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ERP System as an Enabler for Bottom up Innovations

Amgad Badewi Dr
Kent Business School, amgad41@gmail.com

Taghreed AbuSalim Dr
University of Wollongong, taghreedabusalim@uowdubai.ac.ae

Lilas A-Asfahani Dr
Technology Consultant, Lilas.al-asfahani@gmail.com

Doaa Shehata
Cairo University, doaa_abdelfatah_shehata@foc.cu.edu.eg

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Amgad Badewi
Kent university
a.a.m.badewi@kent.ac.uk

Taghreed Abu Salim
University of Wollongong Dubai
TaghreedAbuSalim@uowdubai.ac.ae

Lilas Al Asfahani
Technology Consultant
Lilas.al-asfahani@gmail.com

Doaa Abdel-Fattah Shehata
Cairo University
Doaa_abdelfatah_shehata@foc.cu.edu.eg

Abstract. This research adopts a resource-based approach to develop and test a new framework related to improvement in bottom up innovations by means of enterprise resource planning (ERP) systems. The framework consists of five primary resources: attitude, organisational characteristics, skills, ERP human resources, and ERP technological resources. Responses from 210 organisations that have adopted ERP were analysed using Structural Equation Modelling (SEM). Regarding organisational resources, the research results did not support the premise that an organisation's characteristics (i.e., agility, or the innovation sponsorship) and attitude to technology have direct effects on organisational innovativeness. Rather, it was found that these relationships are fully mediated by the employees' quantitative skills. Regarding technical resources, ERP Human resources, i.e., the ability to create business partnerships, and ERP technical resources, i.e., the customisability of reports, have significant impacts on organisational innovativeness. The main implication of this research is that ERP is not only a planning technology but also a driver of innovation when supported by the necessary organisational and technical resources.

Key words: ERP, innovation, system, and resources.

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1 Introduction

Enterprise resource planning (ERP) is defined as an IT infrastructure that integrates different information systems and technological artefacts into one system (Badewi and Shehab 2013; 2016; Badewi et al. 2018). It is designed mainly to address the problem of information being hoarded by particular employees (Muscatello and Chen 2008) and issues caused by "systems [that] do not talk to each other". By resolving these situations, an organisation's planning capabilities and transformative capacities can be improved. According to a survey conducted by Panorama (2018), respondents of 237 organisations that had adopted ERP perceived that it had transformed their business (10%), had improved interaction with suppliers (15%), and had improved interaction with customers (13%). That is, about 85-90% of respondents did not perceive the anticipated benefits. Although at the end of the twentieth century there was debate regarding the impact of IT investment on organisational performance (Carr 2004; Prybutok et al. 2017), it is now acknowledged that IT creates value for organisations (Kohli and Grover 2008; Kohli, et al. 2012). But, it is still unclear why there is variation in the types and levels of benefits organisations achieve (Staehr et al. 2012).

ERP benefits vary widely in terms of the means and the organisational characteristics required to achieve them: these benefits can be classified as operational, managerial, strategic, relating to IT infrastructure, or organisational (Annamalai and Ramayah 2011; Shang and Seddon 2012). However, the present research adopts Zuboff's framework (Zuboff 1985), classifying benefits as automation, planning, or transformational, as used for ERP systems (Raymond and Uwiseyemungu 2009; Uwiseyemungu and Raymond 2012). ERP automation and planning benefits have already been extensively researched (Chand et al. 2005; Nicolaou and Bhattacharya 2006; Stratman and Roth 2007). However, innovation benefits are open to discussion, there being no clear indication for an organisation as to whether they can be achieved. The relationship between ERP and innovation is not a new topic. ERP systems have always been considered restrictive (Davenport 2000; Trott and Hoechst 2004b; 2004a), and therefore unable to boost innovations in organisations. This idea is, however, challenged by many researchers (e.g., Luo et al. 2012; Srivardhana and Pawlowski 2007).

Resource-based view is a framework that explains the variation in performance between organisations as due to how resources (Borchert 2008) have been combined so as to realise the unique and distinctive value (Karimi et al. 2007; Romero et al. 2010; Stoel and Muhanna 2009). Similarly, IT scholars used the resource-based view theory to establish a positive relationship between innovation benefits and ERP systems. Srivardhana and Pawlowski (2007), in an attempt to understand this relationship, used absorptive capacity theory to propose that ERP could be a source of business innovations

through the improvement of an organisation's ability to assimilate the knowledge. This research is criticised because it only focuses on organisational resources; no mention is made of the relevance of technical resources and the role they play in realising the anticipated innovation benefits from the ERP systems. Sedera et al. (2016) used contingent resource-based view as a framework for understanding the proven relationship between ERP and innovation supported by technological resources. This research lacked the integration of organisational resources. Following Melville et al. (2004), the value of investing in technology is achieved by combining technical and organisational resources. Badewi et al. (2018) used qualitative research to develop a framework with which to establish a theoretical link between achieving the perception of ERP innovation benefits and the endowment of organisational and technical resources. However, this framework has not been tested. This research extends the work of Badewi et al. (2018) by improving, operationalising, and testing the appropriateness of their framework for the measurement of potential to improve the perception of ERP innovation benefits through the adoption of ERP systems. Accordingly, this research aims to answer the following question: How organisations can improve bottom up innovations through their ERP systems?

2 Literature review

2.1 Innovation

Innovation is the process of creating new things. Innovation can be top-down, bottom-up or mixed. Regarding the top-down approach, innovation is a systematic process and triggered and initiated by top management through RandD department (Gaynor 2013). In contrast, top-down process is pioneered by bottom-line employees and managers (Bäckström and Bengtsson 2019). Recent innovation studies specify that non-managerial and non-RandD ordinary employees represent substantial sources and drivers of innovation, even though they are not assigned to formal innovation tasks (Høyrup et al. 2012). As Birkinshaw (2010) argued, Bottom-up innovation efforts benefit from high levels of employee engagement, while top-down innovation efforts benefit from direct alignment with the company's goals. The digitalisation of processes empowered operational employees to innovate because it gives them access to data and knowledge required for recommending insightful ideas for innovating in products or services (Sorescu 2017). This research focuses on bottom up, or employee driven,

innovations because ERP system is a transactional application that mainly used by operational users.

For bottom-up innovations, there is a set of theories focuses on the idiosyncratic characteristics of innovative employees (Janssen et al. 2004; Landau 1993). Literature noted many factors that could leverage employees innovations. They are job autonomy (Bysted 2013), job standardisation (Luoh et al. 2014), role clarity (Cadwallader et al. 2010), decentralisation of decision making (Bysted and Jespersen 2014), participation mechanisms (Talukder 2011) and other innovation-related resources (see for instance Pundt et al. (2010). Employees need to be empowered by knowledge and information to be able give insightful thoughts for improving the organisation innovativeness.

2.2 Resource based view

Frameworks that adopt the resource-based theory are predominant in the literature regarding the value to be gained from investing in technology in general (Hsu 2013; Schryen 2013; Karimi et al. 2007; Nevo and Wade 2011). The resource-based theory emphasises that the endowment, availability, and combinations of resources an organisation has should reflect the differences in that organisation's performance levels (Garud, Tuertscher, and Van de Ven 2013) and provide a competitive advantage to the organisation (Barney 1991; Borchert 2008). For instance, Ruiz-Jiménez and Fuentes-Fuentes (2013) studied 224 Spanish firms and found that knowledge combination capability affects the product and process innovation. Resource-Based View examines resources whether they can be a source of competitive advantage for organisations (Barney 1991). A resource can be a source of competitive advantage if it is Valuable, Rare, Inimitable, and Organisational (VRIO). ERP has been defined as a strategic resource that could enable organisations to gain the competitive advantage, only if it is valuable (i.e., improve the performance), heterogeneously distributed across competing firms, imperfectly mobile, and the firm organised to exploit the full potential of its ERP system (Beard and Sumner 2004).

Research flourished in conceptualising ERP system as a strategic resource that could improve the organisation competitive advantage. For instance, Gupta et al. (2018) used resource-based view (RBV) theory to examine the role of cloud-based ERP services on the organisation performance in terms of financial performance and marketing performance. Also, ERP is found as a strategic resource if it can enable the organisations to innovate. Rodríguez et al. (2019) found that ERP system is an enabler for the business model innovation, mediated by the level of organisational complexity. ERP is also found as a strategic resource that could improve the organisation agility to compete better in

dynamic environments (Almahamid 2019). This kind of agility and complexity can be harnessed, if the required resources are available, for sustaining ongoing innovation in terms of product, services and process (Abu-Salim et al. 2019; Garud et al. 2013).

To frame the ERP as strategic resource to organisation, there is a stream of literature that used a resource-based view to theorise the value creation process of the technology, called IT business value. There various business value models and frameworks with which to understand how investment in IT creates value for organisations (Dedrick et al. 2003; Kohli and Grover 2008; Schryen 2013). Following this approach, the IT business value model of the Melville et al. framework (2004) and subsequent research (Nevo and Wade 2011; Piccoli and Ives 2005; Schryen 2013) argued that an organisation will require particular resources according to its needs in order to realise the anticipated value from investment in IT. According to this framework, IT resources (both technological and human) can achieve the anticipated benefits provided that complementary organisational resources are present, such as a non-IT organisational structure and culture. An ERP system subjects an organisation to objective and critical inspection because it requires—and leads to—a radical change in its culture, structure, and power (Ke and Wei 2008; Morton and Hu 2008), besides making it possible to integrate various information systems and technologies into a harmonised system.

The framework adopted in this research is presented in Figure 1. This ERP blueprint shows ERP resources, which can be either technical or human, and complementary organisational resources. ERP resources are the technical features of the system, and human resources are the competencies of the IT departments (Badewi et al. 2018). The leading ERP technical resources illustrated in the literature are ERP modules, the level of integration, and ERP attributes. Roh and Hong (2015) found that the higher the level of integration and implementation, the greater the benefits ERP bring in terms

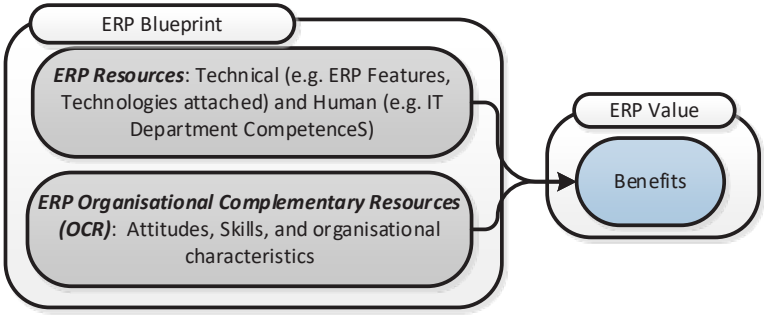

Figure 1. ERP business value framework (adapted from Badewi et al. 2018)

of sales, productivity, and innovation. Since an ERP infrastructure—such as cloud technology (Arnesen 2013; Miranda 2013) and the perception of the convenience of interfaces (Amoako-Gyampah and Salam 2004)—can impact its business value, such an infrastructure is considered to be an ERP technological resource. Similarly, process mining technology is found to influence the value of ERP by improving an organisation's ability to understand its environment (Thiede et al. 2018).

The concept of ERP resources is extended to include the ERP Human Resources in terms of the IT department competencies required to support the organisation with ERP service of the appropriate quality. Since the definition of quality is 'meeting or exceeding customer expectations' (Reeves and Bednar 2011), ERP service quality not only relates to an IT department's ability to respond effectively and efficiently to incidents (bugs or system crashes), and to preserve a system's maintainability, connectivity, and security (Nwankpa 2015), but also includes the ability to convince users that the IT services are reliable and empathetic, with a high level of responsiveness (Hsu et al. 2015). Good quality ERP service is vital for users of an ERP system and the recouping of its costs (Hsu et al. 2015; Nwankpa 2015). The role of IT personnel should not be limited to technical responses; preferably, personnel has a business partnership role (Bassellier and Benbasat 2004; Peppard and Ward 1999). Business partnership role is the ability of the IT personnel to scan users' needs from time to time to discover whether there are new business needs ERP should take into consideration (Mu et al. 2015).

Since ERP is not implemented in a vacuum, complementary organisational resources are argued to be critical to the levels of success (Albu et al. 2015). Complementary organisational resources that the literature considers necessary are factors such as strategy, structure (Albu et al. 2015), technological readiness (Al-Shboul 2018), a control system (Kallunki et al. 2011), and a compensation system (da Silveira et al. 2013). Personnel factors are the demographics (age, cognitive style, education, gender, and work experience) (Jasperson et al. 2005; Sammon and Adam 2010), peer advice ties (Sykes 2017; Venkatesh et al. 2017), and psychological factors (e.g., readiness to adapt their attitude; see Stratman and Roth 2002). The mindset of management was also found to be a contributory factor in the assimilation of ERP. For example, top management can play an important role (Dezdar and Ainin 2011; Law and Ngai 2007) in achieving continuous alignment between an organisation's strategic objectives and the long-term capabilities of ERP (Chou and Chang 2008).

3 Theoretical framework

Benefits can be defined as The ERP business value framework comprises two dimensions: organisational resources (attitudes, skills, and an organisation's characteristics),

and ERP resources (technical and human). Benefit is defined as "an advantage on behalf of a particular stakeholder or group of stakeholder" (Ward and Daniel 2006). Badewi and Shehab (2016) defined it as "a measurable advantage owned by a group of stakeholders incurred by changing the current state through project management mechanisms". These two definitions shows that benefits is a perception, and the the benefit will be harvested only if there is a change in the practices. The perception of ERP innovation benefits is defined as the stakeholders' believes that ERP derived purposeful change in the organisation structure, process, values and norms making it more innovative. The following hypotheses aim to set the theoretical glue between these resources and the innovation benefits of ERP (Badewi et al. 2018).

3.1 The effects of skills on the perception of ERP innovation benefits

An employee's skill level is defined by whether they are able to perform certain tasks effectively and efficiently (Gattiker 1992). ERP requires many skills and competencies (Charland et al. 2016; Huang and Yokota 2019): these comprise technical skills—that is, prior knowledge of IT and the ability to use computers for everyday activities (Hawari and Heeks 2010; Nandi and Vakkayil 2018), business-related skills (Spraakman et al. 2018), and business-ERP skills (Al-Mashari et al. 2003). These skills are highly relevant to the successful delivery and implementation of an ERP system on time and within budget; and to realising a higher return on investment, but not necessarily to improving the competitive advantage or innovation of an organisation (Beard and Sumner 2004; Ram et al. 2014; Yoon 2009; Zhu et al. 2010). Innovation benefits require the intensive examination of data so as to achieve a better understanding of the context and environment than that of competitors, leading to the emergence of innovative ideas (Holmes 2017; Lee et al. 2014).

Recently, data mining literature has discussed the critical importance of numeric skills in revealing the knowledge contained in data (De Mauro et al. 2018). Although ERP can be conceptualised as a transactional application, ERP forms contain information accessible from the use of reports. If operational users can analyse the data in the system, this can help them to develop new ideas on their operational level; leading to innovations in the organisation level. In the same vein, if an ERP system has a vast amount of data, numeric skills for operational users are argued to be relevant to the improvement of organisational innovativeness.

Hypothesis 1: Users' quantitative skills affect perception of ERP innovation benefits positively.

3.2 The effects of organisational characteristics on the perception of ERP innovation benefits

Organisational characteristics relate to the relationship between various actors, tasks, and objectives (Hatch and Cunliffe 1998; Parker 1992). Authority can be given to particular job positions in the hierarchy according to the backgrounds and ideologies of the employees holding those positions (Palm 2002). It is therefore argued that having the personnel to promote innovation could improve a firm's innovativeness (Sawhney et al. 2007). Also, the structure of tasks, in terms of the rigidity and agility of an organisation's processes, plays a significant role in determining the level of innovativeness (Anthony et al. 2006; Bock et al. 2012; Trott and Hoechst 2004b). Similarly, this research argues that organisational characteristics (in terms of agility and innovation sponsorship) play an important role in an organisation's ability to realise innovation benefits from an ERP system.

Hypothesis 2: Organisation Agility affects perception of ERP innovation benefits positively.

Different organisational characteristics endorse different skills and competencies in an organisation. For instance, agile organisations endorse transformational leadership (i.e., by empowering people), whereas rigid organisations promote transactional leadership (i.e., controlling by punishment, rewards, and rules) (Birasnav 2014; Kim and Yoon 2015). The delegation of authority motivates employees to equip themselves for decision-making and the creation of useful knowledge (Conger and Kanungo 2011). Since the main mechanism for creating useful knowledge from an ERP is through analyzing data, this research argues that organisational characteristics affect employees' quantitative skills.

Hypothesis 3: Organisational characteristics affect employees' quantitative skills posititvely**.**

The main premise of this research is that, if an organisation delegates the innovation process to the operational staff, quantitative abilities could be a critical condition for

ensuring product innovation from the use of an ERP system. In other words, ERP enables employee-driven innovations in the organisations.

Hypothesis 4: Organisational characteristics affect the perception of ERP innovation benefits mediated by employees' quantitative skills positively.

3.3 The effects of attitudes on the perception of ERP innovation benefits

Attitude is operationalised as one of the critical resources required for realising benefits from the technology (Melville et al. 2004; Schryen 2013), and so conceptualised as one of the organisations' soft resources (Badewi et al. 2018). According to the theory of reasoned action, attitude is the main driver for any behaviour (Bagchi et al. 2003; Fishbein and Ajzen 1975). If there is a positive attitude to using certain technologies in a particular way, appropriate behaviours will follow (Amoako-Gyampah and Salam 2004; Venkatesh and Davis 2000). Following the same logic, the attitude of personnel to an ERP system is one of the critical factors for success (Al-Mashari 2003). A positive attitude to the use of ERP triggers productive use of the system (Costa et al. 2016). Similarly, if ERP is perceived to be an innovative tool and if there is a positive attitude to using it, this could improve the outcomes of an ERP system.

Hypothesis 5: Attitudes affect the perception of ERP innovation benefits positively.

Following the previous arguments, the literature observes attitude as a driver for improving skills and competencies (Yerdelen-Damar et al. 2017). This is due to increased enthusiasm and curiosity to use and explore the system. Likewise, a positive attitude to ERP as an enabler of innovation could improve users' numeric skills and empower them to realise the required benefits.

Hypothesis 6: Attitudes affect employees' quantitative skills positively.

Although attitude is a driver of behaviours, the ability to undertake a task is essential to the delivery of the required outcomes (Yerdelen-Damar et al. 2017). Accordingly, the impact of attitude on the perception of ERP innovation benefits is mediated by skill levels.

Hypothesis 7: Attitudes affect perceived ERP innovation benefits mediated by quantitative skills positively.

3.4 The effects of ERP technical resources on the perception of ERP innovation benefits

Standardised reporting structures the decision-making process, limiting the capability of the operational users to mine data to obtain the required value. This research proposes that if the operational users are able to reconfigure the data into different meanings, they will be able to understand the environment better; enabling them to introduce more informative and insightful ideas for improving the products or services offered. This research proposes that the customisability of an ERP report empowers users to give recommendations for innovating the products or service by questioning the nature of the data available in the system.

Hypothesis 8: IT resources in terms of the customisability of reports affect ERP innovation benefits positively.

An IT business partnership is defined as a collaboration between the IT department and the business staff; such collaboration comes about in response to the existence of IT business knowledge and competencies (Bassellier and Benbasat 2004; Luftman 2000; Luftman and Brier 2012; Sia et al. 2009). This relationship enables IT staff to transfer their techno-business knowledge to users, which, in turn, helps users to optimise their use of the system and gives them the necessary confidence to use business-related features (Bassellier and Benbasat 2004). Accordingly, this research proposes that an IT business partnership is a crucial resource capable of enabling organisations to realise perceived ERP innovation benefits.

Hypothesis 9: ERP human resources in terms of business partnership affects Perceived ERP innovation benefits positively.

4 Research methodology

To test these hypotheses, this research adopted the positivist research paradigm (Kanellis and Papadopoulos 2011). A survey method is adopted to administer high volume of structured information from organisations in the most convenient way. The questionnaire is distributed to ERP managers on LinkedIn, a UK manufacturing database, and a US ERP manufacturing database. About 600 participants responded to the questionnaire; however, only 210 ERP managers from different companies completed questionnaires successfully, as illustrated in Table 1. Each response represents one ERP manager at a company. In other words, they are 210 organisations represented in the data. There

are 25 respondents did not agree to disclose the industry and sector but fully answered the questionnaire with no missing values.

Industry		*Area*	
Retailing	15	Arab	64
Manufacturing of slow-moving consumer goods (e.g., cars, televisions, computers)	30	Europe	53
Manufacturing of fast-moving consumer goods (e.g., food industry, grocery items)	42	USA	48
Oil and gas	12	Australia	5
Construction	16	Others	15
Service companies (hotels, hospitals, and banks)	70		
Missing (Not disclosed)	25	Missing	25
Total	210	**Total**	210

Table 1: Sample characteristics for validating the framework tool

4.1 Operationalisation of concepts

This research comprises six concepts: innovation benefits, attitude, skills, organisational characteristics, ERP technical resources, and ERP human resources. Perceived ERP innovation benefits are defined as the perception that the ERP improved organisational innovativeness in terms of creating new products and services and new improved ways of production (Badew et al. 2018). The perceived ERP innovation benefits scale is borrowed from Dougherty and Hardy (1996) and Nerkar and Roberts (2004). The three items used are the successful differentiation of an organisation's products from those of its competitors, the continuous improvement of the ways of producing and delivering products and services, and the continuous development of new successful products and services. The attitude items are adapted from Bagchi et al., (2003) and Saeed et al.

(2010) to fit with this research context (i.e., the attitude towards ERP as an innovation enabler). They relate to which planning technologies are required for innovation, and whether users believe that information technologies enable innovation. Skills are developed based on qualitative findings presented in Badewi et al. (2018). These items are accepted, having been validated with the experts. The items are users' understanding of how the use of statistics can enhance their job performance; users' advanced level application of such skills as correlational analysis, regression, and multi-regression; users' application of ERP business warehouse analytic models to an advanced statistics level; users' application of the artificial intelligence capabilities of ERP (such as genetic algorithms and neural networks); and users' ability to develop their reports so as to undertake the calculations of advanced level statistics.

Organisational characteristic is a second-order construct to represents two distinct, but related constructs, that are accounted for the role of the organisational requirement for employee-driven innovations. The second-order constructs are organisational agility and innovation sponsorship. The organisational agility measure is borrowed from (Kester et al. 2014; Wang et al. 2015). These measures identify whether your organisation is able to change its process structure efficiently and whether your organisation is able to respond readily to unforeseen changes in the market. The innovation sponsorship scale is operationalised from research (Cash et al. 2008; Govindarajan and Trimble 2010). The scale identifies how well the benefits realisation process is followed up from the point of implementation of new ideas, whether there is a sponsoring unit (senior manager(s) or department) to identify valid new ideas from a knowledge-sharing system, and whether a sponsoring unit implements and promotes new ideas. This construct is valid as illustrated all loadsare more than 0.6 and no cross loads with other constructs as illustrated in Exploratory Factor Analysis (EFA) (Table 5) and Average Variance Extraction (AVE) = 0.688. Other measures show the internal consistency of this high order construct because the composite reliability 0.916, $\alpha = 0.916$ and rho_A = 0.94.

The ERP technical resources proposed in this research relate to the customisability of reports. Innovation reflects the ability to see data from a variety of perspectives (Ashurst et al. 2012). The customisability of reports is operationalised based on Badewi et al. (2018) and relates to whether users are enabled to customise reports freely; change the layouts of reports; and change the contents of reports, taking into consideration the unified definition of terms.

The ERP human resources required to deliver the perception of ERP innovation benefits mainly relate to the IT business partnership. The scale is adopted from Benbstat and Bassellier (2004) but has been improved based on the comments of our panel of experts. The items are the ability of the IT department to understand and contribute to

business practices by making recommendations, and to develop IS strategy consistent with the business strategy.

All the constructs are valid and reliable, as summarised in Table 2. The tools used to ensure the validity and reliability of the constructs were Exploratory Factor Analysis (EFA) using dimension reduction (see Table 5), heterotrait-monotrait ratios (see Table 6), Cronbach's alpha, composite reliability, average variance extracted, and rho_A. All figures are accepted. The composite reliability and AVE scores are greater than 0.6, which represents adequate convergent validity and reliability (Fornell and Larcker 1981). Also, to ensure discriminate validity, the AVE of each construct is greater than the highest shared variance with other constructs.

This research takes into account the possible presence of systematic error related to the respondents. The presence of respondent error (or common method bias) is tested for using Harman's single-factor test, based on Podsakoff et al. (2003). It was conducted by inserting all independent and dependent variables in exploratory factor analysis. The first factor accounted for 25.81% of the total 86.50% variance, demonstrating a lack of evidence of considerable common method bias in this study.

Items (7 scales)	*Code*	*Reference*
Perceived ERP Innovation Benefits (CR = 0.925, AVE = 0.803, rho_A = 0.925, α = 0.924) *The ERP enabled your organisation to:*		
1.Successfully differentiate its products from those of competitors	Innovating_Benefits1	(Hardy and Dougherty 1996; Nerkar and Roberts, (2004)
2.Continuously improve the ways of producing/ delivering products and services	Innovating_Benefits2	
3.Continuously develop new successful products and services	Innovating_Benefits3	
Attitude (CR = 0.775, AVE = 0.636, rho_A = 0.797, α = 0.762) *How do the employees in your organisation perceive the following:*		
1.There is a positive belief that innovation is critical to the organisation	Attitude1	(Bagchi et al. 2003)
2.Planning technologies are required for innovation	Attitude2	
Skills (CR = 0.938, AVE = 0 .573, rho_A = 0.94, α = 0.938) *How would you describe your employees' competencies and skills?*		

Table 2: Constructs validity, reliability, and references

1.Users understand how using statistics can enhance their job performance	Quantitative_Skills1	(Badewi 2016; Badewi et al. 2018)
2.Users use advanced levels of analysis (such as correlational analysis, regression, and multi-regression)	Quantitative_Skills2	
3.Users use ERP business warehouse analytic models to an advanced statistics level	Quantitative_Skills3	
4.Users use the artificial intelligence capabilities of ERP (such as genetic algorithms and neural networks)	Quantitative_Skills4	
5.Users are able to develop their reports to suit the calculations of advanced level statistics	Quantitative_Skills5	
Organisational Characteristics (agility and of Innovation sponsorship) (CR = 0.916, AVE = 0.688, rho_A = 0.94, α = 0.916) *How do you rank your organisational and personnel capabilities on the following aspects:*		
1.Your organisation is able to change its process structure easily and efficiently	Organisation_ Agility1	(Kester et al. 2014; Wang et al. 2015)
2.Your organisation changes easily to reflect unforeseen changes in the market	Organisation_ Agility2	
3.There is a benefit accountability position to follow up on the benefits realisation process from the implementation of new ideas	Sponsorship1	(Cash et al. 2008; Govindarajan and Trimble 2010)
4.There is a sponsoring unit (senior manager(s) or department) to pick up new valid ideas from the knowledge sharing system in the organisation	Sponsorship2	
5.There is a sponsoring unit to implement new ideas	Sponsorship3	
ERP Technical Resources (customisability of the reports) (CR = 0.944, AVE = 0.808, rho_A = 0.945, α = 0.944) *How would you describe the ERP system and its supporting systems in your organisation?*		
Enables the users to customise their reports freely	Customisability_1	(Badewi et al. 2018)
Change layouts of the reports	Customisability_2	
Changes the contents of reports with taking into consideration the unified definition of terms	Customisability_3	
Customises their report layout	Customisability_4	

Table 2: Constructs validity, reliability, and references(cont.)

ERP Human Resources (business partnership) (CR = 0.825, AVE = 0.707, rho_A = 0.853, α = 0.81) *How would you describe the staff working in your IT department?*		
Understand business practices and add value to them (by making recommendations)	Bus_Partnership1	(Bassellier and Benbasat 2004)
Develop a strategy aligned with the organisation's changing strategy	Bus_Partnership2	

Table 2: Constructs validity, reliability, and references (cont.)

4.2 Analysis

The analysis comprised three stages: rationale for the analytic model, model fitness, and testing of the hypotheses.

Descriptive analysis

From the descriptive analysis, the skills are scored the lowest with 4.7, while the attitude is the highest with score of 5.58 with the lowest standard deviation. Other constructs have scores between these figures. Regarding the correlational analysis, the highest correlation with the ERP innovating benefits are Skills and IT technical resources (i.e., customisability of the reports) with 78.3% and 74.1% (P<0.00) but the lowest are with the attitude and organisation characteristics with 45.8% and 64.8% (P<0.00), respectively.The correlational analysis (Table 3) shows that all relations are significant with perceived ERP innovation benefits. However, this does not necessarily mean they have a direct relationship with them. This is due to the potential multi-collinearity problem caused by high and significant correlations with dependent variables (Fisher and Mason 1981). This sets certain limitations on the use of multiple regressions and partial least squares analysis (Sarstedt et al. 2014; Shmueli et al. 2016). An alternative is to use structured analysis, known as 'structural equation modelling', where co-variances between items can be traced and treated (von Oertzen et al. 2015).

Pearson correlation								
	Mean	*Std. Dev*	*1*	*2*	*3*	*4*	*5*	*6*
1.Perceived ERP Innovation Benefits	4.99	1.55	1					
2.Attitude	5.58	1.05	.458**	1				
3.Skills	4.70	1.59	.783**	.511**	1			
4.Organisation Characteristics	5.12	1.26	.639**	.513**	.718**	1		
5.ERP Technical Resources	4.90	1.60	.741**	.483**	.788**	.658**	1	
6.ERP_Human Resources	5.19	1.33	.648**	.398**	.668**	.625**	.671**	1
**. Correlation is significant at the 0.01 level (2-tailed).								

Table 3: Descriptive Analysis

Model fitness

Before using structural equation modelling to test the hypotheses, model fitness is measured. There are three aspects to consider so as to ensure the suitability of the model: the absolute fitness of the model, its incremental fit, and the parsimony of the model. Absolute fitness has three different measures (Hair et al. 2018). Absolute fit (or 'overall fit') indicators are used to measure the degree to which the structural model, measurement model, and overall model fit the sample data: the chi-square per degree of freedom (x2/df), the goodness-of-fit index, and the root mean square effort of approximation (RMSEA). The chi-square per degree of freedom (x2/df), with a score of 1.27, is lower

than the cut-off points of 2.0 (Byrne 1989) and 5.0 (Marsh and Hocevar 1985). The goodness of fit, with a score of 0.92, is higher than the cut-off point of 0.90 (Hair et al. 1998). The RMSEA is also acceptable since it is 0.036 with a confidence of 90% between 0.02 and 0.05, which is much lower than the cut-off point of 0.05 (Browne et al. 1993).

The incremental fit assesses the discrepancy between the proposed model and the baseline model and comprises three indicators: the Tucker-Lewis index, normed fit index, and comparative index. All three are accepted, as they are greater than the cut-off point of 0.90 (Hu 1999). The scores for the Tucker-Lewis index, normed fit index, and comparative fit index are 0.986, 0.955, and 0.990, respectively. This indicates that this model is significant in relation to the baseline model.

The final measure is the parsimony of the model. The model is accepted, as all indicators are greater than 0.5, which indicates that the model is not over-fitted due to there being too many coefficients (James et al. 1982; Hu and Bentler 1999). The scores for the goodness-of-fit index, comparative fit index, and normed fit index are 0.616, 0.731, and 0.705, respectively.

4.3 Testing hypotheses

The structural equation model confirms most of the hypotheses, as shown in Table 4 and Figure 2, and explains 73.1% of the variation in Perceived ERP innovation benefits across organisations. The model comprises two parts: ERP resources and complementary organisational resources, which are all tested in a single structural equation model. ERP resources in terms of IT human resources (i.e., the business partnership) and technical resources (i.e., customisability of the reports) are found to have significant positive impacts on perceived ERP innovation benefits: (β=0.177,P<0.00) and (β=0.237,P<0.00), respectively, confirming Hypotheses 7 and 8.

Complementary organisational resources have different impacts on perceived ERP innovation benefits. The direct impact of skills on perceived ERP innovation benefits are significant (β=0.548,P<0.00), and confirm Hypothesis 1. The direct impacts of attitudes and organisational characteristics on perceived ERP innovation benefits are weak and insignificant, (β=0.021,P>0.10) and (β=-0.071,P>0.10), respectively, and invalidate Hypotheses 2 and 5. However, the indirect impacts of attitudes and organisational characteristics are both significant, those for organisational characteristics, (β=0.648,P<0.00), are much greater and more significant than those for attitudes, (β=0.685,P<0.05). This confirms Hypotheses 4 and 7. Finally, attitude and organisational characteristics have significant impacts on skills, (β=0.181,P<0.00)

and(β=0.685,P<0.00), respectively, confirming Hypotheses 3 and 5. Both factors explain 64.7% of the change in skills across organisations.

H	*Relationship*	*Effects*	*Decision*
1	Users' quantitative skills affect Perceived ERP innovation benefits	0.548***	Support
2	Organisational characteristics in terms of agility and sponsorship affect perceived ERP innovation benefits	-0.071	No support
3	Organisational characteristics affect an employee's quantitative skills	0.685***	Support
4	Organisational characteristics affect ERP innovation mediated by employees' quantitative skills	0.648***	Support
5	Attitudes affect perceived ERP innovation benefits	0.021	No support
6	Attitudes affect employees' quantitative skills	0.181**	Support
7	Attitudes affect perceived ERP innovation benefits mediated by quantitative skills	0.146**	Support
8	IT resources in terms of customisability of the reports affect perceived ERP innovation benefits	0.177**	Support
9	ERP human resources in terms of the business partnership affect perceived ERP innovation benefits	0.237**	Support
	Perceived ERP Innovation Benefits = 73.1% Quantitative Skills = 64.7%		

**P<0.05, ***P<0.01

Table 4: Summary of the tested hypotheses

5 Discussion

The resource-based approach shows that certain resources could play a significant role in explaining the variation in organisations' performance (Barney 1991; Barney and

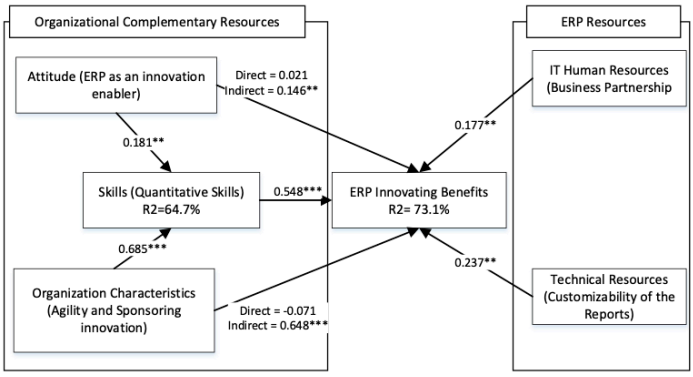

Figure 2. Results of the structural equation model hypothesis testing
**P<0.05, ***P<0.01

Ray 2009; Piccoli and Ives 2005). This research contributes to this argument by showing that although certain resources have no direct effect, their impact could indirectly affect the perceived ERP innovating benefits. The main implication here is that business value researchers should take a closer look at the resource-based approach and the interactions between resources in value creation, rather than merely investigating direct and first-order impacts.

We believe this paper is the first to test the mediating impacts of skills on the relationship between attitudes to technology and perceived ERP innovation benefits. The direct relationship between attitudes and benefits has already been examined in the literature (Costa et al. 2016; Ifinedo et al. 2010; Saeed et al. 2010). However, the current literature focuses only on the benefits of automation (i.e., the efficiency and effectiveness of the current processes and products) (Nwankpa 2015; Ruivo et al. 2015) and does not pay heed to the innovation benefits (i.e., creating new processes and products). This research failed to find evidence to support direct relationships. The reason for this could be that innovation requires more extensive action than merely using a system. Attitude plays an important role in using a system (Saeed et al. 2010); creating a more positive ethos could improve efficiency and effectiveness (Ruivo et al. 2014). Conversely, innovation requires ERP systems to be used differently; rather than being used to make processes more speedy, they should be used to create and assimilate knowledge so as to increase the ability to explore and exploit the knowledge contained in the data. This research finds that positive perceptions of technology as an enabler improve the quantitative skills of users, which leads to increased innovation.

Organisational characteristics play an important role in adopting and embracing of technology (Wang et al. 2006). This research supports the work of others who consider that organisational characteristics could influence the value creation brought about by IT in general (Albu et al. 2015; Kallunki et al. 2011; Sammon and Adam 2010; Silveira et al. 2013). However, this research failed to find evidence for direct impact on innovation. The work is, however, novel in finding that the impact on ERP innovation is mediated by skills; that is, organisational characteristics could be important motivators in helping users to learn and improve their quantitative skills so that the ability to innovate from data can be strengthened.

This paper is the first to operationalise and test the impact of ERP resources in terms of a business partnership and the customisability of reports on the perceived ERP innovation benefits. This research supports other qualitative papers proposing that an IT business partnership can improve organisational innovativeness (Marchand and Peppard 2013; Peppard and Ward 2004); however, this paper goes further than such papers to use quantitative data to test the impact of an IT business partnership. The standardisation of the methods and tools to present and combine data increases rigidity in ideation and the ability to innovate. Building on this argument, this research found that the customisability of ERP reports improves the ability to innovate since users are empowered to explore and discover new information by combining different data through the customisability of the reports.

6 Conclusion

This research adopted the resource-based framework developed by Melville et al. (2004) to explain the potential to improve ERP innovating benefits through the adoption of an ERP system. ERP resources, in terms of human resources (i.e., a business partnership) and technical resources (i.e., customisability of the reports), have a significant impact on organisational innovativeness being obtained from an ERP system. Complementary organisational resources are found to have mixed impacts on organisational innovativeness. Whereas quantitative skills have a significant direct impact on ERP innovation, attitude and organisational characteristics (agility and innovation sponsorship) have no significant direct impact. Rather, attitudes and organisational characteristics have a significant indirect impact on organisational innovativeness mediated by quantitative skills.

6.1 Research recommendations

This research has several implications for operations and IT managers. ERP systems can improve business innovation provided there is a positive attitude to the use of technology for innovation, organisational agility, innovation sponsorship, and the quantitative skills of users. Attitudes to ERP as an innovation enabler can be improved through workshops, leaflets, and videos. We do not argue that this will be directly translated into innovation. Rather, we argue that improving attitudes to ERP systems will motivate users to learn the quantitative skills that permit the use of an ERP system to generate innovation. Accordingly, operations managers should take advantage of the learning tools available to improve users' quantitative skills. A further crucial contributory factor for improving innovation is organisational agility. ERP, according to the literature, can make business processes and ideation too rigid to allow innovation. Organisational agility does not directly improve the success rate but can make users feel empowered, inspiring them to explore by learning quantitative skills.

IT managers could play a role in improving the business value that can be found by investing in IT, not only by improving the reliability and maintainability of the system but also from the perspective of an IT business partnership. This can be achieved through business studies and being able to advise on business operations. Users, over time, become used to undertaking certain functions and actions. ERP IT managers should work with users to advise them on how they can improve business operations through the use of ERP. Also, ERP managers should improve the customisability of reports. Generally speaking, ERP systems leave customisability options available, but ERP managers could deny access to these options. This research argues that these options should be made available, so as to increase users' ability to release the potential of the systems.

6.2 Research limitations and future work

There are certain areas of improvements and potential future research. This research developed a model to examine the role of ERP in improving employee driven innovation; not centralised innovations through R&D. The literature still has knowledge gaps in understanding the role of ERP for improving RandD functions through having up-to-date data in the system. Furthermore, because the aim was focused on the employee-driven innovations, the focus of this research was on operational users not planners; nor strategic decision-makers. Strategic decision-makers could need different enablers, e.g., collaboration, knowledge sharing and implicit knowledge for improving the organisation innovativeness from using the ERP. Additionally, the organisational

innovativeness is measured by perception of ERP innovation benefits (i.e., the perceptions towards the effect of ERP implementation on innovations). This measure could be subjective, and it could be augmented by another study for examining the organisations' data and records to measure the new product development performance.

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Appendix

	Component					
	1	2	3	4	5	6
Innovating_Benefits1	.201	.355	.323	**.721**	.150	.193
Innovating_Benefits2	.253	.247	.349	**.737**	.149	.191
Innovating_Benefits3	.294	.317	.286	**.764**	.125	.198
Attitude1	.217	.123	.089	.106	**.863**	.077
Attitude2	.202	.193	.249	.134	**.787**	.110
Quantitative_Skills1	.246	.277	**.650**	.252	.108	.284
Quantitative_Skills2	.352	.212	**.753**	.220	.179	.131
Quantitative_Skills3	.324	.361	**.702**	.300	.181	.093
Quantitative_Skills4	.255	.332	**.680**	.309	.193	.164
Quantitative_Skills5	.230	.449	**.643**	.331	.149	.240
Organisation_Agility1	**.717**	.265	.372	.091	.050	.243
Organisation_Agility2	**.717**	.234	.264	.226	.136	.217
Sponsorship1	**.711**	.180	.351	.124	.174	.238
Sponsorship2	**.813**	.123	.112	.167	.232	.006
Sponsorship3	**.770**	.260	.165	.249	.180	.140
Customisability_Reports1	.274	**.705**	.345	.295	.104	.238
Customisability_Reports2	.201	**.796**	.335	.206	.141	.157
Customisability_Reports3	.326	**.748**	.264	.218	.132	.221
Customisability_Reports4	.227	**.780**	.229	.296	.238	.177
Bus_Partnership1	.194	.235	.196	.194	.136	**.841**
Bus_Partnership2	.338	.323	.273	.274	.094	**.677**

Extraction method: Principal component analysis.
Rotation method: Varimax with Kaiser normalisation.

a. Rotation converged in 6 iterations.

Table 5. Exploratory factor analysis (EFA)

	Attitude	*ERP Human Resources*	*ERP Tech Resources*	*Innovate Benefits*	*Org Characteristics*
ERP Human Resources	0.534				
ERP_Tech_ Resources	0.565	0.825			
ERP_Innovation_ Benefits	0.542	0.793	0.793		
Org Characteristics	0.612	0.707	0.707	0.693	
Skills	0.598	0.772	0.837	0.84	0.774

Table 6.Heterotrait-monotrait ratio (HTMT)

			Est	*St Est*	*S.E.*	*C.R.*	*P*
Skills	<---	Attitude	0.287	0.181	0.117	2.446	0.014
Skills	<---	Org_ Characteristics	1.274	0.685	0.166	7.661	***
ERP_Innovation_ Benefits	<---	Skills	0.508	0.548	0.099	5.148	***
ERP_Innovation_ Benefits	<---	Attitude	0.031	0.021	0.093	0.329	0.742
ERP_Innovation_ Benefits	<---	Org_ Characteristics	-0.123	-0.071	0.172	-0.716	0.474
ERP_Innovation_ Benefits	<---	ERP_Human_ Resources	0.200	0.177	0.098	2.046	0.041
ERP_Innovation_ Benefits	<---	ERP_Tech_ Resources	0.242	0.237	0.100	2.422	0.015

Table 7. Summary of the results

Items 1 completely disagree - 7 completely agree	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Perceived ERP Innovation Benefits: *The ERP enabled your organisation to:*							
Successfully differentiate its products from those of competitors							
Continuously improve the ways of producing/delivering products and services							
Continuously develop new successful products and services							
Attitude: *How do the employees in your organisation perceive the following:*							
There is a positive belief that innovation is critical to the organisation							
Planning technologies are required for innovation							
Skills :*How would you describe your employees' competencies and skills?*							
Users understand how using statistics can enhance their job performance							
Users use advanced levels of analysis (such as correlational analysis, regression, and multi-regression)							
Users use ERP business warehouse analytic models to an advanced statistics level							
Users use the artificial intelligence capabilities of ERP (such as genetic algorithms and neural networks)							
Users are able to develop their reports to suit the calculations of advanced level statistics							
Organisational Characteristics (agility and of Innovation sponsorship) *How do you rank your organisational and personnel capabilities on the following aspects:*							
Your organisation is able to change its process structure easily and efficiently							
Your organisation changes easily to reflect unforeseen changes in the market							
There is a benefit accountability position to follow up on the benefits realisation process from the implementation of new ideas							
There is a sponsoring unit (senior manager(s) or department) to pick up new valid ideas from the knowledge sharing system in the organisation							
There is a sponsoring unit to implement new ideas							
ERP Technical Resources (customisability of the reports) *How would you describe the ERP system and its supporting systems in your organisation?*							
Enables the users to customise their reports freely							
Change layouts of the reports							
Changes the contents of reports with taking into consideration the unified definition of terms							

Customises their report layout							
ERP Human Resources (business partnership) *How would you describe the staff working in your IT department?*							
Understand business practices and add value to them (by making recommendations)							
Develop a strategy aligned with the organisation's changing strategy							

Table 8. Questionnaire List

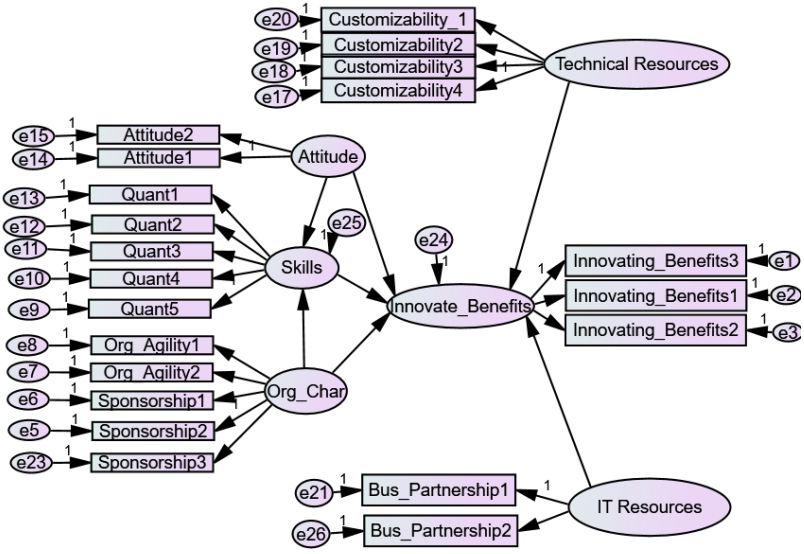

Figure 3: AMOS Model