BUILDING ENTERPRISE SYSTEMS INFRASTRUCTURE FLEXIBILITY AS ENABLER OF ORGANISATIONAL AGILITY: EMPIRICAL EVIDENCE

Complete Research

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Abstract

Enterprise systems (ES) that capture the most advanced developments of information technology are becoming common fixtures in most organisations. However, how ES affect organizational agility (OA) has been less researched and the existing research remains equivocal. From the perspective that ES can positively contribute to OA, this research via theory-based model development and rigorous empirical investigation of the proposed model, has bridged significant research gaps and provided empirical evidence for, and insights into, the effect of ES on OA. The empirical results based on data collected from 179 large organizations in Australia and New Zealand which have implemented and used ES for at least one year show that organisations can achieve agility out of their ES in two ways: by developing ES technical competences to build ES-enabled capabilities that digitise their key sensing and responding processes; and when ES-enabled sensing and responding capabilities are aligned in relatively turbulent environment.

Keywords: Organizational agility, Enterprise systems, Environmental dynamism, Dynamic capability Theory, Strategic alignment, Capabilities, Enterprise system infrastructure

1 Introduction

Over the last decade, more attention has been paid to the role of information technology (IT) and information system (IS) in organisational performance. Facing with challenges from a highly turbulent business environment, contemporary organisations have looked into agility as a new capability to respond to changes and uncertainty and success indicator to achieve high levels of organizational performance (Gunasekaran, 1999, Mathiassen and Pries-Heje, 2006). Likewise, organisational agility (OA) is emerging as the topic of interest in IS research in order to understand the effects of IT/IS on organisational performance. Yet, the IS literature is still dominated by conceptual research (Overby et al., 2006, Sherehiy et al., 2007) and contradictory claims. While some view the role of IS on OA as a facilitator (Fink and Neumann, 2007, Sambamurthy et al., 2003, Tallon, 2008), others consider it as an inhibitor (Newell et al., 2007, Seo and Paz, 2008). Of the limited number of empirical studies available that have investigated IS-related agility antecedents (Bhatt et al. 2010, Fink and Neumann, 2009, Tallon, 2008), nearly all work on the assumption of a direct relationship between IS factors and OA.

To cope with changes in the business environment which come from various sources (e.g. government's regulation, technology, competitors' strategic move, etc.), and under various forms, organisations are required to demonstrate distinctive ways of responding them. Hence, OA, an organisations' ability to sense and respond to changes (Trinh et al., 2012), can be developed from various areas. OA is viewed as having polymorphous aspects (Lee et al., 2007). Simply viewing the direct relationship between IS and OA constrains the understanding of how IS supports the polymorphous aspects of OA. As such, this indicates a limited understanding of the underlying mechanisms and associated conditions of IS-enabled OA. Moreover, previous IS studies on OA have proposed IS-related constructs that are too broad and abstract to provide implications for practitioners (Tan et al., 2009). In particular, the

IS artifact these studies refer to is generically defined and does not address a specific IS which is familiar to the practice. Besides, organisations have increasingly deployed complex ES – large scale packaged software innovations that integrate and automate enterprise-wide organizational processes and information. Although ES such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Supply Chain Management (SCM) are the most representative IS in organisations due to their comprehensiveness and prevalence, except where anecdotally mentioned as examples or cases (Raschke, 2010, Sambamurthy et al., 2005), their role in achieving agility remains underresearched. ES, although classified as one type of IS implemented in organisations and thereby inheriting common IS characteristics, have unique features that differentiate them from legacy IS (e.g. transaction processing systems). ES have been found to provide benefits to organisational performance (Shang and Seddon, 2002). However, the literature on ES is still dominated by ES implementation issues rather than post-implementation issues such as ES effects on OA (Moon, 2007).

The recent IS literature review shows emerging studies (Goodhue et al., 2009, Seethamraju, 2014, Trinh et al., 2012) that aim to explicate the concept of ES-enabled OA. Nevertheless, there are limitations in these scant numbers of studies which urge for further research. In particular, firstly, most of these studies are conceptual (Trinh et al., 2012) or employ case study (Seethamraju, 2014) which limit the generalization of their findings. Secondly, the lack of theories in these studies and conceptual model for ES challenges the logical base of the argument. For instance, Goodhue et al. (2002) and Gattiker et al. (2005) identify the ES characteristics such as built-in flexibility, process integration, data integration, and availability of "add-on" applications to support agility. However these characteristics are considered as the sources of resources rather the actual capabilities that an organisation which has implemented ES would extract out of their system. Thirdly, since the focus of these studies is on ES rather than OA, the definition and construct measurement dimensions of OA are not clearly specified and mostly generally introduced. To address these gaps, this research aims to empirically explain the how and why ES can be exploited to enable OA.

2 Theoretical background

2.1 Organisational agility

Organizational agility has become an emerging topic which is currently attracting research contribution from different perspectives (Nejatian and Zarei, 2013). The concept of "organisational agility" evolves from two related concepts - "organisational adaptability" and "organisational flexibility" (Sherehiy et al., 2007). An agile organization is not only "adaptable" to existing business environment and "flexible" to cater to predictable changes, but also is able sense and respond to unpredictable changes quickly and efficiently (Oosterhout et al., 2006). The two core enabling elements of OA: (1) sensing capability, which refers to an accurate and timely awareness of changes, and (2) responding capability, which refers to an ability to change business processes and to customize operational responses in real time (Dove, 2005) are viewed as the critical antecedent factors to develop OA. Sensing capability is implied in the dimensions of detecting innovations (Sambamurthy et al., 2003), and having entrepreneurial mindset (Lu and Ramamurthy, 2011) while responding capability is implied in the dimensions of seizing opportunities, mobilizing asset, knowledge and relationship (Sambamurthy et al., 2003) or execution, implementation, operational adjustment (Lu and Ramamurthy, 2011). Thus, OA refers to the performance of an organisation to excel in utilizing its resources in order to quickly sense changes from its business environment and respond to those changes appropriately (Trinh et al., 2012). According to the agility literature, OA is measured by the three dimensions of customer agility, operational agility and partnering agility (Sambamurthy et al., 2003, Trinh et al., 2012). These three dimensions indicate the business context where changes interact with organisations.

2.2 Enterprise Systems and Organisational Agility

Literature on ES- OA relationship is divided into three views: facilitating, inhibiting and neutral view (Trinh et al., 2012). From the facilitating view, ES allow firms to gather customers' data and build valuable customer knowledge and hence they have positive influence on the sensing capability (Roberts & Grover 2012). ES competence including business process standardization, integration, visibility and control of processes are critical to achieve high level of OA (Seethamraju, 2014). Despite the dominant of facilitating view, research also reveals that ES inherit the similar issues of other IS which can inhibit OA (e.g. high switching costs, limitation in system's modification capacity, etc) (Oosterhout et al., 2006). Moreover, companies tend to implement ES as a solution for specific problems at specific time which become gradually outdated and inflexible especially under highly turbulent business environment (Seo and Paz, 2008). Finally, from the neutral view, researchers postulate that it is more complicated than just to say ES facilitate or inhibit OA (Overby et al. 2006). ES management interventions such as higher management support, user acceptance, IT staff capability and so on instead of the system itself is the key factor that decides whether ES support OA (Oosterhout et al., 2006). Without appropriate information management strategy, ES will inhibit rather than facilitate OA (Trinh et al. 2012). In summary, the inconclusive findings on ES-OA relationship are due to different approaches in defining ES as (1) a IS artefact or (2) working system which respectively lead to (a) inhibiting view and (b) enabling view. The current research takes a holistic view on ES and is in line with the "facilitating view of IS/ES and OA".

Citation	OA Definition	Roles of IT/IS/ES in OA	Theory	Method
Sambamurthy et al. (2003)	Capability to detect, seize opportunities, mobilize asset, knowledge, relationship, time	IT competence enables organisations to develop digital options, which in turn enable OA.	DCT	Conceptual
Overby et al. (2006)	Capability to sense, respond to environmental change impact directly and indirectly through digitization of business	IT investment increases process and knowledge capabilities which create platform of digital options that can enable organisations to sense and respond to changes	DCT	Conceptual
Lu and Ramamurthy (2011)	Has two dimensions market capitalizing agility, operational adjustment agility	IT capability directly enables OA. IT spending that leads to superior IT capability provides greater OA; IT spending that does not build IT capability shows a negative effect on OA.	RBV	Empirical
Bhatt et al. (2010)	Organisational responsiveness	Through information generation and distribution, IT infrastructure flexibility is significantly and positively related to organisational responsiveness	RBV	Empirical
Roberts and Grover (2012)	Able to sense and respond quickly to customer-based opportunities for innovation and competitive action	Web-based customer infrastructure and the analytical ability of the firms are positively related to customer sensing agility. Internal and external IS integration significantly facilitate customer responding agility.	RBV	Empirical
Trinh et al. (2012)	Organisational performance in quickly sensing and responding to changes from the business environment appropriately	Organizations can exploit ES to improve their agility in two significant ways—by creating and constantly developing an ES-enabled sensing and responding capability	DCT	Conceptual
Seethamraju, (2014)	Reconfigure, redesign, and realign processes to respond to needs, threats, and opportunities at ease and speed.	ES enables process integration, process standardisation which improves companies' information sharing and visibility, control and decision making; thus reflect agility.	RBV	Empirical

Table 1. Researches on ES and OA

The literature review takes a closer look on relationship between ES/IS and OA. Table 1 presents key studies on the IT/IS/ES-OA related topics from IS A-ranking journals upon the four aspects: OA definition, impact of ES/IS on OA, research methodology and theories underlying the model.

Based on this summary, several acknowledgements can be noticed from existing body of knowledge IS/ES impact on OA. Firstly, OA is viewed either as a form of organisational performance or as a type of organisational capability (Trinh et al., 2012). Secondly, OA is viewed as the final result of the leveraging process of IT capability or as the mediator for the impact of IT capability on organisational competitive advantage. Thirdly, OA emphasizes on two dimensions: turbulent business environment and timeliness which appear in the OA definition in all the reviewed studies. Hence, business environmental context plays an important role in determining the required level of OA. Fourthly, the IT/IS capability is specified as the high-order construct which requires the leveraging mechanism from the basic characteristics of IT system such as modularity, scalability (Overby et al., 2006, Sambamurthy et al., 2003). The transformation of IT capability in enabling OA is driven via the involvement of IT in business process and knowledge (Overby et al., 2006, Sambamurthy et al., 2003). Finally, IT/IS capability impacts OA both directly and indirectly.
In summary, the current IS literature suggests a number of explanations on how IT capability can enable OA; however, the mechanism is not clearly specified. The early two conceptual papers of Overby et al. (2006) and Sambamurthy et al. (2003) suggest that the IS competence digitizes business process and knowledge that enable sensing and responding capability which results in advancement of OA level. The later studies have overcome the limitation of being conceptual research of these two studies by proposing conceptual framework and validated it empirically. However, all of these empirical studies employ resource based view model (RBV) which does not provide the mechanism of how IT capabilities enable OA. OA implies the capability to cope with continuous changes coming in different forms and from different sources in turbulent business environment. Hence, a static view of IT capabilities that enable OA from RBV perspective is insufficient to reflect dynamic nature of OA.

3 Research Model and Hypotheses

Our research addresses the discussed gaps by proposing a conceptual model that is drawn from dynamic capability theory (DCT). DCT emphasizes the evolvement of resources (Teece, 2007), which is signified by two processes: resource-picking and capability-building in the organization-learning loop. Hence, organizational resources need to be adaptive, renewable and reconfigurable to provide sustainable competitive advantage (Teece, 2007). Dynamic capabilities are commonly associated with dynamic environment where an organization needs to keep changing its resources to suit the organization strategy at a particular circumstance (O'Connor, 2008). The DCT provides a relevant theoretical lens to conceptualize the link between ES and OA.

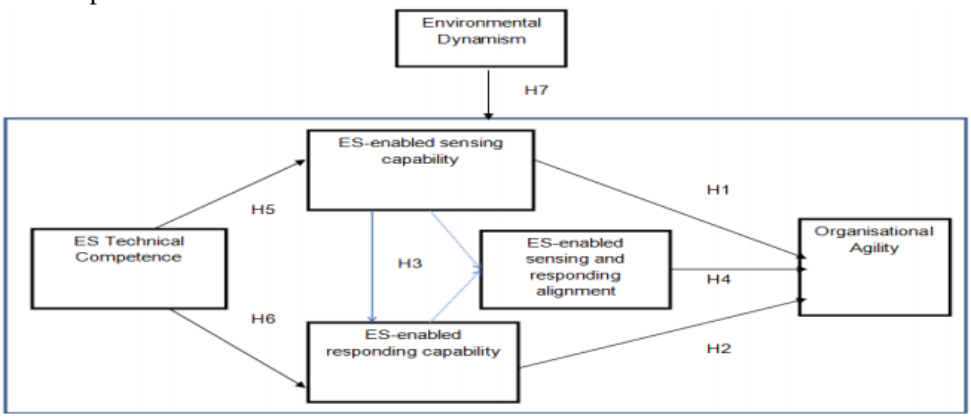


Figure 1. Conceptual framework

In our model, first, ES competences are identified and developed through the ES use. Then, drawing from DCT, the study introduces two distinctive types of higher order ES dynamic capabilities: Enterprise system-enabled sensing capabilities (ESS) and Enterprise system-enabled responding capabilities (ESR) as the missing link between ES competence and OA. The study hypothesizes that organisations that are able to develop ESS and ESR out of their ES competence through the use of ES in business processes that sense and respond to changes in business environment would eventually attain higher level of agility. Moreover, instead of viewing ES competence from holistic view which consists of technology, human, managerial, vendor or functionality (Trinh et al., 2012), we narrow the scope of ES competence to the technical infrastructure of ES. Doing this not only helps the current research share the same boundary of the domain of ES as the main stream of the literature but also enables comparison of the later research findings to the existing knowledge. Furthermore, the alignment of ESS and ESR would positively enable OA and higher level of ESS would result in higher level of ESR. Above all, we would like to test the moderating effect of environmental factors, particular, and the dynamism of the business environment on the relationship between ES technical competence with ESS, ESR and OA.

3.1 Enterprise system-enabled sensing capability

Neill et al. (2007) argue that organisations that possess a better capability to communicate relevant information between members of the decision-making team interpret their environment in a multidimensional way and analyse the information simultaneously by incorporating multiple perspectives will have a greater sensing capability and eventually become more agile. Furthermore, anticipatory capability, which refers to the ability to predict the way that the market is moving, can be an essential dimension of sensing capabilities (Day, 1994). Overall, the development of sensing capability requires organisations to continuously scan the business environment and capture business insights beyond the usual sources. Such capability can be developed by organisational technologies, processes, values, and norms that together generate knowledge about future condition (Sambamurthy et al., 2003). Based on the above logic, it is postulated that ES, as valuable resources, can be deployed as one source of capability building mechanisms to either directly or indirectly enable sensing capability. In this study, this construct is named Enterprise system-enabled sensing capability (ESS) and is defined as a dynamic capability which indicates the ability of an organisation to quickly and efficiently use its ES to digitize the process of sensing and develop strategic market foresight about its business environment. Thus,

Hypothesis 1: *ES-enabled sensing capability has a positive impact on organizational agility*

3.2 ES-enabled responding capability

Response capability is referred as a fundamental characteristic of an agile organisation and is used interchangeably with agility in some research (Christopher et al., 2004, Dove, 2005). Responsive capability and sensing capability allow organisations to generate knowledge of the business environment, and transforms that knowledge into action effectively (Gattiker et al., 2005, Haeckel, 1999). Responding capability is thus reflected by the change-enabling capabilities that are embedded in organizational processes (Li et al., 2008). Overby et al.(2006) suggest responding capability is directed by four fundamental capabilities: (1) production development capabilities to facilitate a firm's ability to embark on new ventures; (2) systems development capabilities to quickly and efficiently implement change to existing systems such as reusable service, SOA; (3) supply-chain and production capabilities to adjust existing ventures by shifting production to match a pending change in demand, such as high supply chain visibility; and (4) flexible resource utilisation to shift resources to areas of need to embark on new ventures or adjust existing ventures. Therefore, this study postulates that ES, as valuable resources, can be deployed as a source of responding capability building mechanisms. This construct is named ES-enabled responding capability (ESR) and is defined as an organisation's dynamic capability to deploy its ES resources and embed them in its production development, systems development, sup-

ply chain and production, and flexible resource utilisation strategies and processes to quickly and efficiently respond to changes. Thus,

Hypothesis 2: *ES-enabled responding capability has a positive impact on organizational agility*

3.3 Alignment between sensing and responding capabilities

The alignment between sensing and responding capabilities and its influence on OA is conceptually suggested in (Overby et al. 2006). The sensing and responding processes are inter-related and should be aligned. If organisations are unable to sense effectively, opportunities and threats remain unobserved and disregarded. This will limit the organisations' ability to take appropriate actions to respond to the opportunities and threats. Alignment between sensing and responding capabilities enables organisations to effectively capture business opportunities by optimising organisational resources (Overby et al., 2006). Moreover, the pressure of change on organisations varies and organisations have different levels of agility needs (Oosterhout et al., 2006, Sharifi and Zhang, 1999). Roberts and Grover (2012) propose and empirically test the model taking the matching perspective on the alignment of sensing and responding capabilities. However, their study tests on the relationship of the alignment of sensing capability and responding capability on competitive activity rather than on OA. Thus,

Hypothesis 3: *ES-enabled sensing capability is positively related to ESR*

Hypothesis 4: *Alignment of ESS and ESR positively influences organizational agility.*

3.4 ES Technical Competence

ES technical competence (EST) is defined as the ability of ES technical infrastructure to deliver and support rapid design, development and implementation of ES, and the ability to distribute any type of information across organisations. Two essential qualities of ES technical infrastructure are integration and adaptability (Sprott, 2000, Stratman and Roth, 2002). Integration refers to the establishment of a collaborative platform, which allows a free-flow of information internally within the organisation and externally with the IS of business partners (Seethamraju, 2014, Swafford et al., 2008). Thus, it supports sensing capability in terms of quickly capturing and analyzing of information to identify changes more efficiently. The adaptability of ES indicates the extent to which the ES can be easily (re)configurable or restructured in accordance with new conditions. EST enables system interoperability with other ES, which may be developed by other ES vendors, or special-purpose add-on systems provided by third-party vendors (Goodhue et al., 2009). This highly flexible ES infrastructure that allows add-ons and reconfiguration of the ES system when needed enables responsive capability.

Hypothesis 5: *ES technical competence has a positive impact on ES-enabled sensing capability*

Hypothesis 6: *ES technical competence has a positive impact on ES-enabled responding capability*

3.5 Environmental Dynamism

Organizations that operate in a dynamic environment require agility more critically than organisations that operate in a less turbulent business environment (Moitra and Ganesh, 2005). The level of environmental dynamism (ED) is dependent on both the sophistication of internal conditions and the turbulence of the external business environment (Oosterhout et al., 2006). However, existing discourses on IS and OA have overlooked the variation of ED from the nomological net of factors that explain OA. The dynamism factors can influence the level of agility required in an organisation (i.e., organizations operating in stable industries will require different level of agility to those who operate in a rapidly changing environment) (Tallon, 2008). The impacts of market-sensing activities on organizational performance vary with the degree of market turbulence (Eisenhardt and Martin, 2000), while ED also significantly requires faster strategic decision-making speed and thus greater responsive capabilities (Baum and Wally, 2003). Organisations operating in turbulent environments face higher uncertainty and therefore need to process information more rapidly than organisations that operate in more stable

business surroundings. ES centrally manage information flows within an organisation and across the organisation and its business partners. Therefore, the extent of ED is proposed to serve as a control variable on how ES can be used to achieve agility:

Hypothesis 7: *Organisations that operate in fast changing environments are more likely to develop high OA, high ESS and ESR than those that operate in a relatively stable environment.*

4 Research Method

4.1 Operationalization of constructs

This study adopts content analysis to draw inferences to address the domain specified above from an extensive review of the IS/ES and OA literature. Where possible, existing measurements of the constructs are adapted and used in this study. The survey questionnaire was examined through pre-testing and pilot test to improve the the instrument validity and reliability. In pre-testing, thirty-six academics who have studied the strategic impact of IS on business performance and ten senior practitioners who have skills and knowledge in using and implementing ES were invited as a panel of experts (PoEs) to give their opinions regarding the relevance of the items on the scale from 1 to 5 with 1 indicates not relevance while 5 indicates relevance of the items in measuring the respective construct. The pilot test was conducted via face-to-face discussion with 2 CIOs who had extensive experience working with ES. After analysing the feedback obtained from the pre-testing and pilot testing, some items were deleted and modifications were made upon the wording of the questions. The domains of constructs, definitions and items operationalizing the constructs are presented in the Appendix.

4.2 Data Collection

Data were collected based on an online survey from the 1400 CIOs or equivalently senior IT managers of medium or large Australian and New Zealand organisations which were randomly selected that have implemented and used an ES for more than a year. Organisations require adequate time to understand and measure the benefits brought about by ES implementation (Shang and Seddon, 2002). As such, this research focuses only on those organisations that have used an ES for at least a year so that ES benefits start to be realised from operational and managerial perspectives. The aim of the research is on organisational benefits of ES at the strategic level. Hence, top IT managers are the most suitable respondent because of their comprehensive knowledge of the organisation's IT issues as well as business performance. The final sample size consisted of 986 respondents after excluding 275 emails bounced back due to wrong address or change of position and 139 respondents requesting to be excluded in the research. Out of 224 responses received which made a response rate of 22.7%, 179 responses were included in the final dataset and retained as usable for this research after excluding 45 incomplete responses in a meticulous data cleaning process. This response rate is in line with the response rate for studies on senior IT managers in large organisations in literature.

5 Analysis and findings

The validation of the model against the data collected from the sample was analysed in two distinct steps. Step 1 involved assessing the validity and reliability of the measurement model using exploratory factor analysis (EFA). The second step involved building and testing the structural model validity using partial least squares (PLS).

5.1 Measurement validation

The result of the EFA indicates that there was a final instrument of 40 items operationalizing 7 factors. The factor patterns were as expected for all constructs, with most items loading highly on their theo-

rized factor affirming the unidimentionality and convergent validity of the constructs. OA construct consists of three subconstructs: customer agility (OA_C), operational agility (OA_O) and partnering agility (OA_P). All 7 constructs were defined as reflective constructs because the indicators are interchangeable in the questionnaires and have a common theme (Petter et al., 2007).

Convergent validity

To measure the significance, the research uses conventional method bootstrapping in PLS estimation (Chin, 1998). Table 2 summarises the results of the convergent validity evaluation for the constructs. The result shows that the indicators demonstrated acceptable reliability, with loadings above the recommended level of 0.7 and all the t-values were greater than the minimum threshold of 1.96 (0.05 significance level) indicating that the correlations between items within the constructs were significant.

Variable	Item	SFL	AVE	Construct Reliability	Cronbach Alpha	Variable	Item	SFL	AVE	Construct Reliability	Cronbach Alpha
OA_C	OA1	0.844	0.723	0.887	0.809		ESR7	0.761			
	OA2	0.838					ESR9	0.68			
	OA3	0.869					ESR10	0.691			
OA_O	OA4	0.71	0.612	0.887	0.84	ESR	ESR1	0.696	0.576	0.89	0.852
	OA5	0.778					ESR2	0.695			
	OA6	0.82					ESR3	0.768			
	OA7	0.83					ESR4	0.831			
	OA8	0.767					ESR5	0.777			
OA_P	OA9	0.85	0.731	0.891	0.816		ESR6	0.776			
	OA10	0.862				EST	EST1	0.793	0.6	0.923	0.905
	OA11	0.853					EST2	0.745			
ESS	ESS1	0.753	0.577	0.931	0.918		EST3	0.778			
	ESS2	0.737					EST4	0.762			
	ESS3	0.842					EST5	0.811			
	ESS4	0.801					EST6	0.791			
	ESS5	0.816					EST7	0.728			
	ESS6	0.722					EST8	0.785			
	ESS7	0.755									

Construct Reliability (0.6 or higher), AVE (0.5 or higher), SFL (0.5 or higher) SMC (threshold 0.3 or higher)

Table 2 Validity and reliability analysis of the first order measurement model

Construct reliability indicates good internal consistency reliability, with the CR values of all the constructs above the recommended critical value of 0.6. The Cronbach's alpha values are all greater than 0.7. The AVE values of all the constructs were greater than 0.5, confirming convergent validity. The results were all higher than the threshold value, which indicates that there is convergent validity in the first order constructs. The tests of validity and reliability for a second order factor follow the same process used to examine the validity of the first order factor (Chin, 1998). The latent constructs of the lower order latent constructs are considered as the indicators for one level higher order latent construct. Table 3 summarizes the results of the convergent validity evaluation on the second order constructs OA. In summary, all the dimensions to evaluate the convergent validity are higher than the threshold values, which confirms that there is convergent validity in the second order construct.

Variable	Item	SFL	t-value	AVE	Construct Reliability	Cronbach Alpha
OA	OA_C	0.791	24.191	0.645	0.899	0.876
	OA_O	0.910	62.435			
	OA_P	0.695	10.849			

Table 3: Validity and reliability analysis of the second order construct OA

Discriminant validity

For the first order constructs, discriminant validity was tested at both item and construct levels. At the item level, the results show that the item loadings are higher than the cross-loadings, confirming discriminant validity. At the construct level, the results in Table 4 show that the AVE values are greater than their respective squared correlations, which indicates good evidence of discriminant validity. To test the discriminant validity of the second order construct (OA), the square root of the AVE values is compared with the correlations among the constructs (see Table 5). The results in Tables 4 and 5 indicate good discriminant validity for all the constructs.

	ESR	ESR*ESS	ESS	EST	OA_C	OA_O	OA_P
ESR	**0.759**	0	0	0	0	0	0
ESR* ESS	-0.063	**0.527**	0	0	0	0	0
ESS	0.661	-0.114	**0.759**	0	0	0	0
EST	0.656	-0.129	0.658	**0.775**	0	0	0
OA_C	0.425	0.213	0.418	0.354	**0.851**	0	0
OA_O	0.492	0.239	0.438	0.443	0.586	**0.782**	0
OA_P	0.237	0.356	0.228	0.193	0.359	0.48	**0.855**

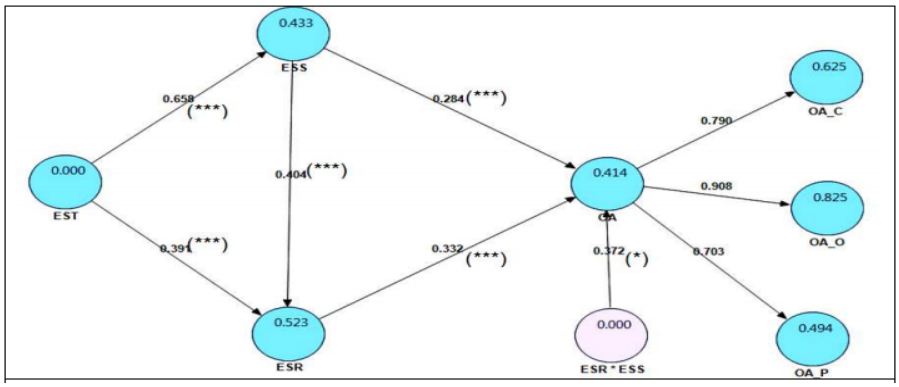
Table 4: First order latent construct correlation matrix

	ESR	ESR*ESS	ESS	EST	OA
ESR	**0.813**	0	0	0	0
ESR* ESS	-0.063	**0.81**	0	0	0
ESS	0.661	-0.114	**0.704**	0	0
EST	0.656	-0.129	0.658	**0.652**	0
OA	0.496	0.318	0.461	0.43	**0.701**

Table 5: Second order latent construct correlation matrix

5.2 Hypothesis tests

Since the dataset contains a number of abnormally distributed variables, this study uses PLS estimation (Wold, 1982) particularly with SmartPLS (Ringle et al., 2005) to build the structural equation model and test the proposed hypotheses. PLS does not require variables to be normally distributed (Chin, 1998).



***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 2. Structural model testing

The validity of a structural model is justified using three dimensions: variance explained (R2), the significance of all path estimates (β) and the effect size (f2) (Wetzels et al., 2009). The model R2 explains 41.4 per cent, 43.3 per cent and 52.3 per cent of the variance in OA, ESS and ESR respectively which all are classified as moderate (Chin, 1998). These results support the validity as well as utility of the structural model. The result of the hypothesis testing summarised in Table 6 indicates that all the paths are valid and fit for interpretation and the six main hypotheses (H1 to H6) were supported. The results of the standardised path coefficients show that except for H1 (β=0.284) and H2 (β=0.332) which indicate medium positive relationships, the other relationships (H3, H4, H5, and H6) are large (Cohen 1992).

Hypothesis	Relationship	β-value	Standard Error	t-value	p-value	Remark
H1	ESS->OA	0.284	0.092	3.090	p<0.01	**Supported**
H2	ESR->OA	0.332	0.087	3.832	p<0.01	**Supported**
H3	ESS->ESR	0.404	0.073	5.505	p<0.01	**Supported**
H4	ESS*ESS->OA	0.372	0.208	1.789	p<0.1	**Supported**
H5	EST->ESS	0.658	0.045	14.617	p<0.01	**Supported**
H6	EST->ESR	0.391	0.062	6.325	p<0.01	**Supported**

Table 6: Hypotheses testing results for the original model

The effect size f2 values shown in Table 7 indicate a small effect size for the constructs ESS (f2=0.134) and ESS*ESR (f2=0.113) and a medium effect size for the construct ESR (f2=0.152) on the overall model explanation power, indicating the utility of ESS and ESR to the model. This result confirms and further supports hypothesis H4.

Latent Varible	R2 Included	R2 Excluded	f 2	Result
ESS	0.414	0.245	0.134	Small
ESR	0.414	0.214	0.152	Medium
ESS*ESR	0.414	0.279	0.113	Small

Table 7: Effect size f^2 of latent variables

Hypothesis 7 postulates that ED acts as a control variable to the structural model. Organisations that operate in dynamic business environments are more likely to develop high OA and high ESS, ESR than those that operate in a relatively stable environment. Hypothesis H7 is thus restructured into three sub-hypotheses, from H7a to H7c. The model is re-estimated each time the moderating effect of ED is examined on a particular relationship (Table 8).

	Relationship	β	Std. Error	t	p	Remark
H7a	ED→OA	0.272	0.073	3.738	0	**Accepted**
H7b	ED→ESS	-0.001	0.064	0.001	0.999	Rejected
H7c	ED→ESR	0.141	0.058	2.444	0.015	**Accepted**

Table 8: Impact of Environmental Dynamism

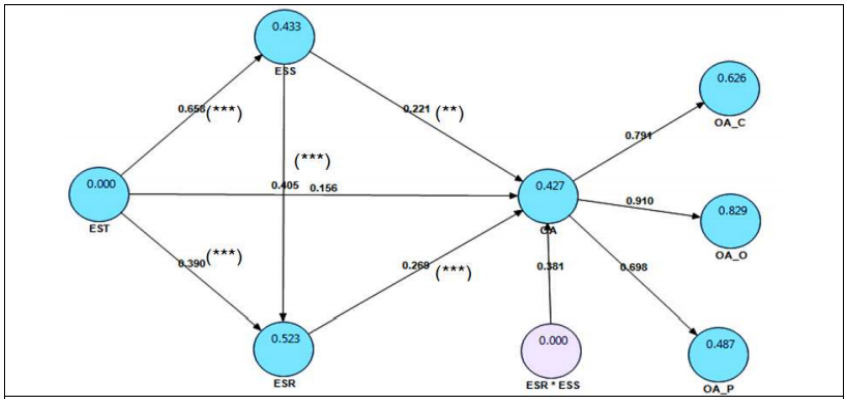
Latent Variable	R^2 Included	R^2 Excluded	f^2	Result
ED (on OA)	0.480	0.414	0.127	**Small**
ED (on ESS)	0.414	0.414	0.00	No effect
ED (on ESR)	0.414	0.414	0.00	No effect

Table 9:Effect size of environmental dynamism

ED is positively correlated with OA (H7a: β=0.272, p<0.001), ESR (H7c: β=0.141, p<0.05). However, the relationship between ED and ESS is not supported. The impact of ED on the framework is measured through its effect size. The effect size f2 values shown in Table 9 indicate a small effect of ED (f2=0.127) on the overall model's explanatory power. In summary, ED has positive and significant direct impact on OA but no effect on ESS, ESR suggesting that organisations operating in hyperactive environment tend to maintain higher level of OA than organisations operating in less dynamic environment.

5.3 Ruling out the rival model

We perform competitive analysis of the model which is derived from the alternative theory on the direct relationship of EST and OA.



***p<0.01, **p<0.05, *p<0.1; R^2 shown within each endogenous construct

Figure 3. Alternative model with direct impact of EST on OA

The structural model validation as shown in the Figure 3 above indicates that the hypothesis on the direct impact of EST on OA is not significant (β=0.156, t=1.424), hence, rejected.

6 Discussions

This study investigates on how ES impact on OA. It has provided several novel findings to the current body of knowledge. *Firstly*, the framework theorises an indirect relationship between ES and OA suggesting its value in explaining how OA can be achieved out of the available EST. Furthermore, the research findings reject the direct impact of ES technical competence on OA which implies that merely investment on technologies will not bring in improvement in OA unless the technologies are leveraged through its usage to develop ESS and ESR capabilities. A search of the IS literature produced no other published empirical research that has the same nomological structure; that is, independent and dependent variables linking EST, ES-enabled sensing and responding capabilities and OA. Therefore, the research can be considered as one of the first studies to conceptualise and empirically examine a research framework demonstrating why and how ES can be exploited to make organisations agile.

Second, the research results are aligned with the findings from previous studies that strategic use of IS competence can positively influence OA (Bhatt et al., 2010, Fink and Neumann, 2007, Tallon, 2008). Although most ES vendors, such as SAP and Oracle, are selling ES as a way to improve agility (Seethamraju, 2014, Tallon, 2008), the current research calls attention to the fact that agility is not entirely dependent on ES functions and technical features. Instead, organisations need to build post-implementation ES technical competences and develop their ability to exploit these competences to develop dynamic ES-enabled sensing and responding capabilities. In contrast to Carr (2003)'s prediction that IT would become a commodity and therefore carries no strategic value, this research provides empirical evidence that regardless of the prevalence of ES, developing EST and capabilities is essential to support OA, hence providing strategic value to organisations. IS such as ES evolves after their implementation through system upgrades (Srivardhana and Pawlowski, 2007), thus EST need to be maintained and developed.

Third, the finding on positive impact of EST on OA via ESS and ESR is in agreement with prior studies on the positive impact of ES on OA (Gattiker et al., 2005, Goodhue et al., 2009, Overby et al., 2006) while at the same time, it does not support the argument that ES inhibits OA from the other research (Newell et al., 2007). In particular, the finding validates the conceptual claim of (Overby et al. 2006) that sensing and responding are essential components of OA and ESS, ESR capability is positively related to the level of OA. It validates the argument of (David et al., 2003) that ES enables sensing capability by offering data accessing throughout the entire range of organisational activities. In particular, the results of the hypothesis testing confirm Sambamurthy et al. (2003)'s conceptual argument that the digitisation of knowledge and business processes will generate OA. This means that the

assimilation of ES in organisations provides knowledge reach by providing business intelligence to decision makers within different functional units across the organisation, and knowledge richness via interpreting business intelligence for different management levels. Additionally, the results add more empirical evidence to Goodhue et al. (2009) case study's finding that ES enables agility by providing data analytic capabilities to access and interpret non-standard data. Finally, the findings support Oosterhout et al. (2006)'s argument that agile organisations are required to be able to quickly filter information for potential changes that may have significant magnitude to decision makers.

Fourth, the research results support the IT-enabled capability perspective Tanriverdi (2005), which argues that IT capability acts as an enabler of higher order organisational capability in the organisation rather than as a higher order organisational capability itself. For example, Powell and Dent-Micallef (1997) find that IT resources have no effect on firm performance unless managers use IT to leverage complementary human and business resources such as flexible culture and supplier relationships. As validated from this research, EST shows no direct impact on OA, instead, the capabilities (i.e ESS and ESR) derived from EST enables OA.

Fifth, the ES-enabled sensing capabilities focus on the actual use of ES in providing a strategic view (predictability, environmental trends) of the business environment rather than basic knowledge management activities. The findings of this study suggest that organisations that excel in using ES in capturing business intelligence from various sources, interpreting it for different management levels, and providing it to decision makers within different functional units across the organisation while prioritizing the most important changes in the business environment, will be able to quickly sense changes in their business environment. Specifically, the use of ES to increase the accuracy of the information used by top management in making strategic decisions, generating new business strategies and empowering end users for taking actions in business operations emphasises the critical role of ES in providing a comprehensive view of the business environment at the strategic level. Likewise, the research findings suggest that organisations that have built ES-enabled capabilities and embedded them in their processes to bring new products or services to market faster than other competitors and to adjust the production volume of their products or services are able to quickly respond to market needs. Thus, this finding validates the conceptual argument of Christopher et al. (2004) that a short time to market, the ability to scale up (or down) quickly and the rapid incorporation of consumer preferences into the design process are typical characteristics of responsiveness.

Sixth, the development of two constructs ESS and ESR provides several implications for ES practitioners for the management of their organisation's ES-enabled capabilities. Organisations should institute a greater focus on assimilating ES into critical business processes that are required to respond to changes. It is not the ES, but the actual use of the ES, that create an ESR capability that is dynamic, renewable, and reconfigurable. The literature suggests that ES should be used to assist organisations in their collaborations with business partners when responding to changes via collaborative plan design, integrated information and business processes as well as shared IS.

Seventh, the hypothesis H4 testing suggested a significant and positive influence of the alignment of ESS and ESR on OA. The finding is consistent with the argument of Overby et al., (2006) and Roberts and Grover (2012) that an organisation with aligned sensing and responding capabilities will not waste their capabilities and perform at a higher level of agility than a non-aligned organisation. Nevertheless, in contrast to these studies, the current study treated ESS and ESR capabilities as antecedents of OA rather than considered them as two dimensions of OA and were not separated from the OA construct domain. On the other hand, the hypothesis H3 on the mediating impact of ESR on the relationship between ESS and OA confirms the findings of previous research that organisations sense opportunities and then respond accordingly based on a process (Haeckel, 1999, Seo and Paz, 2008). Therefore, ESS and ESR are interdependent, in that high levels of ESS will result in high levels of ESR. This result further reinforces the assumption that ESS should not be developed separately from ESR.

Eighth, this research finding supports the theory that dynamism factors can influence the level of agility required in by organisation (i.e., organisations operating in a stable industry with predictable chang-

es will require different levels of agility than those that operate in rapidly changing environments) (Oosterhout et al., 2006). This finding is consistent with the suggestions from the literature. For organisations operating in turbulent markets marked by rapid product obsolescence, short product lifecycles, high levels of customer turnover and price volatility, agility is a vital factor for a firm's survival (Oosterhout et al., 2006).

7 Contributions, Limitations and Conclusion

In IS research, OA has become an increasingly important topic due to the reliance of organizational operations on the management of information resources. This research study focuses on how ES impacts on OA. The model proposed in the research shows a good fit to the data, thus providing a rigor explanation on the indirect influence of ES technical competence on OA through the development of ES-enabled sensing capability and ES-enabled responding capability. The research contributes several implications toward academic IS research and practice.

In terms of theoretical contribution, the model proposed in the research addresses the IS research gap identified by Fink and Neumann (2007) and Lee et al. (2007) that there is a dearth of research exploring the internal mechanisms for deploying and utilising IT resources to enable OA. Further, this study's survey is a response to the call for empirical tests of the IS determinants of OA suggested by recent authors (Overby et al., 2006, Sambamurthy et al., 2003). As such, the research fills this missing link and provides a comprehensive view on how ES enables OA by adding two new constructs which are ESS and ESR.

In terms of contribution to practice, first, the study contributes to the management of ES as it reveals to ES practitioners that ES need not constrain agility. However, EST must be developed and maintained not only as the technical platform but need to be used in actual business processes. Secondly, this research provides the mechanism by which EST enable OA, and the factors to take into consideration in ES practice. Last, this research provides practitioners with a new perspective on measuring OA. This measurement method incorporates the organisation's agility capability and the importance of being agile to address the OA level relative to organisational strategic positioning. The method can be applied to regularly assess the requirements for agility and to incorporate the outcomes in designing appropriate strategy.

Despite the above contributions, the study has limitations that need be noted and taken into consideration as well as open avenues for further research. Firstly, the cross-sectional design of the empirical study using a survey only allowed this research to take a static snapshot of the EST, ES-enabled capabilities and OA of the sample organisations. Therefore, becomes a challenge to infer associations between the various constructs. A longitudinal research design could overcome this limitation. Possible changes in the relationships, if any, may be inferred by comparing the results between two points in time. Secondly, the current research only uses single respondent from each sample company. However, there is distinction between independent and dependent variables in the current study. The dependent variable (OA), which refers to the business performance of an organisation, would be best evaluated by business executives. The independent variables (ES competences) are most appropriately measured by IT senior executives who are well versed in organisational capabilities related to IT. Although statistically common method bias does not appear to threaten the validity of this study, a survey design that selects separately respondents for the independent and dependent variables may have reduced the potential for bias. Finally, in order to focus on explaining how the leveraging processes associated with EST may generate ES-enabled capabilities to enable OA, this research did not include self-learning aspects within the framework. Organisations learn over time and through experiences. Previous experiences help organisations deal with similar events in the future. Initial experiences with building ESS and ESR capabilities will influence the subsequent EST development. Sambamurthy et al. (2003) suggest that self-learning or feedback looping between the capability and outcome may be critical for sustainable OA. Therefore, the future research should investigate the reverse direction of the relationship between the constructs in the framework.

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Appendix: Constructs domain, description and operationalization

Domain	Construct	Items
Agility (Ahsan and Ngo-Ye 2005, Oosterhout et al. 2006, Sambamurthy et al. 2003, Tallon 2008)	OA	To what extent your organisation performs the following: Constantly look for opportunities to add value to our customers; Quickly respond to customers' needs; Continuously anticipate our customers' needs; Quickly adapt to changes from the market (i.e. regulation changes, technological innovations, cultural shifts, competitors' actions, etc); Quickly shorten the time–to-market of new products and/or services; Easily redesign existing business processes; Easily create new business processes; Easily launch new products/services; Easily switch between suppliers; Easily establish new supply chain partnerships; Easily change the type of resources that we acquire from our suppliers
Enterprise system enabled sensing capability (Day 1994, Narver et al. 2004, Overby et al., 2006, Slater, 2001)	ESS	To what extent your organisation's enterprise systems either facilitate or inhibit your organisation's ability to quickly and effectively perform the following: Capture business information from various sources (customer, competitor, supplier) to identify new business opportunities; Generate knowledge about the market (market trend, competitors' actions, regulation changes, cultural shifts, technology developments, etc); Interpret business intelligence for different management levels (i.e. strategic level, operational level); Notify the important changes in the business environment by analysing key performance indicators (KPIs); Provide business intelligence to decision makers of different functional units across the organisation; Develop real time visibility of demand in your supply; Examine trends in the data for the industry foresight
Enterprise system enabled responding capability (Dove 2005, Kohli et al., 1993, Overby et al., 2006)	ESR	To what extent your organisation's enterprise systems either facilitate or inhibit your organisation's ability to quickly and effectively perform the following: Bring new products/services to market faster than other competitors; Adjust the production volume of products/services; Create a high degree of process interconnectivity with trading partners; Collaboratively design plans with trading partners; Increase the accuracy of the data used by trading partners in making their planning decision; Simultaneously develop information systems with several supply chain partners; Increase the accuracy of information used by top management in making strategic decisions; Create a high degree of intra-organisational business process interconnectivity; Generate new business strategies; Empower end-users for taking actions in business operation

ES technology competence (Bharadwaj 2000, Fink and Neumann, 2007, Piccoli and Ives, 2005, Rav chandran, 2007, Stratman and Roth, 2002, Tallon, 2008)	EST	Our enterprise systems: Allow easy transformation of data among various databases; Are fully integrated with our legacy and in-house developed systems; Can easily be integrated with add-ons built by third parties; Are fully integrated with each other (for example CRM with SCM); Allows easy integration with our business partners' systems; Allow easy sharing of information with our business partners' systems; Are fully component based; Are highly adaptable to future requirements
Alignment ESS-ESR (Overby et al., 2006, Roberts and Grover, 2012, Seo and Paz, 2008)		The extent to which an organisation using ES senses only those opportunities that it can respond to and correspondingly respond only to those opportunities that it has sensed as important.
Environmental dynamism (Tallon, 2008)	ED	The rate of new product innovation in the industry; The speed of technology changes related to our organisation's products and/or services; The rate of change of customers' preferences; The rate of change of industry regulations