty (20) firms that consistently appeared across the lists were selected, including four Big 4 and 16 non-Big 4 firms. This technique was used to select top-consulting firms as there is no comprehensive list of business and management consulting firms in Nigeria. Some studies have used a similar approach in sample selection (e.g. Soobaroyen and Poorundersing, 2008; Oyewo, 2017).

3.2 Data-collection method and measurement of variables

Data collection was by a structured questionnaire distributed through the consulting firms to individual consultants. Fifteen (15) copies were distributed in each of the Big 4 considering their size, while seven (7) copies were distributed to each of the sixteen (16) non-Big 4 firms, making a total of one hundred and seventy-two (172) copies distributed.

3.3 Measurement of variables

The variables of the study are organizational characteristics, adoption rate of BDA and level of use of BDA. These variables were measured as follows:

3.3.1 Organizational characteristics. Characteristics of consulting firms measured were size, international affiliation and scope of operation. *Size of consulting firm* was operationalized using the number of partners. Stratification of firm size based on the number of partners was guided by the class of license issued by The Institute of Chartered Accountants of Nigeria (ICAN) – the professional body regulating accountancy practice in Nigeria. The categories were: sole practitioner (1 partner), medium firm (2–4 partners), large firm (5–9 partners) and very large firm (10 partners and above). *International affiliation* was measured by requesting respondents to declare whether their firms are affiliated to international consulting firm(s) or not. *Scope of operation* was measured by segregating firms into those with global scope (Big 4) and others with no global visibility (non-Big 4). The Big 4 audit/consulting firms enjoy more presence in the international scene than non-Big 4 (Okaro and Okafor, 2013). The Big 4 firms (PwC, KPMG, Ernst & Young and Deloitte) arguably offer the highest attainable assurance engagement services due to their technical as well as professional capabilities (Bloom and Schrim, 2008; Okaro and Okafor, 2013). The personal profile of consultants elicited was length of work experience, measured in five categories of: less than 3, 3–6, 7–10, 11–15 and over 15 years, respectively.

3.3.2 Adoption rate of big data analytics. Adoption rate of BDA, in the context of this study, refers to the recency of adopting BDA as a new idea by a consulting firm. This was measured through a self-developed scale by requesting respondents to indicate, on a scale of 1 ("currently underway"), 2 ("within 2 years ago"), 3 ("within the past 3 years"), 4 ("4–5 years ago") to 5 ("more than 5 years ago"), the recentness of applying BDA by their firms in ten critical areas of business and management consulting: (1) Human Resource Management; (2) Risk Management; (3) Financial Advisory Services; (4) Innovation and Strategy; (5) Brand building and Product Positioning; (6) Market Research/Diagnostic Studies; (7) Scenario-Based Planning/Business Simulation; (8) Information Technology; (9) Internal Control/Internal Audit; (10) Taxation and Tax Management. Hierarchical cluster analysis (applying the *between-groups linkage* cluster method using *squared Euclidean distance* interval measure) was used to regroup firms into three adopter categories of [using Rogers' (2003) nomenclature]: *innovators* (firms with relatively early adoption), *early majority* (firms characterized by recent adoption); and *laggards* (firms with very recent adoption). Studies on diffusion of innovation have used a similar methodology to group adopters of innovations (e.g. Kivlin, 1960; Ostlund, 1974; Holloway, 1977).

3.3.3 Usage level of big data analytics. Usage level of BDA was measured through a self-developed scale by requesting respondents to rate on a scale of 1 ("not applied") to 5 ("very extensive") the extent to which BDA is applied by their firms in ten critical areas of consulting services covering: (1) Human Resource Management; (2) Risk Management; (3) Financial Advisory Services; (4) Innovation and Strategy; (5) Brand Building and Product Positioning; (6) Market Research/Diagnostic Studies; (7) Scenario-Based Planning/Business Simulation; (8) Information Technology; (9) Internal Control/Internal Audit; (10) Taxation and Tax Management. Hierarchical cluster analysis (applying the *between-groups linkage* cluster

method using *squared Euclidean distance* interval measure) was used to group firms into those applying BDA at *basic* and *advanced* levels.

3.4 Validity and reliability

Face and content validity were achieved by submitting initial draft of the questionnaire to three experts (one academic and two consultants) for critiquing (Blumberg *et al.*, 2005; Saunders *et al.*, 2007). Feedbacks obtained were used to improve questionnaire quality. Multi-item measures were used to minimize measurement error (Chenhall and Morris, 1986; Cadez and Guilding, 2008; Ajibolade, 2013). Considering that most variables were measured using multidimensional scales, exploratory factor analysis (principal component analysis extraction method) was applied to assess construct validity for the loading of items across components at a 0.60 threshold (Easterby-Smith *et al.*, 2002; Drost, 2011).

Items measuring adoption rate of BDA all loaded strongly on component 1 (accounting for 50.99% of the variance) above 0.40. Items measuring level of use of BDA also loaded well above 0.60 in component 1 (with 53.27% variance explained). The loading of variables above 0.40 on component 1 in all cases confirms construct validity. Cronbach's alpha, Guttman split-half coefficient and Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy were used to gauge the reliability of the multi-item variable measurement as reported in Table A1. All items loaded above a 0.70 threshold (Nunnally, 1978; Qingping, 2009), thus establishing internal consistency.

3.5 Method of data analysis

Descriptive and inferential statistics (one-way multivariate analysis of variance (MANOVA), multivariate discriminant analysis and multivariable logistic regression) were applied in data analysis. MANOVA was applied to assess the omnibus effect of each organizational characteristic on the adoption rate of BDA in the ten areas of consulting. Discriminant analysis was applied to further explore the strength of each organizational factor in accounting for the difference in the adoption rate of BDA among consulting firms. Multivariable logistic regression analysis was used to evaluate the potency of the organizational factors in predicting the usage level of BDA by consulting firms.

3.6 Respondents' attrition and response rate

From the one hundred and seventy-two (172) copies of the questionnaire administered, one hundred and twenty-three (123) copies were retrieved, representing a response rate of 71.5%. Five (5) copies were found unsuitable for use because of incomplete response, thereby reducing the number of useable copies to one hundred and eighteen (118) and diminishing the effective response rate to 68.6%. The 118 copies were processed for analysis. Nonresponse bias was assessed by comparing the first 20% of responses obtained with the last 20% responses using global presence (Big 4/non-Big 4) as a basis for comparison of early response with late response. Independent sample *t*-test result shows no significant difference at 5% ($p = 0.355$), thus confirming the absence of nonresponse bias.

4. Results and discussion

4.1 Firm attributes and respondents' profile

Analysis of firm attributes and respondents' profile is reported in Table 1.

An inspection of respondents' profile and firm attributes in Table 1 shows that while 49 (41.5%) respondents have between 3 and 6 years of work experience, majority of the consultants have work experience of at least 7 years ($n = 69$, 58.5%). Specifically, 37 (31.4%), 27 (22.9%) and 4 (4.2%) respondents have work experiences of 7–10 years, 11–15 years and

Table 1.
Respondents' profile and consulting firms' attributes

Variable	Category	Freq	%	Total
Length of experience as a consultant (years)	3–6	49	41.5	
	7–10	37	31.4	
	11–15	27	22.9	
	Over 15	4	4.2	118
Number of partner(s) in firm (firm size)	2–4 partners	17	14.4	
	5–9 partners	50	42.4	
	10 and above partners	51	43.2	118
Affiliation to international firm	Affiliated	101	85.6	
	Not affiliated	17	14.4	118
Scope of operation	Big 4	56	47.5	
	Non-Big 4	62	52.5	118

over 15 years, respectively. Also, respondents from consulting firms of varying sizes participated in the study. In total, 17 (14.4%) respondents are from medium-sized firms, 50 (42.4%) from large firms, while 51 (43.2%) are from very large consulting firms. In total, 101 (85.6%) respondents are from firms affiliated to international consulting firms while 17 (14.4%) are from indigenous firms with no international affiliation. In total, 56 (47.5%) of the consultants are from the Big 4 and 62 (52.5%) are from non-Big 4 consulting firms. The distribution of consulting firms across various size, foreign affiliation and global presence suggests that the responses obtained cut across consulting firms from diverse background. The heterogeneity in the attributes of sample firms provides an appropriate context for examining the research subject.

4.2 Organizational characteristics determining the adoption rate of big data analytics

4.2.1 Result from MANOVA analysis. 4.2.1.1 Firm size. From Table 2, the various multivariate statistics (Pillai's trace, Wilks' lambda, Hotelling's trace and Roy's largest root) associated with the one-way MANOVA reveal a significant multivariate main effect for consulting firm size (Field, 2009). Specifically, the Wilks' $\lambda = 0.602$, $F\,(20, 212.000) = 3.063$, $p < 0.01$. Power to detect the effect was 1.00 for all multivariate statistics. This result confirms that consulting firm size has a significant omnibus impact on the adoption rate of BDA.

4.2.1.2 International affiliation. With $p < 0.05$ for each of the multivariate statistics of the one-way MANOVA (Table 3), it is established that there is a significant multivariate main effect for international affiliation. The Wilks' $\lambda = 0.823$, $F\,(10, 107.000) = 2.297$, $p < 0.05$. Power to detect the effect was 0.910 for all the multivariate statistics. Thus, it is confirmed that international affiliation of consulting firms significantly affects the adoption rate of BDA.

4.2.1.3 Scope of operation. In Table 4, the one-way MANOVA multivariate statistics (Pillai's trace, Wilks' lambda, Hotelling's trace and Roy's largest root) reveal a significant multivariate main effect for scope of operation ($p = 0.02 < 0.05$ in all cases). Further, Wilks' $\lambda = 0.829$, $F\,(10, 107.000) = 2.213$, $p < 0.05$. Power to detect the effect is 0.897 in all cases. Hence, it is confirmed that scope of operation significantly affects adoption rate of BDA among consulting firms.

To recapitulate, the results in Tables 2–4 establish that each of the three organizational characteristics significantly affects the adoption rate of BDA (research objective 1). The MANOVA result shows the omnibus effect of each organizational characteristic on the adoption rate of BDA in the various areas of consulting. However, this is less informative as the analysis does not indicate the predictive ability of the organizational characteristics in determining BDA adoption rate. Multivariate discriminant analysis was employed to address this concern.

Table 2. Multivariate tests for impact of firm size on adoption rate of BDA

Effect		Value	*F*	Hypothesis df	Error df	Sig	Partial Eta squared	Noncent. Parameter	Observed Power
Intercept	Pillai's trace	0.976	423.829	10.000	106.000	0.000	0.976	4238.291	1.000
	Wilks' lambda	0.024	423.829	10.000	106.000	0.000	0.976	4238.291	1.000
	Hotelling's trace	39.984	423.829	10.000	106.000	0.000	0.976	4238.291	1.000
	Roy's largest root	39.984	423.829	10.000	106.000	0.000	0.976	4238.291	1.000
Size	Pillai's trace	0.421	2.853	20.000	214.000	0.000	0.211	57.067	0.999
	Wilks' lambda	0.602	3.063	20.000	212.000	0.000	0.224	61.270	1.000
	Hotelling's trace	0.623	3.273	20.000	210.000	0.000	0.238	65.465	1.000
	Roy's largest root	0.555	5.937	10.000	107.000	0.000	0.357	59.373	1.000

Table 3.
Multivariate tests for impact of international affiliation on adoption rate of BDA

Effect		Value	*F*	Hypothesis df	Error df	Sig	Partial Eta squared	Noncent. Parameter	Observed power
Intercept	Pillai's trace	0.961	262.986	10.000	107.000	0.000	0.961	2629.864	1.000
	Wilks' lambda	0.039	262.986	10.000	107.000	0.000	0.961	2629.864	1.000
	Hotelling's trace	24.578	262.986	10.000	107.000	0.000	0.961	2629.864	1.000
	Roy's largest root	24.578	262.986	10.000	107.000	0.000	0.961	2629.864	1.000
Affiliation	Pillai's trace	0.177	2.297	10.000	107.000	0.017	0.177	22.967	0.910
	Wilks' lambda	0.823	2.297	10.000	107.000	0.017	0.177	22.967	0.910
	Hotelling's trace	0.215	2.297	10.000	107.000	0.017	0.177	22.967	0.910
	Roy's largest root	0.215	2.297	10.000	107.000	0.017	0.177	22.967	0.910

Effect		Value	*F*	Hypothesis df	Error df	Sig	Partial Eta squared	Noncent. Parameter	Observed Power
Intercept	Pillai's trace	0.981	556.899	10.000	107.000	0.000	0.981	5568.993	1.000
	Wilks' lambda	0.019	556.899	10.000	107.000	0.000	0.981	5568.993	1.000
	Hotelling's trace	52.047	556.899	10.000	107.000	0.000	0.981	5568.993	1.000
	Roy's largest root	52.047	556.899	10.000	107.000	0.000	0.981	5568.993	1.000
Scope	Pillai's trace	0.171	2.213	10.000	107.000	0.022	0.171	22.135	0.897
	Wilks' lambda	0.829	2.213	10.000	107.000	0.022	0.171	22.135	0.897
	Hotelling's trace	0.207	2.213	10.000	107.000	0.022	0.171	22.135	0.897
	Roy's largest root	0.207	2.213	10.000	107.000	0.022	0.171	22.135	0.897

Table 4.
Multivariate tests for impact of scope of operation on adoption rate of BDA

4.2.2 Result from multivariate discriminant analysis. Results from multidiscriminant analysis assessing the degree to which each of the organizational characteristics determines the adoption rate of BDA are captured in Tables 5–7.

The multidiscriminant analysis generated two functions (1 and 2) with 97.0% variance explained by Function 1, while Function 2 explains 3.0% of the variation (Table 5). The eigenvalue (0.134) and canonical correlation (0.344) of Function 1 contrast sharply with that of Function 2 at 0.004 and 0.065, respectively. The Wilks' lambda (λ) of Function 1 through 2 (0.878) is lower than that of Function 2 (0.996) (Table 5). While Function 1 is statistically significant at 5% ($p = 0.022 < 0.5$), Function 2 is not ($p = 0.788$) (Table 5); this implies that the three organizational characteristics were able to significantly discriminate the adoption rate of BDA among consulting firms. As these statistics suggest that Function 1 is more sophisticated than Function 2, discriminant analysis yielded by Function 1 was retained for analysis. The hit ratio of the discriminant analysis at 50.0% ($47 + 0 + 12 = 59/118$) (Table 6) suggests that the discriminant function was fairly accurate in predicting the influence of organizational characteristics on the adoption rate of BDA.

Result in Table 7 indicates the discriminating power of the organizational characteristics. Reckoning with the absolute value of the coefficients to gauge the magnitude of contribution of each predictor to the function (Malhotra and Birks, 2007), rating on the extent to which the organizational factors determine the adoption rate of BDA (under the standardized canonical function) is in the descending order of: scope of operation (Big 4/non-Big 4) (0.929), international affiliation (0.872) and firm size (0.026). The structure matrix in Table 7 displays

Table 5.
Goodness of fit for discriminant function

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation	Wilks' Lambda	Chi-square	Sig
1	0.134[a]	97.0	97.0	0.344	0.878	14.801	0.022
2	0.004[a]	3.0	100.0	0.065	0.996	0.477	0.788

Note(s): a. First two canonical discriminant functions were used in the analysis

Table 6.
Classification results[a]

			Predicted group membership			
		BDA adoption	Innovators	Early majority	Laggards	Total
Original	Count	Innovators	47	0	16	63
		Early majority	20	0	18	38
		Laggards	5	0	12	17
	%	Innovators	74.6	0.0	25.4	100.0
		Early majority	52.6	0.0	47.4	100.0
		Laggards	29.4	0.0	70.6	100.0

Note(s): a. 50.0% of original grouped cases correctly classified

Table 7.
Coefficients of organizational characteristics determining BDA adoption rate

	Standardized canonical function		Structure matrix	
Organizational characteristics	1	2	1	2
Firm size	0.026	−0.782	0.310	−0.243
International affiliation	−0.872	0.494	−0.500	0.637
Scope of operation (Big 4/non-Big 4)	0.929	0.818	0.598	0.605

the pooled within-groups correlations between the discriminating variables and standardized canonical discriminant functions. The factors are ordered by absolute size of correlation within function in the descending order of: scope of operation (Big 4/non-Big 4) (0.598), international affiliation (0.500) and firm size (0.310). The ranking of the organizational factors as per their discriminating abilities under the standardized canonical function is consistent with that of the structure matrix (Table 7).

In summary, the result from MANOVA is consistent with that of multidiscriminant analysis that organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of BDA, with scope of operation emerging as the strongest determinant (research objective 1).

4.3 Organizational characteristics affecting usage level of big data analytics

4.3.1 Result from logistic regression analysis. Result from logistic regression analysis is reported in Tables 8–11.

The full model was statistically significant at 5% [χ^2 (3) = 11.388, p = 0.01 < 0.05] (Table 8). The model was able to successfully distinguish between firms applying BDA at a basic level

		Chi-square	df	Sig
Step 1	Step	11.388	3	0.010
	Block	11.388	3	0.010
	Model	11.388	3	0.010

Table 8. Omnibus tests of model coefficients

Step	−2 Log likelihood	Cox and Snell *R* square	Nagelkerke *R* square
1	151.652[a]	0.092	0.123

Note(s): a. Estimation terminated at iteration number 4 because parameter estimates changed by less than 0.001

Table 9. Model summary

			Predicted BDA usage level		
	Observed		Advanced	Basic	Percentage correct
Step 1	BDA usage level	Advanced	47	16	74.6
		Basic	25	30	54.5
	Overall percentage				65.3

Note(s): [a]The cut value is 0.500

Table 10. Classification table[a] on the usage level of BDA

Factors		B	S.E.	Wald	df	Sig	OR
Step 1	Size	0.045	0.327	0.019	1	0.889	1.047
	Affiliation	1.459	0.613	5.662	1	0.017**	0.232
	Scope of operation	1.242	0.479	6.729	1	0.009***	3.461
	Constant	-0.736	1.235	0.355	1	0.551	0.479

Note(s): ***p significant at 1%; **p significant at 5%

Table 11. Organizational characteristics affecting the level of use of BDA

from those utilizing it at an advanced level. The Cox and Snell R square coefficient of 0.092 and the Nagelkerke R square of 0.123 (Table 9) connote that 9.2% to 12.3% of the likelihood of the usage of BDA is attributable to the selected predictor variables. Predictions were correct 77 times out of 118 times, accounting for an overall success rate of 65.3% (Table 10).

From the result in Table 11, two variables – international affiliation ($p = 0.017 < 0.05$) and scope of operation ($p = 0.009 < 0.001$) – have statistical significance, while firm size is not statistically significant ($p = 0.889$). The odds ratio (OR) suggests that firms with global scope of operation (i.e. the Big 4) are 3.461 times more likely to extensively apply BDA than the non-Big 4. Moreover, internationally affiliated consulting firms are 0.232 times more likely to apply BDA at an advanced level than local firms with no foreign integration. In sum, organizational factors such as international affiliation and scope of operation significantly affect the usage level of BDA by consulting firms (research objective 2).

4.3.2 Additional analysis – level of BDA usage in various areas of consulting by big 4 and non-big 4 firms. Seeing that scope of operation (the Big 4/non-Big 4 dichotomy) is the strongest predictor of the usage level of BDA, further examination (post-hoc analysis) was carried out to closely examine usage rate in the various areas of consulting (results reported in Tables 12 and 13).

The trend observable in Table 12 is that the Big 4 group has higher mean score than the non-Big 4 in almost all the areas of consulting except in financial advisory services (non-Big 4 = 4.13; Big 4 = 4.05). Also, significant difference was observed in the level of use in six out of ten areas investigated (including Human Resource Consulting, Brand building and Product Positioning, Scenario-Based Planning/Business Simulation, Information Technology Consulting, Internal Control/Internal audit Consulting and Taxation and Tax Management Consulting), with application level higher for the Big 4 in all of the six cases. In comparing the overall level of use (Table 13), the Big 4 group recorded higher application level than the non-Big 4 ($p = 0.018 < 0.05$), thus buttressing the result that scope of operation significantly affects the usage level, while firms with global presence have higher propensity to apply BDA at an advanced level (research objective 2).

4.4 Test of hypotheses

MANOVA result (Tables 2, 3 and 4) and discriminant analysis result (Table 5) establish that the organizational factors examined significantly determine the adoption rate of BDA. Since the p values in the referred tables are significant at 5%, H1 is accepted. In Table 11, international affiliation ($p = 0.017 < 0.05$) and scope of operation ($p = 0.009 < 0.001$) have significant p values. Hence, H2b and H2c are accepted. The p value of firm size is not statistically significant, leading to the rejection of H2a (Table 14).

4.5 Discussion of findings

Result from MANOVA (Tables 3, 4 and 5) corroborates the result of the discriminant analysis (Tables 5–7) that organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of BDA, with scope of operation emerging as the strongest determinant [acceptance of H1] (research objective 1). This finding supports the submission of innovation diffusion scholars that organizational characteristics affect innovation adoption (Rogers, 2003; Aarons *et al.*, 2011; Wisdom *et al.*, 2014). However, two organizational factors (international affiliation and scope of operation), except firm size, significantly explain the usage level of BDA, with scope of operation being the strongest predictor (research objective 2).

The emergence of scope of operation as both the strongest determinant of BDA adoption rate and the strongest predictor of BDA usage level (acceptance of H2c) establishes that the scope of operation is the strongest organizational factor affecting the diffusion of BDA. The

Table 12.
Level of BDA usage in various areas of consulting by Big 4 and non-Big 4 firms

Areas of consulting		*N*	Mean	Std. Deviation	Std. Error	95% Confidence interval for mean Lower bound	Upper bound	Minimum	Maximum	*t*-test *p* value
Human resource consulting	Non-Big 4	62	3.16	0.927	0.118	2.93	3.40	1	5	
	Big 4	56	3.52	0.738	0.099	3.32	3.72	2	5	0.024
	Total	118	3.33	0.858	0.079	3.17	3.49	1	5	
Risk consulting	Non-Big 4	62	3.35	1.282	0.163	3.03	3.68	1	5	
	Big 4	56	3.66	1.083	0.145	3.37	3.95	1	5	0.167
	Total	118	3.50	1.197	0.110	3.28	3.72	1	5	
Financial advisory services	Non-Big 4	62	4.13	0.799	0.102	3.93	4.33	3	5	
	Big 4	56	4.05	0.749	0.100	3.85	4.25	2	5	0.599
	Total	118	4.09	0.773	0.071	3.95	4.23	2	5	
Innovation and strategy consulting	Non-Big 4	62	3.35	1.073	0.136	3.08	3.63	1	5	
	Big 4	56	3.57	0.828	0.111	3.35	3.79	2	5	0.226
	Total	118	3.46	0.966	0.089	3.28	3.63	1	5	
Brand building and product positioning	Non-Big 4	62	2.97	1.173	0.149	2.67	3.27	1	5	
	Big 4	56	3.39	0.908	0.121	3.15	3.64	2	5	0.031
	Total	118	3.17	1.073	0.099	2.97	3.37	1	5	
Market research/diagnostic studies	Non-Big 4	62	3.45	1.111	0.141	3.17	3.73	1	5	
	Big 4	56	3.66	0.940	0.126	3.41	3.91	2	5	0.275
	Total	118	3.55	1.034	0.095	3.36	3.74	1	5	
Scenario-based planning/business simulation	Non-Big 4	62	3.21	1.058	0.134	2.94	3.48	1	5	
	Big 4	56	3.61	0.846	0.113	3.38	3.83	2	5	0.027
	Total	118	3.40	0.980	0.090	3.22	3.58	1	5	

(*continued*)

Table 12.

Areas of consulting		*N*	Mean	Std. Deviation	Std. Error	95% Confidence interval for mean Lower bound	Upper bound	Minimum	Maximum	*t*-test *p* value
Information technology consulting	Non-Big 4	62	3.27	1.203	0.153	2.97	3.58	1	5	
	Big 4	56	3.68	0.834	0.111	3.46	3.90	2	5	0.038
	Total	118	3.47	1.060	0.098	3.27	3.66	1	5	
Internal control/internal audit consulting	Non-Big 4	62	3.68	0.919	0.117	3.44	3.91	1	5	
	Big 4	56	4.00	0.661	0.088	3.82	4.18	2	5	0.032
	Total	118	3.83	0.820	0.075	3.68	3.98	1	5	
Taxation and tax management consulting	Non-Big 4	62	3.77	0.965	0.123	3.53	4.02	1	5	
	Big 4	56	4.18	0.716	0.096	3.99	4.37	2	5	0.012
	Total	118	3.97	0.876	0.081	3.81	4.13	1	5	

Big 4 may anticipatorily record higher adoption rate and more extensive usage of BDA in comparison to the non-Big 4 owing to their strengths in size, reputation, reach, resources and global presence (Khurana and Raman 2004; Behn *et al.*, 2008; Lawrence *et al.*, 2011). Post-hoc analysis (Tables 12 and 13) reinforces that the Big 4 are more rigorous in applying BDA in critical areas of consulting.

Affiliation to international consulting firms surfaced as the second high-ranking organizational factor associated with the diffusion of BDA and also assumed statistical significance (Table 11). Internationally affiliated consulting firms are likely to witness higher diffusion rate of BDA than local firms (acceptance of H2b). This is because firms belonging to a network of cosmopolitan organizations with presence in different parts of the world have a tendency to adopt an innovation (Rogers, 2003; Feldstein and Glasgow, 2008; Oldenburg and Glanz, 2008). Similarly, consulting firms collaborating with other international accounting/consulting organizations should expectedly deploy innovative approach such as BDA to proffer solution to business problems of clients (acceptance of H2b).

The low ranking of firm size as a discriminating variable in BDA adoption rate and the inability of firm size to significantly predict the usage level of BDA (Table 11) [rejection of H2a] prove that firm size is not strongly associated with the diffusion of BDA. This observation controverts common knowledge that firm size is positively associated with the adoption of innovation (Graham and Logan, 2004; Mendel *et al.*, 2008) but provides support for the argument that size may not usually affect the uptake of an innovation (e.g. Cinquini and Tenucci, 2007; Pavlatos, 2011).

5. Conclusion

This study investigates the characteristics of business and management consulting firms (namely firm size, international affiliation and scope of operation) affecting the adoption rate (i.e. recency of adopting BDA as a new idea) and usage level of BDA. Ten critical areas of BDA

Table 13. Overall level of use of BDA by Big 4 and non-Big 4 firms

	N	Mean	Std. Deviation	Std. Error	95% Confidence interval for mean Lower bound	Upper bound	Minimum	Maximum	*t*-test [*p* value]
Non-big 4	62	3.4355	0.71060	0.09025	3.2550	3.6159	1.70	5.00	0.018
Big 4	56	3.7321	0.61795	0.08258	3.5667	3.8976	2.40	5.00	
Total	118	3.5763	0.68184	0.06277	3.4520	3.7006	1.70	5.00	

Table 14. Summary of hypothesis test results

Hypo No	Proposition	Decision
H1	*Organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of big data analytics by consulting firms*	Strongly supported
H2a	*Large-sized consulting firms will record higher usage rate of big data analytics than small-sized firms*	Not supported
H2b	*Internationally affiliated consulting firms are likely to witness higher usage rate of big data analytics than local firms*	Supported
H2c	*The Big 4 firms will have higher usage rate of big data analytics than the non-Big 4 firms*	Strongly supported

application to business and management consulting were investigated, (1) Human Resource Management; (2) Risk Management; (3) Financial Advisory Services; (4) Innovation and Strategy; (5) Brand building and Product Positioning; (6) Market Research/Diagnostic Studies; (7) Scenario-Based Planning/Business Simulation; (8) Information Technology; (9) Internal Control/Internal Audit; and (10) Taxation and Tax Management. The organizational characteristics investigated were: consulting firm size, affiliation to international consulting firms and scope of operation (Big 4/ non-Big 4 dichotomy). Result shows that organizational characteristics such as firm size, international affiliation and scope of operation significantly determine the adoption rate of BDA, with scope of operation emerging as the strongest determinant (research objective 1). Moreover, affiliation to international accounting/consulting firm and scope of operation significantly predict the usage level of BDA among consulting firms, with scope of operation emerging as the strongest predictor (research objective 2). Internationally affiliated consulting firms are likely to witness higher usage rate of BDA than local firms. The Big 4 accounting/consulting firms will have higher usage rate of BDA than the non-Big 4 firms. Contrary to common knowledge that firm size is positively associated with the adoption of an innovation, the study found no evidence to support this claim in respect of the spread of BDA.

The study contributes to knowledge by exposing the factors promoting the uptake of BDA in a developing country. The originality of the current study stems from the consideration that it is the first, to the researchers' knowledge, to investigate the application of BDA by consulting firms in the Nigerian context. The study adds to literature on management accounting in the digital economy.

This study is not without its limitations. The investigation was limited to top 20 consulting firms in Nigeria; future studies may expand the scope to other consulting organizations to enhance generalizability of results. Considering that data was collected through a structured questionnaire, one cannot rule out the possibility response bias as is typical of survey studies. Responses may be trumped up, thereby creating socially desirable response bias. However, the study employed multi-informant strategy in an effort to improve reliability of information supplied by respondents and minimize response bias. Future studies may triangulate data collection to ensure well-validated results. Overall, these limitations in no way invalidate the results of this research, but provide rationale for study replication in other jurisdictions given the nascent yet ubiquitous nature of the BDA discourse. Future studies may examine how factors such as organizational assimilation process (managerial intervention, subjective norms, facilitating conditions, individual adoption process and assimilation stages), innovation attributes (such as relative advantage, compatibility, complexity, trialability and observability) and stakeholders' action influence the diffusion of BDA in various sectors.

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Further reading

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Appendix

Table A1.
Reliability test results

Variable	Number of items	Reliability statistics: Cronbach's alpha	Reliability statistics: Guttman split-half coefficient	Reliability statistics: Kaiser–Meyer–Olkin measure of sampling adequacy
Adoption rate of big data analytics	10	0.885	0.905	0.765***
Use of big data analytics	10	0.880	0.830	0.783***

Note(s): ***significant at 1%

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