HOW BUSINESS ANALYTICS SYSTEMS PROVIDE BENE-FITS AND CONTRIBUTE TO FIRM PERFORMANCE

Complete Research

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Abstract

Organisations invest in Business analytics (BA) systems to improve firm performance and gain competitive advantage. BA systems use advanced analytical tools and techniques to analyse organisational data and generate insights. Decision makers at different levels of the organisations leverage the insights and take competitive actions. In this paper, we utilise Resource-based View (RBV) and business value of IT literature to develop a research model to explain the firm performance impacts of BA systems in customer relations. The research model proposes that BA capability creates informational benefits in customer relations using two pathways: (1) Direct creation of informational benefits, and (2) Indirect creation of informational benefits through developing higher-order Analytical CRM capability. Informational benefits once created, contribute to superior firm performance. The research model is evaluated using survey data in Large US-based organisations.

Keywords: Business analytics, Resource-based view, Informational benefits, Firm performance.

1   Introduction

Business Analytics (BA) systems involve the use of BA capabilities and technologies to collect, store, analyse and gain insight from data to support decision-making in organisations (Chen et al. 2012; Davenport 2010). Data are analysed to gain insights into past performance, optimise business process-es and predict future trends (Davenport and Harris 2007; LaValle and Lesser 2013). BA systems pro-vide benefits and competitive advantage to organisations in many areas including customer relation-ship management, marketing, manufacturing, production planning, and supply chain operations (Ko-havi et al. 2002; Davenport and Harris 2007). The use of BA systems promotes evidence-based man-agement and entrenches BA within organisational culture (Davenport and Harris 2007).

BA systems evolved from the Decision Support Systems (DSS) of the 1970s that support managerial decision-making and the Business Intelligence (BI) systems of the 1990s that provide decision-makers with standard reports, dashboards and online analytical processing (OLAP) tools to improve their de-cisions (Davenport 2010). The term "Business Analytics" emerged in the early 2000s, when complex statistical and mathematical data analysis techniques were applied to solve critical business problems (Chen et al. 2012; Davenport 2010). BA systems and their use in business processes have matured over the years to include more sophisticated data analysis and enhanced data visualisation and report-ing (Watson and Wixom 2007). BA systems include both BI reporting and OLAP tools and advanced analytical techniques to address complex business problems using data (Chen et al. 2102).

Many case studies and success stories in both the research and practitioners literature have confirmed that BA systems provide benefits to organisations and contribute to firm performance (Anderson-Lehman and Watson 2004; Asadi Someh and Shanks 2013a, 2013b, 2014; Davenport and Harris 2007; Davenport et al. 2010; Goodhue et al. 2002; Kohavi et al. 2002; Piccoli and Watson 2008; Shanks and Bekmamedova 2012; Shanks et al. 2012; Wixom et al. 2013). We focus on the role of informational benefits in particular. These are the intangible benefits organisations achieve from the use of BA sys-tems and include factual decisions, actions based on facts, real-time decisions and a 'single version of the truth' for data within the organisations (Wixom et al. 2013). The means by which information ben-efits are created, their measurement and how they contribute to firm performance has not yet been ad-dressed in the literature. We build on prior BA research and, through an analysis of the business value of IT literature, identify two pathways through which BA systems provide informational benefits and contribute to firm performance: either directly or indirectly via other organisational capabilities. The research question we seek to answer in this paper is:

> *How do BA systems provide informational benefits and contribute to firm performance?*

The research question is explored is the context of Customer Relationship Management (CRM) processes. CRM involves managing customer processes and interactions in sales, marketing and service (Buttle 2004). IT assets and capabilities have a key impact on the quality of interactions with customers (Ray et al. 2005). Specifically, BA systems have been widely used in CRM processes and provided CRM people and processes with insights from customer value analysis, customer behavior analysis and customer segmentation (Goodhue et al. 2002). This use of BA has transformed CRM from an operational capability to a strategic capabilities for many organisations (Goodhue et al. 2002) and organisations have appropriated benefits from using BA in their for more than a decade. Therefore, CRM is a suitable context to test for benefits and firm performance impacts of BA systems.

Understanding how BA systems provide benefits and contribute to firm performance is important for three reasons. First, BA systems are an important strategic investment for many organisations (Daven-port et al. 2010). Understanding how BA systems provide benefits and contribute to firm performance is important in justifying the investment. Second, BA is consistently ranked highly among the con-cerns of Chief Information Officers (CIOs) (Hagerty et al. 2012). Understanding how to better manage BA capabilities and technologies to achieve benefits and contribute to firm performance is crucial for CIOs. Third, it is important to strengthen the theoretical base of research into how BA systems provide benefits and contribute to firm performance. We develop a theoretical model soundly based in the re-

source-based view (RBV) (Barney 1991) using a process-oriented approach from the business value of IT literature (Pang et al. 2014).

The paper is organised as follows. First, we discuss the theoretical background to the research, including RBV and three important themes that emerge from the business value of IT literature. Then we present the research model, and provide definitions for the constructs and hypotheses in the model. Following that we discuss the survey research approach used in the study, including instrument development, data collection and data analysis. In the following section we present the results for the measurement model and the structural model. We then discuss the contributions to knowledge of the study, and its implications and practitioners. Finally we discuss limitations and future research and conclude the paper.

2 Theoretical Background

BA systems are a subset of informational IT resources (Aral and Weill 2007), and are grounded in the business value of IT literature. Early research was unable to demonstrate unequivocally that investments in IT provided business value, with some arguing that IT was a commodity and not associated with strategic value (Brynjolfsson 1993; Carr 2003; Lucas 1999). This stream of research contributed to the creation of the IT productivity paradox (Brynjolfsson and Hitt 1998; Carr 2003), later criticised by many researchers including Aral and Weill (2007), Devaraj and Kohli (2003a) and Pavlou and El Sawy (2006). To address the productivity paradox, researchers have sought new conceptualisations, theories, measures, data and analytical methods to assess the business value of IT. The current business value of IT literature is diverse in characterising the IT and business value constructs, theories applied and the analytical and methodological approaches employed for empirical assessment. In order to answer the research question, we use concepts from RBV and three themes that emerged from an analysis of the business value of IT literature.

2.1 Resource-based View

Business value of IT researchers have used RBV as the main theoretical foundation to conceptualise the relationship between IT and firm performance (Melville et al. 2004; Wade and Hulland 2004). Within RBV, organisations are conceptualised as collections of resources, comprising assets and capabilities (Barney 1991). RBV assumes that resources are heterogeneously distributed in the market and that there is imperfect competition among participating firms. RBV argues that sustainable competitive advantage is the result of resources that are valuable, rare, difficult to imitate and non-substitutable (VRIN properties) (Barney 1991). A valuable resource exploits opportunities and fends off threats. A rare resource is unavailable to current or potential rivals. Rivals cannot easily copy an inimitable resource. A non-substitutable resource does not have strategic equivalents. Therefore, valuable, rare, inimitable and non-substitutable resources explain the variance in the firm performance.

2.2 Research themes from business value of IT literature

Three themes emerged from an analysis of the business value of IT literature.

Research theme 1: IT capabilities are important in generating business value

Many researchers have argued that IT assets and investments do not necessarily explain variations in firm performance (Melville et al. 2004; Wade and Hulland 2004). Rather, firm-specific IT capabilities developed over time to effectively leverage IT assets in business processes are the main source of business value and competitive advantage (Bharadwaj 2000; Wade and Hulland 2004). This is because investing in IT has become a competitive necessity for organisations (Clemons and Row 1991) and IT assets are readily available for many competing firms. Therefore, investments in IT are not likely to explain the variance in business value. However, capabilities refer to how the IT assets are utilised and leveraged in business processes. IT capabilities satisfy the VRIN properties of RBV theory, due to isolating mechanisms including causal ambiguity and path dependencies (Bharadwaj 2000). Therefore,

they can lead to improved firm performance and competitive advantage (Bharadwaj 2000; Wade and Hulland 2004).

Based on RBV theory, BA resources can be defined as combinations of BA assets and capabilities (Aral and Weill 2007). BA assets are the technologies that organisations invest in to enable their analytical capability, including data warehouses, Extract Transform and Load (ETL) tools, reporting and OLAP tools, digital dashboards, analytical software packages, data mining tools, and high-quality data (Shanks and Bekmamedova 2012). BA capabilities are interlocking systems of competencies and practices (Aral and Weill 2007). BA capabilities include the skills, routines and processes to effectively use BA in business processes. They include the effective use of ETL and data warehousing tools, data quality management, the use of reporting and OLAP tools and other analytical software packages to provide actionable information to decision-makers (Shanks and Bekmamedova 2012). Based on this theme, BA capabilities are considered as the source of competitive advantage.

Research theme 2: IT Asset Classes Generate Value Consistent with Their Strategic Goal

Four types of IT asset class may be defined: Infrastructure, Transactional, Informational and Strategic (Weill 1992). Infrastructure assets are the shared IT resources utilised across organisations such as servers, networks and databases. Transactional IT assets standardise and automate business processes to reduce costs or increase efficiency for the same cost. Examples of transactional IT systems include CRM systems and Supply Chain Management (SCM) systems. Informational IT assets provide information for purposes such as accounting, sales, marketing, compliance and communication. Examples include decision support, BI and BA systems. Strategic IT resources help organisations achieve competitive advantage by supporting entry into new markets or by helping to develop new products, services or business processes (such as mobile services in banking). Each of these asset classes will contribute to business value consistent with the strategic goal of that class. For instance, transactional IT investments contribute to reduced costs while investments in informational IT assets influence profitability (Aral and Weill 2007).

Research theme 3: Process-oriented perspective on the business value of IT capabilities

The process-oriented perspective argues that IT resources influence firm performance indirectly through IT-enabled business processes, functions or projects (Barua 1995; Barua et al. 2004; Bharadwaj 2000; Devaraj and Kohli 2003b; Elbashir et al. 2008; Mithas et al. 2011; Pavlou and El Sawy 2006; Rai et al. 2006; Sambamurthy et al. 2003; Tanriverdi 2005). The indirect relationship of IT resources with firm performance is due to the complementary nature of IT resources in supporting and enhancing other organisational resources (Wade and Hulland 2004). IT resources influence business processes and transform them into higher-order IT-enabled business processes. The notion of higher-order organisational capabilities was proposed in the strategic management literature to extend the RBV (Grant 1996; Teece et al. 1997). While RBV theory treats individual resources as the basic unit of analysis contributing to sustainable competitive advantage (Barney 1991), Grant (1996) emphasizes the assembling of resources to create higher-order organisational capabilities. The emergent higher-order IT-enabled capabilities are highly complex and may not be easily duplicated by competitors and can be effective in creating business value.

3   Research model

The research model focuses on the impact of BA Capability and Informational Benefits in explaining variations in Firm Performance (see Figure 1 for research model and Table 1 for construct definitions). Building on RBV theory and the three research themes, we identify two pathways through which BA Capability creates Informational Benefits. The two pathways are: (1) the direct impact of BA Capability in creating Information Benefits and (2) the indirect impact of BA Capability, via the mediating role of Analytical CRM Capability, in creating Informational Benefits. The research model differs from many existing studies on the business value of BA systems (Elbashir et al. 2008; Isik et al. 2011; Shanks and Bekmamedova 2012; Tamm et al. 2013; Watson and Wixom 2007; Wixom and Watson 2001) by focusing on how informational benefits can be achieved from BA capabilities. It also extends

business value of IT literature (Aral and Weill 2007; Bharadwaj 2000; Mithas et al. 2011, 2012; Rai et al. 2006) by examining how Informational Benefits can explain variations in Firm Performance.
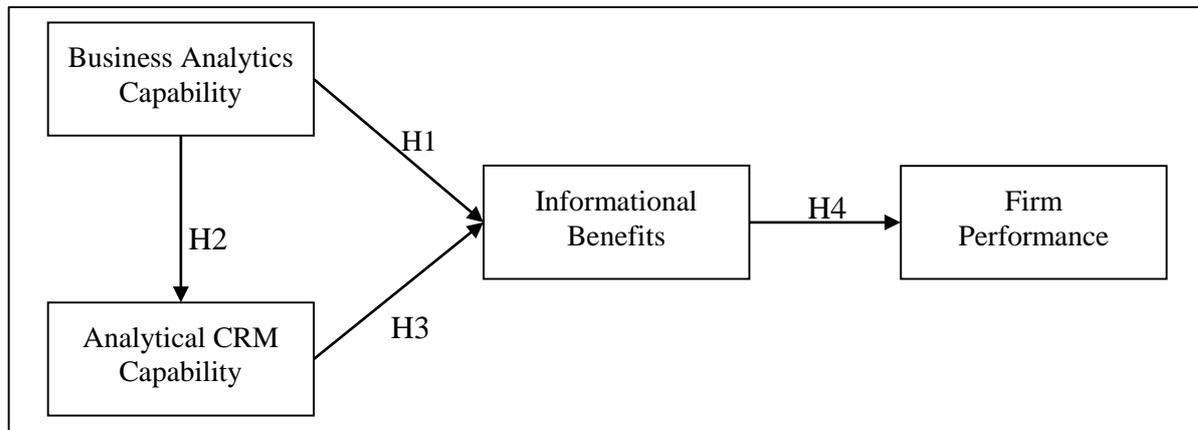

Figure 1.   Firm performance impacts from BA capability and BA-enabled CRM capability

Construct	Definition	Reference
Business Analytics Capability	Skills and practices of the BA unit in generating insights from customer data.	(Davenport and Harris 2007)
Analytical CRM Capability	Skills and practices of the CRM unit in leveraging analytical tools and insights in customer-facing processes.	(Buttle 2004)
Informational Benefits	Benefits achieved from the use of analytical insights in customer-facing processes.	(Wixom et al. 2013)
Firm Performance	The degree to which a firm has superior performance relative to its competitors.	(MIT-CISR 2013)

Table 1.   Definition of constructs in the research model

3.1   Construct definition

The definitions of constructs in the research model are provided below.

Business Analytics Capability refers to the skills and practices of the BA people (data scientists and analytical professionals) in generating insights and meaningful information from customer data. The notion of BA capability in this study is adopted from Davenport and Harris (2007) and LaValle and Lesser (2013). There are four dimensions of BA capability that help develop such critical insights from data: (1) collecting data from different sources and performing ETL processes, (2) ensuring data quality, (3) performing advanced data analysis and (4) reporting the information to the right people and at the right time. The BA capability ensures that required insights are generated and analytical tools inform all customer-facing processes.

Analytical CRM Capability refers to the skills and practices of the CRM business people (e.g. marketers and sales people) in leveraging analytical tools and insights to take competitive actions in customer-facing processes. The analytical CRM capability is a cross-functional integration of BA tools and insights into CRM processes. This capability ensures that the decisions and actions of CRM people are based on the analytical insights and tools provided by the BA system (Buttle 2012). For example, front-line staff leverage the analytical insights to cross-sell and up-sell products to customers.

Informational Benefits refers to the benefits achieved from the BA capability in customer-facing processes. We adopt the informational benefits notion from Wixom et al. (2013). Informational benefits include fact-based decision making, real-time decisions and a 'single version of the truth' for data used in customer-facing processes in customer relations (Wixom et al. 2013).

Firm Performance is the degree to which a firm has superior performance relative to its competitors. Different dimension of firm performance include revenue, cost of operations, profitability, customer experience, time to market and innovation (MIT-CISR 2013).

3.2 Hypotheses Development

The underlying mechanisms for the relationships proposed in the research model are explained below. In the research model, variance in firm performance is attributed to variations in informational benefits. Informational benefits are created through two pathways: direct and indirect, discussed earlier.

3.2.1 Creating informational benefits from BA capability (Hypotheses 1-3)

Pathway 1: Direct creation of informational benefits from BA capability

This pathway is based on the first research theme, arguing that different IT asset classes generate benefits consistent with the strategic goal of that asset. BA capability, as an informational resource, will generate informational benefits for organisations (Aral and Weill 2007). Higher levels of BA capability help to develop a single version of truth, fact-based decision-making, real-time decisions and actions based on analytical insights (Wixom et al. 2013). Therefore, it is hypothesised that:

Hypothesis 1: Firms with higher levels of BA Capability will also have higher levels of Informational Benefits.

Pathway 2: Indirect creation of informational benefits from BA capability

This relationship is based on the process view of the business value of IT resources (research theme 3). This perspective argues that BA capabilities generate organisational benefits by transforming CRM business capabilities into higher-order analytical CRM capabilities. The higher-order analytical CRM capabilities, in turn, contribute to superior benefits. The notion of higher-order capabilities stems from the paper by Grant (1996), in which IT provides a basis for developing a hierarchy of higher-order business capabilities. The indirect pathway includes two research hypotheses explained below.

Developing Analytical CRM capability using BA capability: Higher levels of BA capability in the context of customer relations helps develop better analytical CRM capabilities. BA capability influences CRM processes by generating insights and informating the customer-facing processes. It helps develop higher-order analytical processes by integrating all customer-related data, storing it in data warehouses, ensuring data quality, analysing the data and generating meaningful information and insights (Goodhue et al. 2002). Insights from the BA team help develop the analytical CRM capability in two ways: first, by providing advisory services to CRM business managers and helping them in their strategic and unstructured decisions and second, by developing and embedding analytical tools in CRM processes that can be frequently used in routine and every-day decision making (Tamm et al. 2013). BA capability is a first-order variable which influences and enables the development of a higher-order analytical CRM capability. Therefore, BA is critical in transforming a CRM capability into an analytical capability. Thus, it is hypothesised that:

Hypothesis 2: Firms with higher levels of BA Capability will also have higher levels of Analytical CRM Capability.

Creating informational benefits from analytical CRM capability: Analytical CRM capability helps create informational benefits by using insights from BA to accomplish customer-facing processes. Exploitation and exploration mechanises also help create informational benefits from analytical CRM capability (March 1991). Based on the exploitation mechanism, CRM people use analytical tools and insights in customer-facing processes. Then learn and become more competent in leveraging the tools and insights. Therefore, CRM people will be more competent in fact-based decision-making and taking actions based on facts, generating more informational benefits. Based on the exploration mechanism, BA people will sense new opportunities in CRM processes to implement BA initiatives. The new initiatives will transform more CRM processes into analytical CRM processes and increase the scope of analytical CRM processes, which leads to the generation of informational benefits. Therefore, we argue that use of analytical insights in CRM processes creates informational benefits:

Hypothesis 3: Firms with higher levels of Analytical CRM Capability will also have higher levels of Informational Benefits.

3.2.2 Linking informational benefits to firm performance

Many organisations are investing significant amounts of money in BA systems to improve firm performance and compete with rivals (Davenport and Harris 2007). There is some evidence that informational benefits including fact-based decision-making and actions taken based on facts will improve several firm performance measures including time to market, revenue generation, cost reduction, improved customer experience and innovation (Aral and Weill 2007; Davenport and Harris 2007; LaValle and Lesser 2013; Wixom et al. 2013). Our goal is to assess if the informational benefits created directly from BA and indirectly from Analytical CRM capability will lead to superior firm performance. Therefore, it is hypothesised that:

Hypothesis 4: Firms with higher levels of Informational Benefits will also have higher levels of Firm Performance.

4 Research method

The hypotheses were tested using a cross-sectional survey. Several researchers have encouraged empirical evaluation of the link between IT resources and firm performance (Melville et al. 2004; Nevo and Wade 2011). The instrument development, dissemination and data analysis are explained below.

4.1 Instrument development

We surveyed the literature for validated measures. Analytical CRM Capability measures were adopted from Iriana and Buttle (2006) and Firm Performance measures from MIT-CISR (2013). For the BA Capability and Informational Benefits constructs, scales were developed using instrument development guidelines in the literature (MacKenzie et al. 2011; Moore and Benbasat 1991). Initial items for BA Capability were generated from Davenport and Harris (2007) and (LaValle and Lesser 2013). Initial items for Informational Benefits were adopted from Wixom et al. (2013). The initial items were refined in several stages including academic interviews, expert interviews, a two staged Q-sorting exercise, pre-testing and a pilot test. The survey instrument development process and final instrument are presented in Table 2 and Table 3, respectively.

Phase	Description
Item generation	Scales were adopted from the literature for two of the constructs. Items were developed for the other two constructs from relevant literature.
Academic interviews	Five interviews were conducted with senior IS academics. Minor modifications were made to the items.
Expert interviews	Five interviews were conducted with BA managers from large organizations. Several items were refined based on empirical evidence.
Q-sorting	A two-staged Q-sorting exercise (Moore and Benbasat 1991) was conducted to improve construct validity. This task was conducted using the Qualtrics Q-sorting feature, in which participants were asked to drag and drop the randomized items into four item piles based on construct definitions. Ten academics, professionals and IS students participated in the first stage. In the second stage, three academics and practitioners participated, which led to wording modifications in several items.
Pre-testing	To further improve the content validity, five academics completed the initial survey. Minor changes were made to the wording, length and structure of the survey.
Pilot test	30 academics, professionals and students in the BA area completed the questionnaire. Minor changes were made based on their feedback.

Table 2.   Survey instrument development phases

Indicators		References
BA Capability		
Our business analytics team:		(Davenport and Harris 2007; LaValle and Lesser 2013)
BA1	integrates, extracts, transforms and loads customer data from different sources into data warehouses	
BA2	ensures that the customer data are complete, accurate, timely and relevant	
BA3	uses a variety of business analytics tools to analyse customer data	
BA4	generates standard and ad-hoc reports based on the decision needs of the CRM unit	
BA5	leverages analytical tools to convert customer data into actionable information	
Analytical CRM Capability		
Use of business analytics in customer-facing operations has helped us:		(Buttle 2004; Iriana and Buttle 2006)
AC1	create a comprehensive customer-related database	
AC2	deliver customer data to our front-line staff so that they can sell, market and service our customers based on facts	
AC3	deliver customer data to our marketing, sales and service staff at the right time so that they can cross-sell and up-sell to customers	
AC4	conduct intelligent analysis of customer data to guide our marketing and sales efforts	
Informational Benefits		
Use of business analytics has helped us:		(Wixom et al. 2013)
IB1	discover insights from customer data	
IB2	build a single version of the truth	
IB3	promote fact-based decision-making	
IB4	make real-time decisions	
IB5	act on facts	
Firm Performance		
Organisational performance relative to other firms using the following metrics:		(MIT-CISR 2013)
FP1	Time to market for new business initiatives	
FP2	Customer experience	
FP3	Cost of operations	
FP4	Revenue growth	
FP5	Innovation	

Table 3.   Constructs and associated indicators used in this study

BA Capability, Informational Benefits and Firm Performance were conceptualised as formative construct to capture different dimensions in their conceptual domain. Analytical CRM Capability was conceptualised as a reflective construct to capture the use of BA in customer-facing processes.

4.2   Data collection

Data was collected using a web-based survey from CRM, marketing and sales managers with extensive experience in using BA in large American organisations. A purposive sampling technique was employed to select participants who were especially informative in relation to BA and analytical CRM capabilities (Neuman 2006). Respondents were selected using three screening criteria: holding a management position in the CRM, marketing or sales areas, having at least two years of experience in using BA and working in large organisations (more than 500 employees). Managers are a valid source for acquiring performance related data (Tallon and Kraemer 2007). BA Capability, Analytical CRM Capability and Informational Benefits were measured using seven point Likert scales ranging from strongly disagree to strongly agree. Firm performance was measured using a different scale to reduce common method bias (Podsakoff et al. 2003). The scale range included: Significantly worse than

competitors, Somewhat worse than competitors, About the same, Somewhat better than competitors and Significantly better than competitors. Qualtrics administrated the survey instrument to the targeted sample and reported a 10% response-rate. The final sample included 98 complete responses. Qualtrics is a US-based research company that conducts quantitative and qualitative research studies.

5   Data analysis

The hypotheses were tested using Partial Least Squares-Structural Equation Modelling (PLS-SEM). PLS-SEM is recommended for use in studies where theory is less developed (Gefen et al. 2011) and the research model includes formative constructs (Gefen et al. 2011; Petter et al. 2007). PLS-SEM was selected for this study because very few studies have theorised and empirically assessed firm performance impacts from BA systems. In particular, BA capability influencing business capability, generating informational benefits and improving firm performance has not been tested. Furthermore, BA Capability, Informational Benefits and Firm Performance are conceptualised as formative constructs.

5.1   Informants

We used a key informant approach (Bagozzi et al. 1991) to collect data on the performance impacts of BA capability in customer relations. Table 4 represents the characteristics of the sample in terms of their positions, years of experience and the industry sector of their firms. The informants in the study were all in managerial positions and 76% of them had more than five years of experience in using BA in their customer-facing operations. Based on their positions within their organisations, informants were likely to have participated in decision-making processes related to the topic of this survey (Phillips 1981). All the managers were from large organisations with at least 500 employees.

Industry	%	Position	%	Years of experience	%
- Wholesale/Retail/Distribution	27	CRM manager	23	2-5 years	23
- Marketing/Advertising	12	Marketing manager	40	5-10 years	37
- Banking/Finance/Insurance	12	Sales manager	35	>10 years	38
- Manufacturing/Mining	10				
- Transportation/Utilities	9				
- Other	28				

Table 4.   Sample characteristics

5.2   Common method bias and non-response bias

Common method bias was assessed by conducting an exploratory factor analysis (EFA). Harman's single-factor test was conducted by entering all independent and dependent variables in the analysis (Podsakoff et al. 2003). As the first factor accounted for 38.42% of the total variance, common method bias is not likely a concern in this study.

We assessed non-response bias by comparing early and late respondents on all measures of al variables using a t-test. The t-test results did not find significant differences between the two respondent groups, supporting an absence of non-response bias (Armstrong and Overton 1977).

5.3   Measurement validation

We first used Principal Components Analysis (PCA) to assess the construct validity of the formative constructs (Petter et al. 2007). The weights and communalities are shown in Table 5.

The associated KMO with the PCA analysis was 0.85, Bartlett's test was significant at $p<0.000$ and all the communalities were above 0.47. All weights were above 0.48. Only one item (FP3) cross-loaded on another component. Since the cross-loading value (0.39) was low and the item represented a formative construct, we retained the item. Overall, the results supported the validity of the constructs.

To evaluate the reliability of formative constructs, multicollinearity was examined using Variance Inflation of Factor (VIF) (Petter et al. 2007). All the VIF scores were less than 2.29, indicating reliability of the formative constructs (Petter et al. 2007). Also, item to construct importance was established using the PLS algorithm. All items were significant at the 0.05 level or better, except for BA1, BA4, IB1, FP2, FP4 and FP5. We retained all the items because of the formative nature of the constructs.

Construct	Indicators	Component			Communalities
		1	2	3	
BA capability	BA1	**0.810**			0.626
	BA2	**0.578**			0.589
	BA3	**0.582**			0.547
	BA4	**0.718**			0.494
	BA5	**0.613**			0.631
Informational benefits	IB1		**0.810**		0.620
	IB2		**0.719**		0.611
	IB3		**0.745**		0.674
	IB4		**0.665**		0.565
	IB5		**0.696**		0.582
Firm performance	FP1			**0.740**	0.691
	FP2			**0.787**	0.592
	FP3	0.361		**0.509**	0.473
	FP4			**0.624**	0.434
	FP5			**0.879**	0.737

Table 5.   PCA analysis for formative constructs

To assess the measurement properties of the reflective construct, Common Factor Analysis (CFA) was carried out using the PLS algorithm (SmartPLS 3.0). The measurement properties then were evaluated in terms of convergent validity, discriminant validity and construct reliability.

Convergent validity was assessed using two tests. First, by observing the loadings of the items. All the loadings for the items were greater than 0.7 (Table 6), indicating strong convergent validity (Comrey 1973). Convergent validity was also examined by observing the square root of the average variance extracted (AVE). The square root of the AVE for the reflective construct was greater than 0.70, indicating satisfactory convergent validity (Fornell and Larcker 1981).

Construct	Indicator	Loading	Composite Reliability	Cronbach's α	AVE
Analytical CRM Capability	AC1	0.78	0.89	0.83	0.66
	AC2	0.84			
	AC3	0.86			
	AC4	0.77			

Table 6.   Confirmatory factor analysis

Discriminant validity was assessed using three tests. First, by using the Fornell-Larcker criterion (Fornell and Larcker 1981), in which the square roots of the AVE (diagonal elements in Table 7) were larger than the correlations between the construct and the other constructs (off-diagonal elements). Second, evidence for discriminant validity was obtained by observing that each reflective indicator loaded highest on the construct it was measuring. Third, the Q-sorting exercise found that the constructs and their indicators were conceptually distinct (Moore and Benbasat 1991).

Construct reliability was assessed using Composite Reliability (CR) score (Table 6). The CR for the reflective construct was greater than 0.7, indicating that the results based on this scale are consistent (Gefen et al. 2000). Cronbach's alpha was greater than 0.7, supporting the reliability of the construct.

Construct	A-CRM capability	BA capability	Informational benefits	Firm performance
A-CRM Capability	**0.81**			
BA Capability	0.748	-		
Informational Benefits	0.698	0.679	-	
Firm Performance	0.410	0.392	0.524	-

Diagonal elements are the square root of the AVE among constructs and their associated measures. Off-diagonal elements are correlations among constructs.

BA capability, informational benefits and firm performance are formative constructs and have no AVE.

Table 7.   Inter-construct correlations

5.4   Evaluation of the structural model

The structural model was tested using the PLS algorithm. To assess the significance of the structural paths, a bootstrapping procedure (500 samples) was carried out. The bootstrapping procedure also revealed the amount of variance in the dependent variables attributed to the explanatory variable, R^2 (Chin 1998). The path coefficients, significance level and R^2 values are presented in Figure 2.
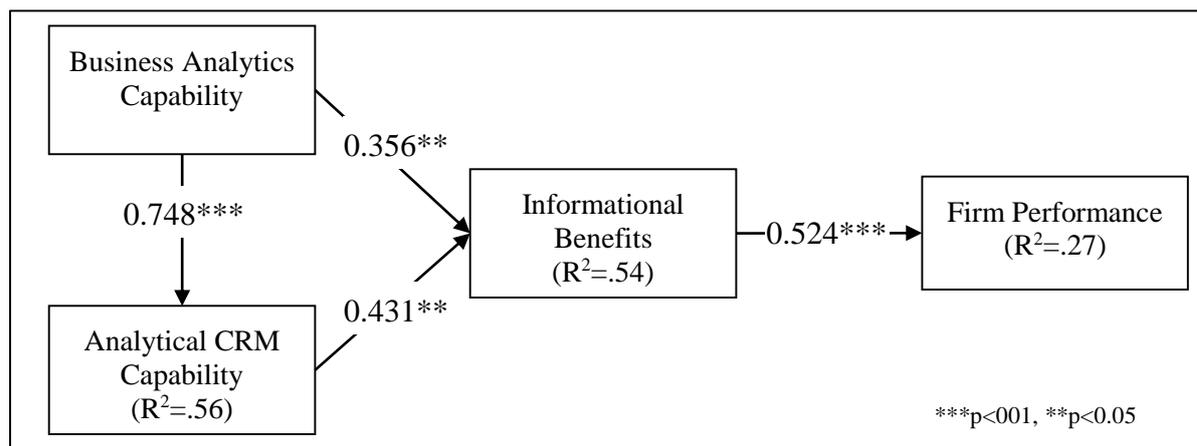

Figure 2.   Empirical model

The results generated for the structural model using PLS provided support for all the hypotheses. All the structural paths coefficients were significant at the $p<0.05$ level or better (See Table 8).

Hypothesis	Path coefficient	p-value	Empirical evidence
H1: BA -> Informational Benefits	0.356	0.026**	Supported
H2: BA -> A-CRM	0.748	0.000***	Supported
H3: A-CRM -> Informational Benefits	0.431	0.012**	Supported
H4: Informational Benefits -> Firm Performance	0.524	0.000***	Supported

Table 8.   Summary results of hypotheses testing

The predictive power of the structural model was then assessed in terms of the percentage of variance attributed to the explanatory variable. The model explained the following variances: Analytical CRM Capability (56%), Informational Benefits (54%) and Firm Performance (27%).

5.4.1 Mediation analysis

Hypotheses 2 and 3 imply a meditating role for Analytical CRM Capability in creating Informational Benefits from BA. Since BA capability creates some of the informational benefits directly, we argue that analytical CRM capability will partially mediate the relationship between BA capability and informational benefits. To verify this partial mediation role, we used guidelines from Baron and Kenny (1986). The analysis was conducted based on a bootstrapping procedure (5000 samples) (Hair et al. 2013). The results are summarised in Table 9. First, the direct relationship between BA capability and informational benefits was estimated, which was significant. Second, the mediator was included to test the significance of the indirect effect. The results showed a significant relationship between BA capability and analytical CRM capability (0.748), as well as analytical CRM capability and informational benefits (0.431). Hence, the indirect effect of BA capability on informational benefits through analytical CRM capability was 0.322 (0.748 × 0.431) and its significance was confirmed by the p-value of the indirect relation. The relative size of the mediating was identified by calculating the Variance Accounted For (VAF) based on Shrout and Bolger (2002). The VAF value indicated that analytical CRM capability partially, but strongly mediated the relations between BA and informational benefits.

Hypothesis	Direct effect without mediation	Direct effect with mediation	Indirect effect	VAF	Mediation type observed
H4	0.665***	0.356**	0.322***	0.475	Partial mediation

***<0.001, **p<.05   VAF>0.80 full mediation, .20<VAF<0.80 partial mediation, VAF<.2 no mediation

Table 9.   The mediating role of Analytical CRM capability

6 Discussion

Our study contributes to BA research by conceptualising and empirically testing the relationship between BA capability, informational benefits and firm performance. It also contributes to the business value of IT research by conceptualising informational benefits as an outcome of developing BA capability and as a predictor of firm performance. To the best of our knowledge informational benefits has not been conceptually specified and empirically examined using survey data.

6.1 Contributions to research

The research findings indicate that BA capability has some direct effect on informational benefits (hypothesis 1). This effect indicates that the implementation of BA systems helps organisations change their routines, behaviours and the culture of the organisation to be analytically enabled. For example BA systems are able to build a single version of truth within the organisation. This finding is consistent with Aral and Weill (2007), who argue that each class of IT asset influence specific types of benefits. It is also consistent with Wixom et al. (2013) in arguing that BA systems will create informational benefits for organisations. Moreover, our research indicates that some of the informational benefits are created by the organisation's analytical CRM capability, which is enabled by the BA capability (hypothesis 2 and 3). CRM people and processes consume the insights and tools created by BA people and processes. When the tools and insights are effectively used in customer processes, more informational benefits are created for the organisation. We also confirmed a partial mediation role for analytical CRM capability in creating informational benefits. This is because of the complementary nature of IT resources in general and BA resources in particular to other organisational resources (Elbashir et al. 2008; Melville et al. 2004; Mithas et al. 2011; Pavlou and El Sawy 2006; Rai et al. 2006). BA capability provides the other organisational resources with new tools, changes the processes and behaviours of people and enhances organisational effectiveness. This indirect relationship signifies that the effective use of BA in organisational processes is critical in achieving informational benefits and improving firm performance.

The research findings also indicated that informational benefits are positively associated with firm performance measures including time to market and reduced cost of operations. Based on Wixom et al.

(2013), BA systems are associated with a range of transactional, informational and strategic benefits for the organisation. The insights and tools developed using the BA capability help organisations to identify the inefficiencies in processes and improve the actions of employees by supplying them with the right information at a right time (see Wixom et al. (2013) for a case study about how BA helped to create transactional benefits). On the other hand, BA capability helps CRM people to gain insight into their business, customers and markets, so that they can sense opportunities and take competitive actions to create benefits for organisations.

We also developed and validated new scales for BA capability and informational benefits. Since both these constructs are conceptualised as formative constructs, they can also be used to assess the level of BA capability and informational benefits in customer relations.

6.2   Implications for practice

Our findings have important implications for practice. Practitioners struggle to justify the considerable investments on BA systems. Our research demonstrates that strong BA capability is important in creating informational benefits. In today's competitive environment, information is a strategic resource and organisations are required to leverage it to gain competitive advantage. The notion of informational benefits is helpful for practitioners, because the firm-level performance impacts of IT and BA capabilities may require more time to be realised. We believe it is important to communicate with practitioners about the new measures for informational benefits that can help them to evaluate their initiatives. Moreover, informational benefits improve firm performance. In particular, strong BA capability is important in speeding time to market and therefore gaining a first-mover advantage.

6.3   Limitations and future research

This study has several limitations. First, we measured informational benefits and firm performance using the perceptions of managers. Objective measures of firm performance may provide additional insights and complement the findings of this study. Second, our sample includes large organisations with more than 500 employees. Hence, our findings may not be applicable to small and medium firms.

Despite its limitations, we believe our study offers new avenues for future research. First, the study demonstrated that BA capability influences other organisational resources to develop higher-order analytically-enabled organisational resources such as analytical CRM. We believe that understanding the mechanisms by which BA capability influences and transforms the behaviour, culture and processes of other organisational resources is important and will advance our understanding of how IT helps to transform organisations. The second direction is investigating and controlling for context-specific characteristics of BA systems and organisations. For example, future research could control for the impact of different BA packages such as IBM Cognos or Oracle Business Analytics Suite. Also future research can control for and compare the benefits achieved from BA in different industries.

7   Conclusion

The objective if our study was to examine how BA capability can create informational benefits and how informational benefits lead to superior firm performance. BA capability in customer relations creates informational benefits in two pathways: directly and indirectly through mediating role of analytical CRM capability. A research model was proposed and empirically tested. The results provided support for both pathways. This result indicates that some informational benefits will be created directly from the BA capability and some benefits will be created indirectly once the BA tools and insights are effectively used in CRM processes. Furthermore, the creation of Informational benefits will lead superior firm performance.

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