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Big data and predictive analytics for supply chain and organizational performance☆

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ABSTRACT

Scholars acknowledge the importance of big data and predictive analytics (BDPA) in achieving business value and firm performance. However, the impact of BDPA assimilation on supply chain (SCP) and organizational performance (OP) has not been thoroughly investigated. To address this gap, this paper draws on resource-based view. It conceptualizes assimilation as a three stage process (acceptance, routinization, and assimilation) and identifies the influence of resources (connectivity and information sharing) under the mediation effect of top management commitment on big data assimilation (capability), SCP and OP. The findings suggest that connectivity and information sharing under the mediation effect of top management commitment are positively related to BDPA acceptance, which is positively related to BDPA assimilation under the mediation effect of BDPA routinization, and positively related to SCP and OP. Limitations and future research directions are provided.

1. Introduction

Big data and predictive analytics (BDPA) is an all-encompassing term for techniques destined to handle big data characterized in terms of high volume, velocity and variety (Duan & Xiong, 2015; Wang, Gunasekaran, Ngai, & Papadopoulos, 2016; Zhou, Chawla, Jin, & Williams, 2014). Big data can help address critical challenges of predictive analytics that refer to data capture, storage, transfer & sharing (i.e. system architecture), and search, analysis, and visualization (i.e. data analytics) (Chen, Chiang, & Storey, 2012; Duan & Xiong, 2015; Erevelles, Fukawa, & Swayne, 2016). BDPA can improve supply chain performance by improving visibility (Barratt & Oke, 2007), resilience and robustness (Brandon-Jones, Squire, Autry, & Petersen, 2014), and organizational performance (OP) (Schoenherr & Speier-Pero, 2015; Waller & Fawcett, 2013).

Nevertheless, Hazen, Boone, Ezell, and Jones-Farmer (2014) claim that knowledge on how to assimilate BDPA and its influence on SCP and OP is scant. To address this gap, this research draws on resource based view (RBV) (Barney, 1991; Barney & Clark, 2007; Peteraf, 1993; Wernerfelt, 1984), management commitment (Jarvenpaa & Ives, 1991; Liang, Saraf, Hu, & Xue, 2007) and post-adoption diffusion of innovation (Hazen, Overstreet, & Cegielski, 2012; Saga & Zmud, 1994) to develop and test a model that explains the impact of BDPA in SCP and OP. Assimilation is the extent to which technology diffuses across organizational processes, and is part of three-stage post-diffusion process (i.e. acceptance, routinization, and assimilation) (Hazen et al., 2012; Saga & Zmud, 1994). Acceptance concerns how well an organization's stakeholders perceive the BDPA. Routinization concerns how well an organization's governance systems are adjusted to accommodate BDPA, and assimilation concerns how well BDPA has diffused across organizational process. This paper contributes to the BDPA literature (Ji-Fan Ren, Wamba, Akter, Dubey, & Childe, 2016; Whitten, Green, & Zelbst, 2012) by investigating to what extent resources (connectivity and information sharing) impact on BPDA acceptance and assimilation capabilities under the mediating effect of top management commitment, and the impact of BDPA assimilation on SCP and OP. This research, hence, extends those studies focusing on the role of information sharing and top management commitment on supply chain transformation and firm performance (Hitt, Xu, & Carnes, 2015;

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Prajogo & Olhager, 2012; Waller & Fawcett, 2013; Wu, Yeniyurt, Kim, & Cavusgil, 2006) for the achievement of competitive advantage.

2. Theoretical background

2.1. Resource-based view

Resource based view argues that organizations achieve competitive advantage by creating bundles of strategic resources and/or capabilities (Barney, 1991; Barney, Wright, & Ketchen, 2001; Sirmon, Hitt, Ireland, & Gilbert, 2011). Superior firm performance relies on the extent a firm possesses simultaneously valuable (V), rare (R), imperfectly imitable (I) resources which are properly organized (O) (Amit & Schoemaker, 1993; Barney et al., 2001). Resources can be 'physical capital', 'human capital', 'technological capital', and 'reputational capital', either 'tangible' (e.g. infrastructure) or 'intangible' (e.g. information or knowledge sharing) (Größler & Grübner, 2006). When bundled, resources have significant value (Grant, 1991; Sirmon, Gove, & Hitt, 2008). Whereas resources refer to the tangible and intangible assets, capabilities are subsets of a firm's resources which are non-transferable and aim at enhancing the productivity of other resources (Makadok, 1999). Hence, capabilities are an absolute necessity for an organization (Hitt, Ireland, Sirmon, & Trahms, 2011) and depend on the environmental conditions in which an organization operates.

However, RBV recognizes that resources cannot provide competitive advantage by themselves. Sirmon, Hitt, and Ireland (2007) highlight the role of top managers in capability building, structuring the resource portfolio using the particular processes (acquiring, accumulating, and divesting); other studies investigate the importance of managerial decisions in resource acquisition and deployment (Grewal & Slotegraaf, 2007), and the role of managers in orchestrating resources (Chadwick, Super, & Kwon, 2015).

However, few studies investigate the effect of the combination of resources and capabilities on performance (Brandon-Jones et al., 2014; Ravichandran & Lertwongsatien, 2005; Rungtusanatham, Salvador, Forza, & Choi, 2003). For instance, Wu et al. (2006) argue that the utilization of capabilities may help organizations to achieve or sustain competitive advantage.

In this paper RBV is used to conceptualise BDPA assimilation as a capability that impacts on SCP and OP. Resources such as connectivity and information sharing under the mediation effect of top management commitment (TMC) help BDPA assimilation (capability), which impacts on SCP and OP (Fig. 1).

2.2. Connectivity and information sharing

Following RBV, resources are bundled together to build capabilities (Grant, 1991). Connectivity (C) and information sharing (IS) are resources (Fig. 1) (Ji-Fan Ren et al., 2016; Wamba, Akter, Edwards, Chopin, & Gnanzou, 2015). Premkumar and King (1994) define IS as organizational capital that focuses on the flow of information. Hazen et al. (2014) argue that the utilization of IS depends on quality. However, Ji-Fan Ren et al. (2016) postulate that quality, accessibility, accuracy, and relevance of IS rely on effective delivery, depends on IT infrastructure (Fawcett, Wallin, Allred, & Magnan, 2009; Sharif & Irani, 2006; Irani, 2010; Brandon-Jones et al., 2014). Therefore:

H1. Connectivity is positively related to information sharing.

2.3. Impact of connectivity and information sharing on BDPA acceptance under the mediation effect of top management commitment

Literature underlines the role of top management in knowledge and IS (Luo & Hassan, 2009). Chatterjee, Grewal, and Sambamurthy (2002) look into top management beliefs and their influence on opportunities and risks related to the assimilation of Web technologies, whereas Liang et al. (2007) investigate the mediating role of TMC in the successful assimilation of ERP. Following an RBV perspective, C and IS are resources that build 'BDPA acceptance' capability.

Scholars (Sirmon et al., 2007; Augier & Teece, 2009; Hitt et al., 2015) highlight the role of top managers in building capabilities and subsequently helping firms achieve competitive advantage. Management commitment orchestrates resources and creates capabilities (Chadwick et al., 2015; Prajogo & Olhager, 2012).

Notwithstanding the importance of TMC in the assimilation of technologies, literature is underdeveloped in the case of building BDPA acceptance capability. Scholars suggest that the acceptance of technology (i.e. BDPA) is the first stage of the assimilation process (Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003), followed by routinization and assimilation (Hazen et al., 2012; Saga & Zmud, 1994). Hence, both C and IS impact positively on BDPA acceptance under the mediation effect of TMC. Therefore,

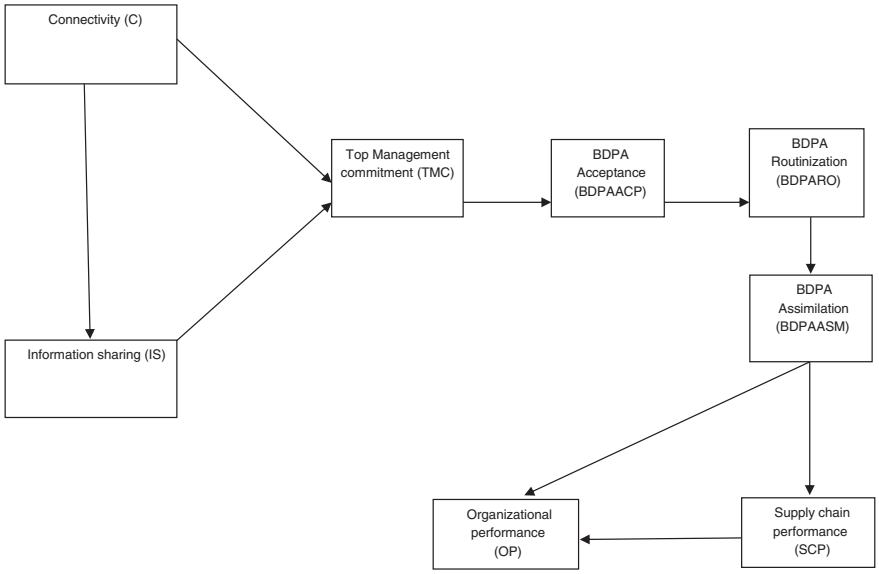

Fig. 1. Proposed model.

Table 1
Construct operationalization.

Constructs	Derived from	Measures
Connectivity (C)	Fawcett et al. (2009); Brandon-Jones et al. (2014); Duan and Xiong (2015)	(i) Current information systems satisfy communications requirements (C1) (ii) Information applications are highly integrated within the firm and supply chain (C2) (iii) Adequate information systems linkages exist with partners in supply chain network (C3)
Information sharing (IS)	Cao and Zhang (2011)	Our organization exchanges with our partners: (i) relevant information (IS1) (ii) timely information (IS2) (iii) accurate information (IS3) (iv) complete information (IS4) (v) sensitive information (IS5)
Top management commitment (TMC)	Liang et al. (2007)	Top management: (i) expresses how supply chain partnering will provide significant business benefits to the firm (TMC1) (ii) expresses how supply chain partnering will create a significant competitive arena (TMC2) (iii) articulates vision for supply chain collaboration (TMC3) (iv) formulates strategy for organizational information sharing (TMC4) (v) establishes the metrics to monitor supply chain success through partnering (TMC5)
BDPA acceptance	Hazen et al. (2012)	(i) The degree to which you believe that embracing BDPA helps you enhance your job performance (ACP1). (ii) The degree to which you and your colleagues associate with the BDPA systems (ACP2). (iii) The degree to which you believe that an organizational and technical infrastructure exists to support use of the BDPA(ACP3).
BDPA routinization	Hazen et al. (2012)	(i) The degree to which procedures are established for replacement of old systems (RO1). (ii) The degree to which the BDPA process is supported by the normal budgeting (RO2). (iii) There is a dedicated organizational unit for BDPA (RO3). (iv) The degree to which technical support can be obtained according to organizational procedures (RO4). (v) The degree to which organization is able to hire and retain qualified people (RO5). (vi) The degree to which an organization offers opportunities for initial and/or recurring training regarding the BDPA (RO6). (vii) The degree to which persons familiar with BDPA background have been promoted to higher positions of greater authority such that they can support BDPA initiatives (RO7).
BDPA assimilation	Liang et al. (2007); Hazen et al. (2012)	(i) Volume: the extent to which your organization has used BDPA as an important tool in every department (%) (ASM1). (ii) Diversity: number of functional areas that are using BDPA for decision making in your organization (ASM2). (iii) Depth: For each functional area in your firm (as indicated by you), identify the level at which the BDPA is used: (a) Operation (b) Management (c) Decision making (ASM3).
Supply chain performance (SCP)	Whitten et al. (2012)	(i) This organization has full visibility of our supply chain (ii) This organization appropriately manages supply chain risk (iii) This organization's primary supply chain has the ability to minimize total product cost to final customers. (iv) This organization's primary supply chain has the ability to deliver product precisely on-time delivery to final customers. (v) This organization's primary supply chain has the ability to deliver zero-defect products to final customers. (vi) This organization's primary supply chain has the ability to minimize all types of waste throughout the supply chain. (vii) This organization's primary supply chain has the ability to deliver right-sized lot sizes and shipping case sizes to final customers. (viii) This organization's primary supply chain has the ability to eliminate late, damaged and incomplete orders to final customers. (ix) This organization has the ability to minimize channel safety stock throughout the supply chain. (x) This organization's primary supply chain has the ability to deliver value-added services to final customers. (xi) This organizations supply chain has the ability to respond faster than competitors to changing environments.
Organizational performance (OP)	Whitten et al. (2012)	(i) Average return on investment. (ii) Average profit. (iii) Average return on sales. (iv) Average market share growth. (v) Average sales volume growth. (vi) Average sales (in dollars) growth.

Table 2
Descriptive statistics of sample frame.

Title	Number	Percentage
Annual sales revenue		
Under USD 10 million	15	7.32
USD 10-USD 25 million	20	9.76
USD 26-USD 50 million	30	14.63
USD 76-USD100 million	52	25.37
USD 101-USD250 million	18	8.78
USD 251-USD500 million	17	8.29
Over 251 million	53	25.85
Number of employees		
0–50	6	2.93
51–100	10	4.88
101–200	19	9.27
201–500	11	5.37
501–1000	102	49.76
1001+	57	27.80
Industry		
Manufacturing	78	38.05
Consulting	39	19.02
E-commerce	13	6.34
Technology company	75	36.59

H2. Connectivity under the mediation effect of top management commitment is positively related to BDPA acceptance.

H3. Information sharing under the mediation effect of top management commitment is positively related to BDPA acceptance.

2.4. BDPA acceptance, BDPA routinization and BDPA assimilation

Zmud & Apple (1992, p.149) define routinization as "the permanent adjustment of an organization's governance system to account for the incorporation of a technology". Hazen et al. (2012), based on Saga and Zmud (1994), argue that routinization is the second stage of a threefold process (i.e. acceptance, routinization, and assimilation). To obtain the anticipated benefits, organizations need to accept, routinize, and assimilate technologies (Hazen et al., 2012). From an RBV perspective, an organization needs to develop BDPA acceptance and assimilation capabilities through the mediating construct of BDPA routinization. Therefore,

H4. BDPA acceptance is positively related to BDPA assimilation under the mediation effect of BDPA routinization.

2.5. BDPA assimilation, supply chain performance, and organizational performance

Scholars highlight the importance of BDPA for transforming supply chains (Chae, 2015; Hazen et al., 2014; Waller & Fawcett, 2013). Schoenherr and Speier-Pero (2015) note that BDPA can assist in reducing supply chain costs and achieving efficiency, responding faster to changing environment, providing more power in supplier relationships with suppliers and enhancing sales and operations planning capabilities. Ji-Fan Ren et al. (2016) acknowledge the positive impact of the use of big data analytics on firm performance.

From an RBV perspective, literature highlights the positive impact of supply chain integration capabilities – firm-specific and hard-to-copy across organizations – through the use of IT on firm performance (e.g. Rai, Patnayakuni, & Seth, 2006; Wu et al., 2006). Liu, Ke, Wei, and Hua (2013) look into the effect of IT capabilities on firm performance through absorptive capacity and supply chain agility, whereas Jin, Vonderembse, Ragu-Nathan, and Smith (2014) claim that IT-enabled sharing capabilities impact on competitive performance. Literature does not, however, look into post-diffusion of BDPA and in particular the impact of developing BDPA capabilities and their impact on SCP and OP. Therefore,

Table 3
Convergent validity test.

Scale (Cronbach's alpha)	Indicators	Standard loading	Variance	Error	SCR	AVE
BDPA assimilation (0.63)	ASM1	0.71	0.50	0.50	0.78	0.54
	ASM2	0.66	0.43	0.57		
	ASM3	0.83	0.69	0.31		
BDPA acceptance (0.713)	ACP1	0.98	0.95	0.05	0.94	0.85
	ACP2	0.93	0.86	0.14		
	ACP3	0.85	0.72	0.28		
BDPA routinization (0.948)	RO1	0.87	0.76	0.24	0.93	0.67
	RO2	0.80	0.63	0.37		
	RO3	0.80	0.65	0.35		
	RO4	0.80	0.64	0.36		
	RO5	0.77	0.59	0.41		
	RO6	0.84	0.71	0.29		
	RO7	0.85	0.73	0.27		
Top management commitment (0.971)	TMC1	0.95	0.91	0.09	0.98	0.90
	TMC2	0.95	0.90	0.10		
	TMC3	0.98	0.96	0.04		
	TMC4	0.94	0.89	0.11		
	TMC5	0.93	0.86	0.14		
Information sharing (0.937)	IS1	0.72	0.52	0.48	0.87	0.58
	IS2	0.72	0.51	0.49		
	IS3	0.87	0.76	0.24		
	IS4	0.65	0.43	0.57		
	IS5	0.82	0.68	0.32		
Connectivity (0.967)	C1	0.84	0.71	0.29	0.87	0.68
	C2	0.84	0.71	0.29		
	C3	0.79	0.63	0.37		
Supply chain performance (0.881)	SCP1	0.89	0.79	0.21	0.98	0.85
	SCP2	0.94	0.89	0.11		
	SCP3	0.90	0.80	0.20		
	SCP4	0.92	0.85	0.15		
	SCP5	0.87	0.76	0.24		
	SCP6	0.89	0.78	0.22		
	SCP7	0.77	0.60	0.40		
	SCP8	0.99	0.98	0.02		
	SCP9	0.99	0.99	0.01		
	SCP10	0.99	0.97	0.03		
	SCP11	0.97	0.95	0.05		
Organizational performance (0.74)	OP1	0.98	0.95	0.05	0.93	0.68
	OP2	0.93	0.86	0.14		
	OP3	0.70	0.49	0.51		
	OP4	0.73	0.53	0.47		
	OP5	0.72	0.52	0.48		
	OP6	0.85	0.71	0.29		

H5. BDPA assimilation is positively related to a firm's supply chain performance.

H6. BDPA assimilation is positively related to organizational performance.

2.6. Impact of supply chain performance on organizational performance

Choudhury, Tiwari, and Mukhopadhyay (2004) note that a firm's SCP can positively impact market performance by enhancing market

Table 4
Discriminant validity test.

	RO	TMC	IS	ACP	C	ASM	SCP	OP
RO	**0.82**							
TMC	0.57	**0.95**						
IS	0.08	0.23	**0.76**					
ACP	0.50	0.13	−0.05	**0.92**				
C	0.42	0.25	0.12	0.54	**0.83**			
ASM	0.27	0.23	0.06	0.08	0.04	**0.74**		
SCP	−0.13	−0.10	−0.04	−0.10	−0.13	0.06	**0.82**	
OP	−0.08	−0.26	−0.10	0.09	−0.03	−0.12	0.13	**0.82**

Table 5
Mediating regression results for top management commitment and BDPA routinization.

Hypothesis	Beta coefficient for Path A (SEa)	Beta coefficient for Path B (SEb)	Beta coefficient for Path C (total effect)	Beta coefficient for Path D (controlling for the mediator)	Mediation	Sobel *p* value
H2	0.625 (0.053)	0.201 (0.043)	0.243	0.198	Partial mediation	0.00
H3	0.762 (0.073)	0.201 (0.043)	0.3	0.296	Partial mediation	0.00
H4	0.868 (0.067)	0.238 (0.076)	0.08	0.08	Partial mediation	0.002

share and financial performance by reducing supply chain cost. Chen and Paulraj (2004) propose 'supply chain cost' and 'delivery of quality products and services in precise quantities and precise times' as measures of supply chain performance. Li, Ragu-Nathan, Ragu-Nathan, and Rao (2006) argue that supply chain practices (including level and quality of information sharing) can lead to improved OP. Green, Whitten, and Inman (2008) note that supply chain productivity positively impacts on OP whereas in a later study, Whitten et al. (2012) note that SCP is positively linked to OP. Therefore,

H7. Supply chain performance is positively related to organizational performance.

2.7. Statistical controls

Two control variables are included. These variables are 'organization size' (measured by total number of employees) and 'revenue generated by the organization in a financial year' (Liang et al., 2007).

3. Research methods

3.1. Instrument development

This study uses a survey-based approach. Appropriate scales from the literature were used to design the instrument. They were measured on a five-point Likert scale with anchors ranging from strongly disagree (1) to strongly agree (5) (Chen & Paulraj, 2004). The survey was pre-tested in two stages. Firstly, six experienced researchers critiqued the questionnaire for ambiguity, clarity, and appropriateness of the measures used to operationalize each construct (DeVellis, 2012). They also assessed the extent to which the measures sufficiently addressed the subject area (Dillman, 1978), leading to a further modification based on their feedback. Secondly, the questionnaire was emailed to 45 supply chain consultants and managers who are members of American Production and Inventory Control Society (APICS) and are working with major organizations engaged in consulting, and manufacturing. They were asked to review the survey instrument for structure, readability, ambiguity and completeness and their comments were included in the final survey instrument. All of the exogenous constructs in the model are operationalized as reflective. The dependent constructs (SCP and OP), were operationalized as formative constructs. (Table 1).

3.2. Data collection

This study uses a cross-sectional e-mail survey of a sample of manufacturing companies, consulting companies, e-commerce companies and technology companies located in three major cities in India (Hyderabad, Bangalore, & Pune). The initial sample consisted of 315 firms derived from databases provided by Dun & Bradstreet. The response rate was improved by following a modified version of Dillman's (2011) total design test method. The survey questionnaires were sent to key informants who are functional heads associated with SCM (logistics/transportation, operations management, and purchasing/procurement). Each survey included a cover letter, and was

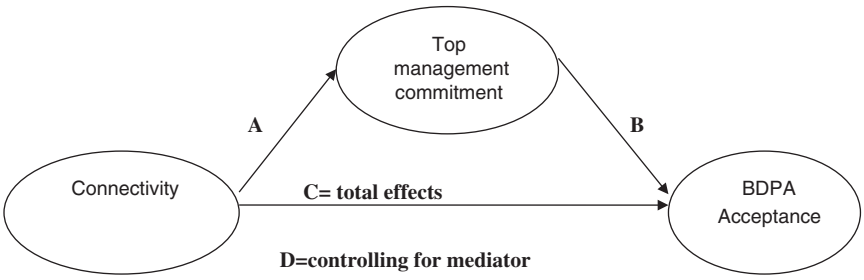

Fig. 2. Mediating effects of top management commitment.

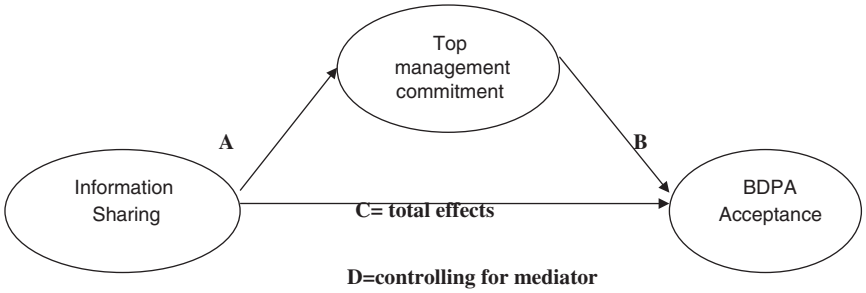

Fig. 3. Mediating effects of top management commitment.

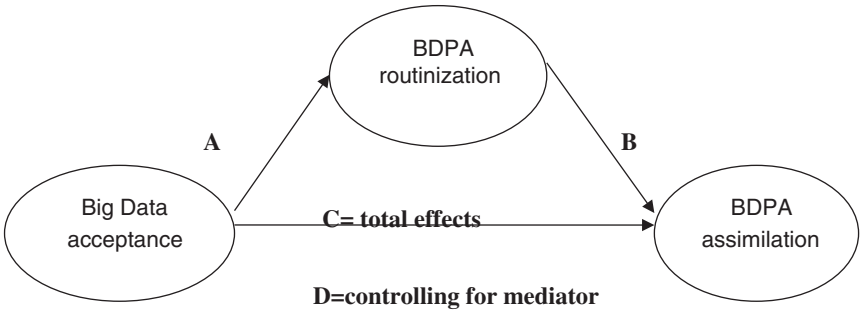

Fig. 4. Mediating effects of BDPA routinization.

followed up with phone calls. This design is suitable for research in the light of India's unique social and cultural context where business activities are largely based on personal relationships instead of incentive mechanisms (Baruch & Holtom, 2008). Personal relationships and support from apex organizations that is, CII (Confederation of Indian Industries) and FICCI (Federation of Indian Chambers of Commerce and Industry) improved the response rate. 205 complete and usable responses were received, resulting in an effective response rate of 65.08%. The respondents' (firm-level) demographic information is presented in Table 2.

3.3. Nonresponse bias

A comparison of early waves (respondents who have returned their response within first three weeks), late respondents (respondents who have returned their response in the fourth week or later), and non-respondents (a subsample of 20 respondents was selected at random from the initial contact list) took place (Armstrong & Overton, 1977; Chen & Paulraj, 2004; Lambert & Harrington, 1990). Student's *t*-tests were performed on early and late waves on all variables and no significant difference between respondents and non-respondents was found. Demographic characteristics such as age, education, and employment status were fairly standard, and hence no further elaboration is necessary (Dickerson & Gentry, 1983).

4. Data analysis and results

The residual plots by predicted value, rankits plot of residuals and statistics of skewness and kurtosis were conducted (Curran, West, & Finch, 1996). The maximum absolute values of skewness and kurtosis of the measures in the remaining dataset were 1.67 and 2.37 respectively (Appendix 1). The reported values are well within limits (univariate skewness < 2, kurtosis < 7) (Curran et al., 1996). Therefore neither the plots nor the statistics indicated any significant deviances from the standard values.

4.1. Measurement validation

This study uses a three-stage improvement cycle to develop measures that satisfied all the requirements of reliability, validity and uni-dimensionality (Chen & Paulraj, 2004). Both Cronbach's alpha and scale composite reliability (SCR) (Fornell & Larcker, 1981) were used (Henseler, Ringle, & Sinkovics, 2009; Revelle & Zinbarg, 2009). Apart from a few constructs, no significant difference between two measures was observed.

Commonly used method (Fornell & Larcker, 1981) was used to calculate convergent and discriminant validity. Items load on the intended constructs with standardized loadings >0.5 or higher, and ideally 0.7 or higher, the SCR >0.7 and the average variance extracted (AVE) >0.5 (Hair, Black, Babin, Anderson, & Tatham, 2006) (Table 3), and hence convergent validity exists. Fawcett et al. (2014) note that for discriminant validity all the items should have higher loadings on their assigned constructs than any other constructs. Furthermore, the mean shared variance should be below 0.50. Alternatively, the square root of the AVE for each construct should be greater than any correlation estimate (Table 4). Discriminant validity has been therefore observed.

Various measurement tests (Bentler, 1990; Bentler & Bonett, 1980; Hu & Bentler, 1999) tested the unidimensionality the overall fit of the model. Based on several fit indices (χ^2/degrees of freedom = 1.68; goodness of fit [*GFI*] = 0.97; adjusted goodness of fit [*AGFI*] = 0.95; Bentler and Bonett's normed fit index [*NFI*] = 0.98; Bentler and Bonett's non-normed fit index [*NNFI*] = 0.97; Bentler comparative fit index [*CFI*] = 0.99; and root mean square error of approximation [*RMSEA*] = 0.08), the constructs show unidimensionality.

4.2. Common method bias

Harmon one-factor test on the eight conceptually crucial variables was conducted (Podsakoff & Organ, 1986; Fuller, Simmering, Atinc, Atinc, & Babin, 2016). The results show that the eight factors are present and the most covariance explained by one factor is 22.25% (Appendix 2). Therefore, common method bias is not likely to affect the results.

4.3. Hypothesis testing

Multiple regression analysis with mediation tests was used to test the hypotheses due to the complexity of the model and available data points (Eckstein, Goellner, Blome, & Henke, 2015). All variables are mean-centred to reduce the risk of multicollinearity of the interaction terms (Brandon-Jones et al., 2014). Multicollinearity tests were conducted by calculating variance inflation factors (VIF) for each regression coefficient. The VIF values ranged from 1.000 to 4.913, significantly below recommended threshold value of 10 (Hair et al., 2006).

Hypotheses' testing (H1, H5, H6 & H7) took place by using regression analysis. H1 (i.e. C → IS) was supported ($\beta = 0.88$; $t = 28.183$; $p = 0.00$) for the prediction that connectivity (C) is positively associated with information sharing (IS) and the size of the organization did not have a significant effect on the model. H5 (BDPA → SCP) was supported, since BDPA assimilation is positively associated to supply chain performance ($\beta = 0.45$; $t = 14.13$; $p = 0.00$). H6 (BDPA → OP) was supported since BDPA assimilation is positively associated to organizational performance ($\beta = 0.17$; $t = 2.48$; $p = 0.01$). Additionally, H7 (SCP → OP) was supported. SCP is positively associated to OP ($\beta = 0.21$; $t = 4.7$; $p = 0.00$).

H2, H3 and H4 were tested using hierarchical mediation regression analyses (Baron & Kenny, 1986) (Table 5). Figs. 2, 3, and 4 illustrate the results.

H2 regression test was performed with C as independent variable and TMC as dependent variable (path A). C has significant influence

on TMC (β = 0.625; $p < 0.001$). The next step was BDPA acceptance on TMC path (path C), which showed significant influence on big data acceptance (β = 0.243; $p < 0.001$). The third regression was BDPA acceptance on C and TMC (paths B and D). Path D is the direct of C on BDPA acceptance (β = 0.198; $p < 0.001$). The significance of mediating was tested using Sobel test (Sobel, 1982). The results showed that in case of BDPA acceptance partial mediation effect exist since paths A, B and D are all significant.

H3 regression test was performed with IS as independent variable and TMC as dependent variable (path A). IS has significant influence on TMC (β = 0.762; $p < 0.001$). The next step was IS acceptance on TMC path (path C), which showed significant influence on big data acceptance (β = 0.3; $p < 0.001$). The third regression was BDPA acceptance on information sharing and top management commitment (paths B and D). Thereby, path D is the direct of IS on BDPA acceptance (β = 0.296; $p < 0.001$). We further tested the significance of mediating using Sobel test (Sobel, 1982). We found that in case of BDPA acceptance partial mediation effect exist since paths A, B and D are all significant.

H4 regression test was performed with BDPA acceptance as independent variable and BDPA routinization as dependent variable (path A). The BDPA acceptance has significant influence on BDPA routinization (β = 0.868; $p < 0.001$). The next step was BDPA acceptance on BDPA routinization path (path C), which showed significant influence on big data assimilation (β = 0.08; $p < 0.002$). The third regression was BDPA assimilation on BDPA acceptance and BDPA routinization (paths B and D). Path D is the direct of BDPA acceptance on BDPA assimilation (β = 0.08; $p < 0.002$). Furthermore, the significance of mediating was tested (Sobel, 1982). In case of BDPA assimilation partial mediation effect exist since paths A, B and D are all significant.

5. Discussion

5.1. Theoretical implications

This paper moves beyond adoption stage to post-diffusion. It conceptualizes BDPA assimilation as a threefold process involving acceptance, routinization, and assimilation (Hazen et al., 2014; Saga & Zmud, 1994). Furthermore, it considers the impact of resources (connectivity and information sharing) and capabilities (big data assimilation capability) on SCP and OP. The analytical distinction between BDPA acceptance and BDPA assimilation helps refine the argument that C and IS are likely to be mediated by TMC to achieve BDPA acceptance which is the first step to assimilation.

This study argues that RBV is relevant for understanding BDPA assimilation as a capability that is dependent on bundling C and IS (resources), and impacts positively on SCP and OP and subsequently to the achievement of competitive advantage at a firm and supply chain level (Barney, 2014). The role of RBV in explaining BDPA is discussed within the operations and supply chain management literature (Ji-Fan Ren et al., 2016) but not in relation to SCP and OP; a study by Whitten et al. (2012) claims that SCP is positively associated with market and financial performance. This research addresses this gap and argues that BDPA assimilation is positively associated to OP, thereby extending studies focusing on the role of IT, information sharing, and supply chain integration and transformation on supply chain and firm performance (Prajogo & Olhager, 2012; Waller & Fawcett, 2013; Wu et al., 2006). This research conforms to Schoenherr and Speier-Pero (2015) who have noted that BDPA offers significant benefits in terms of improvement in supply chain costs and efficiencies, responding faster to changing environment, providing greater power in relationships with suppliers, and enhancing sales and operations planning capabilities.

Finally, this research draws on the literature that highlights the role of top management in building capabilities through the orchestration of resources (Chadwick et al., 2015), thereby assisting firms to achieve competitive advantage (Hitt et al., 2015; Sirmon et al., 2007).

5.2. Managerial implications

The mediating role of TMC between resources and BDPA acceptance highlights that concrete meta-structuring actions by the top management play a significant role in assimilating BDPA in organizations. Top management needs to be able not only to acquire resources (C and IS) but to commit to this process by orchestrating and investing on resource bundling, in order to build BDPA assimilation capability and achieve high SCP and OP. Furthermore, the finding that BDPA assimilation capabilities enhance SCP and OP means that top managers need to be able to acquire (through for instance external acquisition) resources and create appropriate BDPA capabilities to achieve higher SCP and OP.

5.3. Limitations and future research

Notwithstanding the substantial insights of this study for researchers and practitioners, limitations and future research directions need to be outlined. One limitation is the focus of the study on data connectivity and information sharing as the resources that refer to system architecture. The impact of data analytics on BDPA could be explored in future research to significantly improve the explanatory power of the current model. Another potential limitation is the investigation of the role of BDPA assimilation as a capability that impacts on SCP and OP. TMC may need to be further explored through investigating the role of institutional pressures on top managers and their commitment towards developing a firm's BDPA assimilation capabilities. In such an attempt, institutional theory (Bhakoo & Choi, 2013; DiMaggio & Powell, 1983; Kauppi, 2013) may be useful. Furthermore, the sample is homogeneous and the maturity of big data has not been considered. Future studies could control for the effect of big data maturity on big data assimilation, SCP, and OP. Finally, this study relies on a survey based approach. To offer better insights into BDPA assimilation a mixed research approach could be useful, for instance using both a survey and semi-structured interviews with managers and decision makers although, it is a well used methodological approach, see for example Irani and Love (2001). In this vein, the relationships between the constructs of the proposed model could be further understood.

Appendix 1. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. error	Statistic	Std. error
ASM1	205	1.00	5.00	3.93	0.82	−0.57	0.17	0.54	0.34
ASM2	205	2.00	5.00	4.18	0.68	−0.43	0.17	−0.07	0.34
ASM3	205	2.00	5.00	3.91	0.69	−0.42	0.17	0.41	0.34
ACP1	205	3.00	5.00	4.66	0.58	−1.49	0.17	1.23	0.34

Appendix 1 (*continued*)

	N	Minimum	Maximum	Mean	Std. deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. error	Statistic	Std. error
ACP2	205	2.00	5.00	3.79	0.53	−0.54	0.17	0.79	0.34
ACP3	205	2.00	5.00	3.80	0.50	−0.81	0.17	1.23	0.34
RO1	205	3.00	5.00	3.80	0.51	−0.27	0.17	0.06	0.34
RO2	205	2.00	5.00	3.79	0.49	−0.64	0.17	0.68	0.34
RO3	205	2.00	5.00	3.81	0.55	−0.27	0.17	0.39	0.34
RO4	205	2.00	5.00	3.91	0.59	−0.41	0.17	1.05	0.34
RO5	205	2.00	5.00	3.91	0.57	−0.17	0.17	0.51	0.34
RO6	205	2.00	5.00	3.93	0.61	−0.09	0.17	0.07	0.34
RO7	205	2.00	5.00	3.93	0.62	−0.08	0.17	−0.06	0.34
TMC1	205	2.00	5.00	4.52	0.65	−1.13	0.17	0.63	0.34
TMC2	205	3.00	5.00	4.52	0.61	−0.86	0.17	−0.24	0.34
TMC3	205	2.00	5.00	4.49	0.65	−1.02	0.17	0.43	0.34
TMC4	205	3.00	5.00	4.52	0.63	−0.95	0.17	−0.15	0.34
TMC5	205	3.00	5.00	4.50	0.60	−0.75	0.17	−0.40	0.34
IS1	205	3.00	5.00	4.28	0.64	−0.32	0.17	−0.68	0.34
IS2	205	3.00	5.00	4.27	0.64	−0.33	0.17	−0.70	0.34
IS3	205	2.00	5.00	4.04	0.68	−0.43	0.17	0.40	0.34
IS4	205	2.00	5.00	4.06	0.70	−0.34	0.17	−0.07	0.34
IS5	205	2.00	5.00	4.05	0.65	−0.27	0.17	0.13	0.34
C1	205	3.00	5.00	4.23	0.61	−0.16	0.17	−0.51	0.34
C2	205	2.00	5.00	4.22	0.62	−0.32	0.17	−0.01	0.34
C3	205	3.00	5.00	4.24	0.63	−0.25	0.17	−0.64	0.34
SCP1	205	3.00	5.00	4.50	0.61	−0.80	0.17	−0.33	0.34
SCP2	205	2.00	5.00	3.62	0.55	−0.22	0.17	−0.55	0.34
SCP3	205	2.00	5.00	3.62	0.54	−0.12	0.17	−0.77	0.34
SCP4	205	2.00	5.00	3.63	0.56	−0.36	0.17	−0.32	0.34
SCP5	205	2.00	5.00	3.64	0.55	−0.30	0.17	−0.46	0.34
SCP6	205	2.00	5.00	3.61	0.55	−0.26	0.17	−0.65	0.34
SCP7	205	2.00	5.00	3.63	0.55	−0.28	0.17	−0.49	0.34
SCP8	205	3.00	5.00	4.66	0.58	−1.52	0.17	1.31	0.34
SCP9	205	3.00	5.00	4.67	0.57	−1.51	0.17	1.31	0.34
SCP10	205	3.00	5.00	4.67	0.56	−1.54	0.17	1.40	0.34
SCP11	205	2.00	5.00	4.65	0.60	−1.67	0.17	2.37	0.34
OP1	205	3.00	5.00	4.66	0.58	−1.49	0.17	1.23	0.34
OP2	205	2.00	5.00	3.79	0.53	−0.54	0.17	0.79	0.34
OP3	205	3.00	5.00	4.44	0.52	0.03	0.17	−1.50	0.34
OP4	205	3.00	5.00	4.53	0.57	−0.76	0.17	−0.42	0.34
OP5	205	2.00	5.00	4.56	0.54	−0.80	0.17	0.71	0.34
OP6	205	3.00	5.00	4.66	0.51	−1.02	0.17	−0.21	0.34
Valid N (listwise)	205								

Appendix 2. Loadings and cross loadings

	RO	TMC	IS	ACP	C	ASM	SCP	OP
ASM1	−0.026	−0.131	0.069	0.242	−0.145	0.708	−0.062	−0.225
ASM2	0.023	−0.006	−0.027	−0.172	0.083	0.659	−0.162	0.653
ASM3	0.032	−0.051	0.009	0.141	−0.085	0.832	0.135	0.193
ACP1	−0.011	0.032	0.005	0.976	0.009	−0.003	−0.003	−0.015
ACP2	−0.032	0.074	0.004	0.930	0.043	0.100	0.046	−0.086
ACP3	−0.132	0.047	−0.021	0.850	0.179	0.089	0.089	−0.040
RO1	0.870	0.070	0.016	−0.006	0.068	0.060	−0.024	−0.008
RO2	0.797	0.019	−0.007	−0.027	0.127	0.039	−0.002	−0.012
RO3	0.805	0.081	0.181	−0.006	−0.039	−0.012	−0.034	−0.033
RO4	0.798	−0.168	0.042	0.331	−0.083	−0.090	−0.021	0.184
RO5	0.767	−0.120	0.005	0.358	−0.072	−0.098	−0.056	0.185
RO6	0.843	−0.104	0.012	0.294	−0.098	−0.073	−0.037	0.138
RO7	0.853	−0.102	0.029	0.242	−0.055	−0.096	−0.051	0.120
TMC1	0.028	0.955	0.037	0.074	−0.085	−0.057	−0.011	0.047
TMC2	−0.011	0.951	0.006	0.085	0.000	−0.050	−0.025	−0.002
TMC3	−0.017	0.978	−0.005	0.042	−0.026	−0.036	−0.042	0.135
TMC4	0.027	0.945	−0.006	0.049	−0.063	−0.091	−0.037	0.026
TMC5	−0.012	0.925	0.000	0.095	−0.027	0.034	−0.021	0.015
IS1	0.016	0.284	0.722	−0.128	0.063	0.084	0.033	−0.070
IS2	0.012	0.284	0.717	−0.111	0.056	0.081	0.045	−0.081
IS3	−0.045	−0.078	0.870	0.065	−0.012	−0.056	0.015	−0.154
IS4	0.030	0.127	0.653	0.004	0.074	0.118	0.022	−0.172
IS5	−0.048	0.076	0.824	0.029	−0.049	−0.102	−0.060	−0.099
C1	0.085	0.138	−0.005	−0.217	0.840	0.101	0.054	−0.085
C2	0.091	0.091	−0.039	−0.206	0.845	0.112	0.066	−0.120

(*continued on next page*)

Appendix 2 (*continued*)

	RO	TMC	IS	ACP	C	ASM	SCP	OP
C3	0.074	0.213	0.007	−0.163	0.793	0.103	0.060	−0.058
SCP1	0.093	0.018	−0.004	0.013	0.019	−0.031	0.890	0.035
SCP2	0.011	−0.047	0.005	0.010	0.018	−0.015	0.944	0.006
SCP3	0.002	−0.072	0.034	0.078	−0.010	−0.063	0.896	−0.027
SCP4	0.046	−0.060	−0.035	0.020	−0.035	0.018	0.921	−0.008
SCP5	0.037	−0.006	0.011	0.076	−0.018	−0.028	0.874	0.045
SCP6	−0.059	−0.026	0.043	0.059	−0.044	−0.136	0.885	0.018
SCP7	0.032	0.060	−0.025	0.145	0.067	−0.002	0.775	0.061
SCP8	−0.023	0.009	−0.006	−0.003	−0.033	0.006	0.991	0.016
SCP9	0.032	−0.035	0.021	−0.013	−0.020	0.006	0.995	0.008
SCP10	−0.016	0.004	0.006	−0.023	0.011	0.010	0.987	0.010
SCP11	−0.001	−0.010	−0.007	−0.011	0.014	0.051	0.973	0.022
OP1	−0.011	0.032	−0.015	0.005	0.009	−0.003	−0.003	0.976
OP2	−0.032	0.074	0.004	−0.086	0.043	0.100	0.046	0.930
OP3	0.040	−0.130	0.099	0.060	−0.067	0.000	−0.110	0.699
OP4	0.047	0.024	0.012	−0.087	0.028	−0.197	0.277	0.726
OP5	−0.022	−0.004	−0.113	0.136	−0.015	0.210	0.053	0.721
OP6	−0.179	0.140	0.026	−0.070	0.021	−0.010	0.117	0.845
Eigen value	4.807563	4.94709	2.970644	3.285001	2.209916	1.89481	9.569568	4.823872
% Variance	11.18038	11.50486	6.908473	7.639537	5.13934	4.406534	22.25481	11.21831

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