The impact of Business Analytics on organisations: An Information Processing Theory perspective

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Abstract

Over the last few years, the number of organisations adopting business analytics (BA) has grown rapidly. Organisations adopt BA to gain better insights on their processes and structures that help them to make more informed business decisions. There are several studies that investigate how BA systems can improve decision-making, create competitive advantage and provide value. Mostly, the focus of these studies have been on the technical aspects of BA and its implementation in areas such as supply chain management, marketing, and finance. However, there is a lack of significant body of literature reporting on the impact of BA adoption on organisations. This study aims to develop a richer understanding of BA capabilities and organisational impact. Information processing theory (IPT) as a theoretical lens is used to investigate this phenomenon. This study will utilise an in-depth case study to provide rich explanations on the impact of BA adoption on organisations.

Keywords Business analytics, information processing theory, information processing needs, information processing capabilities, fit, performance.

1   Introduction

Relevant data, is a highly valuable, meaningful and reliable resource for organisations; if used properly. Managers use Business Analytics (BA) tools and techniques to get valuable insights from the data that could eventually help them to improve their business process, structures and decision-making processes (Watson and Wixom 2007). Organisations invest in BA to create competitive advantage (Peteraf and Barney 2003) and achieve business targets using less resources (Seddon et al. 2017). Reasons identified for the increased interest in BA are: information technology advances, organisations' need to find a way to gather data from all resources, and meeting new challenges (such as big data - "*high volume, high velocity, and high variety*"(Watson 2014, p. 1249)). To process big data, organisations need new technologies, and consequently, BA adoption has increased. In addition, organisations face tougher competition in the marketplace, so they need to improve their decision-making systems to be faster and more accurate.

For the purposes of this study, BA is defined as a set of systems, technologies and techniques which analyse data to support a better understanding of organisational situations and making valid decisions (Chen et al. 2012). A review of the BA literature shows that many published studies investigate how different models of BA can be built and deployed in organisations (Chen et al. 2012; Wixom et al. 2013). Some other studies focus on the impact that BA has on industries such as supply chain (Cosic et al. 2012) or transportation (Iovan 2017). Despite these studies establishing a relationship between BA adoption and operational and financial performance improvement (Bedeley 2017), there are fewer studies which investigate how BA adoption impact organisational design.

Most of the literature focus on technical aspects of BA. In this study we argue that organisations need to understand their information process and how BA impact these. This study is going to explore what information process changes needs to occur to take advantages of BA. Adoption of BA in organisations is considered as an evolutionary process which is executed over and over in different departments of organisations (Seddon et al. 2017).

There are many organisations that use BA techniques with a variation in the outcome. To explain this variance, this study takes a particular perspective using Information Processing Theory (IPT). Furthermore, a conceptual framework based on IPT is developed which is used as a framework to gather in-depth perspectives from decision-makers and managers. The following research question will be addressed: How does the adoption of BA impact organisational design? To gain this in-depth knowledge, an interpretive case study will be conducted using interviews, observations and document analysis to collect data.

The structure of this paper is as follows: a literature review outlining BA capabilities, IPT as a theoretical lens and contributions followed by the proposed methodology.

2   Literature review

2.1 Business Analytics (BA)

BA is the use of data to drive decision-making and business actions (Davenport and Harris 2007). Broadly defined BA is '*the techniques, technologies, systems, practices, methodologies, and applications that analyse critical business data to help an enterprise better understand it's business and market and make timely business decisions*' (Chen et al. 2012, p 1166). Using BA, information is transferred at the right time to the right person in the right forms (Bose 2009) assisting supply and demand integration, improved processing power, and advanced customer behaviour knowledge among others (Ramanathan et al. 2017).

The purpose of BA is to support insight to manage and develop the business (Musumano 2016). In many publications BA refers to different approaches for modelling different business situations, predicting customer behaviours and preferences, feasibility studies, anticipating risks and market preferences (Ray et al. 2013). Davenport and Harris (2007) argue that high performing organisations like Walmart, Netflix, and Amazon use analytics to inform their decision-making 50% more than low performing organisations. These organisations have managers who know the value of analytics. In addition, the return on investment (ROI) in the companies which are using BA on their projects, was 56% more (Davenport and Harris 2007).

Seddon et al. (2017) has brought together from the literature a number of models to show how BA contribute to business value. They argued the factors that influences the adoption of BA and they assumed BA adoption as an evolutionary process which is executed over and over in each departments.

Since BA is not a transient concept, misunderstandings may impact its growth trend. This research tries to make a brighter view of BA as well as present definitions and some perspectives and categories of BA. BA implementation is a complex process engaging technical and social aspects of organisations. Therefore, technical knowledge and organisational capacities are as important as the manager's commitment and sponsorship (Yeoh and Koronios 2010). Some other critical factors include organisational culture, infrastructure, and system quality (Yeoh and Koronios 2010). In other words, if the organisational processing requirements do not fit with its IPCs, the organisation can be less successful in adopting and implementing BA systems. One of the information system theories that posit a fit between IPCs and IPNs is IPT, which is discussed in the following section.

2.2 Information Processing Theory (IPT)

IPT was originally developed by Galbraith in 1973 as a framework for organisational design. This theory describes four critical concepts: IPNs, IPCs, Fit and Performance. The following section explains these concepts in more details.

2.2.1 Information Processing Needs (IPNs)

Galbraith (1973) identified uncertainty as the root of IPNs. Uncertainty is the difference between the amount of information that organisations already have and the amount that they need (Galbraith 1973). He argued that to attain an acceptable level of performance task uncertainty should be reduced. Daft and Lengel (1986) extend Galbraith's theory to include equivocality. This element includes a complex task that is not well understood is characterised by equivocality, and a task's concept may not be entirely comprehensible due to its incompatibility with the history and the current situation of the organisation. According to their theory, organisations need to reduce both uncertainty and equivocality at the same time to perform effectively.

2.2.2 Information Processing Capabilities (IPCs)

There are many mechanisms that can be used by managers to increase IPCs. Bensaou and Venkatraman (1995) classified these mechanisms into three basic types: structural mechanisms, process mechanisms, information technology mechanisms. Structural mechanisms describe relationship differences between organisational departments. Structural mechanisms include "Rules and procedures, direct contacts, liaison roles, integral roles, task forces and teams"(Daft and Lengel 1986, p. 560) and have three dimensions: *multiplicity* of information exchange, the *frequency* of information exchange and the extent of formalization of the information exchange (Bensaou and Venkatraman 1995).Process mechanisms refers to the socio-political processes that "affect the extent to which information is freely exchanged between the dyad members because or in spite of the nature of the structural mechanisms" (Bensaou and Venkatraman 1995, p. 1475). Information technology mechanisms refer to the use of information technology that increase the IPCs of organisations. The increase in IPC can facilitate organisational coordination (Bensaou and Venkatraman 1995). BA as a specific information technology system will be the focal technology studied.

2.2.3 Fit

Fit plays the most important role in IPT (Premkumar et al. 2005). One of the primary goals of managers is achieving a fit between IPNs and IPCs to improve the organisational performance and decision-making process (Daft and Lengel 1986; Premkumar et al. 2005). There are few studies which focus on fit in information systems literature (Bensaou and Venkatraman 1995; Premkumar et al. 2005). Galbraith and Nathanson (1978) have posed that "*although the concept of fit is a useful one, it lacks the precise definition needed to test and recognise that organisation has it or not*". Umanath (2003) investigated the conceptual and methodological meaning of fit argued that there are two major perspectives for fit - congruence and contingency. He proposed some statistical methods to analyse expressions of fit and identified three types of fit: a) fit as congruence, b) fit as contingency and, c) fit as holistic configurations. Venkatraman (1989) argued that fit has played an important role in several theories and areas such as strategic management, and organisational design. He has classified fit in six alternative perspectives: fit as moderation, fit as mediation, fit as matching, fit as gestalts, fit as profile deviation, and fit as co-variation.

Tushman and Nadler (1978) proposed fit as matching and argued that if organisations could match IPNs and IPCs, they would be more effective. They proposed Table 3 to show the relation between IPNs and IPCs, arguing that if departments have high uncertainty in tasks, they should employ high IPCs to attain the fit (Cell A). On the other hand, if a department faced less uncertainty, information processing mechanisms do not need to be complex (Cell D). In cell B, IPCs are not adequate to manage the

uncertainty. Thus, managers would make decisions with the less-than-the-optimal amount of information. In the case of cell C, an organisation is faced extra-IPCs, which is excessive and costly. Following Tushman and Nadler (1978) effectiveness will be used as means to evaluate fit. Effectiveness can be evaluated in many ways (Chang and King 2005; Wang and Strong 1996). For this study accessibility and reliability of information will be used as a measure to evaluate effectiveness (Chang and King 2005).

Information processing needs	Information processing capabilities	
	High	Low
High	(A) Fit	(B) Not fit
Low	(C) Not fit	(D) Fit

- *Table 1. Relationships between IPNs and IPCs: (adopted from (Tushman and Nadler 1978))*

2.2.4 Performance

Fit or not-fit has an impact on the performance of organisations. Many studies investigate performance (Brancheau and Wetherbe 1987; Dickson et al. 1984). Some researchers focus on the operational level and others on the organisational level. It mostly depends on the types of questions which are addressed and the type of data being used (Hitt and Brynjolfsson 1996). Some information systems (IS) researchers use the balanced scorecard method to measure organisational performance and suggest several indicators such as cost control, investment return, and revenue generation (Martinsons et al. 1999). Krishnamoorthi and Mathew (2018) summarised performance measurement indicators in IS literature as productivity, enhancement, profitability improvement, cost reduction, competitive advantage, and inventory reduction. From a broad perspective, organisational performance in IS literature can be divided into financial performance and non-financial (operational) performance (Venkatraman and Ramanujam 1986). Financial performance focuses on the outcome and economic indicators while non-financial performance focuses on the technological and operational measurements (Krishnamoorthi and Mathew 2018). Weill (1990) argues that there are four basic parameters that determine the effectiveness of IT systems, namely management commitment, stable internal politics, proceeding experience, and user satisfaction.

This research investigates the organisational level of performance that includes financial indicators and measures of technological efficiency. Two fundamental dimensions are chosen to study organisational performance, which are 1) organisational benefits from the usage of BA, which refer to the intangible benefits of BA that are derived by organisations and 2) return of investment (ROI) as a financial indicator.

3   Proposed Research Framework

To address the research question, this study provides a theoretical framework of IPT adapted from models developed by Bensaou and Venkatraman (1995) and Cooper and Wolfe (2005). Bensaou and Venkatraman (1995) advanced Galbraith's thesis for an inter-organisational relationship, adding new concepts to IPNs and IPCs. They derived structural mechanisms, process mechanisms and information technology mechanisms as IPCs and identified three kinds of uncertainty (environmental uncertainty, partnership uncertainty and task uncertainty) to cover IPNs. Another IPT framework developed by Cooper and Wolfe (2005) highlight the intra-organisational perspective of IPT, arguing that appropriately fitting "*information processing volume and richness to uncertainty and equivocality reduction requirements of an IT innovation contributes to successful IT adaptation*" (Cooper and Wolfe 2005, p. 30). This framework takes an IT adaptation perspective and argue that uncertainty and equivocality play an important role. They have identified two elements have influence on uncertainty and equivocality. Organisational technology which includes task variety and task analysability and interdepartmental relations that includes departmental interdependence and differentiation.

Task variety is defined as the "*frequency of unexpected events*" while task analysability "*is related to the extent to which individuals are able to follow an objective, computational procedures in completing a task*" (Cooper and Wolfe 2005, p. 34). Interdepartmental relations refers to the extent of interdependence and differentiation in organisations. With the rise of interdependence, the stability of departments reduces and organisations should experience more uncertainty (Cooper and Wolfe 2005).

The degree of differentiation of the departments depends on the different goals, process, and procedures and communications of departments that leads to ambiguity (Allen and Cohen 1969).

On the basis of this literature, this study develops the following framework by combining the findings of Bensaou and Venkatraman (1995) and Cooper and Wolfe (2005). In this framework, solid lines present the relations between the main elements of the framework and dotted lines show the factors which are going to be used to evaluate the main factors.
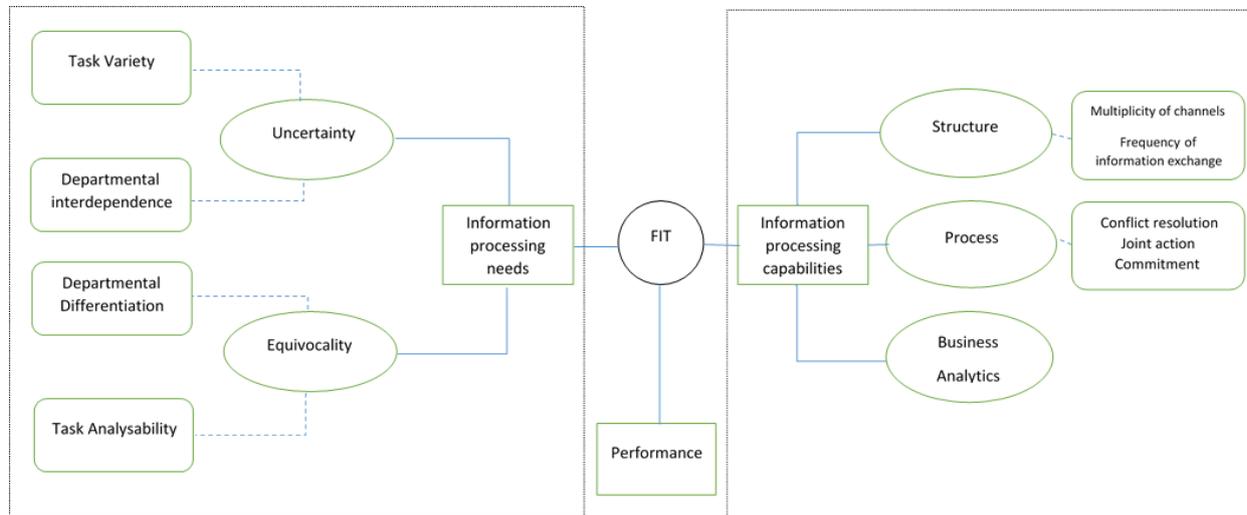

Figure 1. Conceptual framework based on literature

This study explores the impact of BA adoption on the components of the framework and will evaluate the following measures adapted from Bensaou and Venkatraman (1995) and Cooper and Wolfe (2005):

- Changes in the extent of similarity and variety of tasks after BA adoption

- Changes in the activities of department in relation to coordination and delegation of activities between departments.

- Changes in extent of data clarity and the type of data that are gathered and interpreted.

- Changes in task instructions, procedures and task descriptions.

- Changes in the extent of control versus coordination and the number of activities which are done by more than one departments.

- Changes in the way major conflicts are solved (by negotiation or opposition) as well as joint effort and collaboration between departments.

4   Research methodology

This research follows an in-depth case study approach to investigate the impact of issues in the natural setting (Walsham 2006). Documents, archival records, interviews, observation and physical artefacts are the resources of data for a case study research, and it is important to use multiple sources of data to increase the quality of the case study (Yin 2009). The interview method is selected as the main method of data collection in this research. Interviews are a critical source of data for case studies since most case studies are about human behaviour (Yin 2009). To ensure the consideration of all the aspects of behavioural issues, gathering documents and observation are chosen in this research.

This study will use a single case study of an organization that has already adopted business analytics and will conduct a total of 25 interviews with a range of key informants such as executives, senior managers, business analysts, IT analytics team, and range of business users. Interviews will be conducted in the location of the organisation. A copy of the semi-structured interview questionnaire will be provided to each interviewee before the interview to enable them to think about the best answers.

In the interpretive approaches analysing and gathering the data begin at the same time (Neuman 2013). Patterns and broad trends will be extracted from the data by organising, integrating, examining and coding of data. An integral part of data analysis is coding. "*Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study*" (Neuman 2013, p

510). Neuman (2013) defined three types of data coding and proposed to review the data on three occasions using a different coding each time which are open coding, axial coding, and selective coding. The three stages of coding qualitative data will be applied for data analysis. All the interviews will be categorised and summarised using concepts from IPT as a guiding framework, and NVivo software will be applied to manage and analyse the data.

5   Research gaps

A review of the existing literature has highlighted the following limitation:

- The early BA studies have focused on technical aspects, however some newer studies have focused on adoption and factors influencing BA adoption. To the best of our knowledge, few studies have investigated the changes of organisations due to this adoption.

- Despite the evidence of the value, business process improvement, and competitive advantage provided by BA technology in many studies (Seddon et al. 2017; Vidgen et al. 2017), there is a lack of theoretical underpinning of how and why this occurs.

- A review of several articles and studies in BA impacts on the organisational performance and decision making shows that they are mostly focused on quantitative factors and explain the impact of BA on some predicted indicators such as cost, financial indicators, price dynamics, and quality (IDC 2002; Schläfke et al. 2012).

- Academics have pointed out many challenges in the usability of BA due to complexity in outputs.

6   Conclusion and future directions

There are significant gaps in understanding of the impact BA has on organisational design. This study is going to collect and analyse the data in the next phase and it is expected to contribute to both theory and practice by addressing the research question and providing in-depth insight into the impact of BA adoption on organisational design. The findings of this study will increase understanding of organisational changes due to this adoption, therefore, pave the way toward meaningful and thoughtful adoption of BA technologies in the future. The IPT framework is used as means to evaluate the impact BA has on organisational design.

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