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Exploring the direct and mediating effects of intangible resources and capabilities in ERP project success

Mudiarasan Kuppusamy
Yi-Chen Lan
Stephen Teo

Abstract

Enterprise resource planning (ERP) system is well-acknowledged as one of the central technological infrastructure that facilitates business operations and growth in a dynamic business landscape. Adoption of the system however is mired with numerous problems, a well cited reality in multitude industrial and academic reports. In this research, we use the dynamic capabilities theoretical lens to investigate the direct and mediating effects of Malaysian service firms' capacity to build, integrate or reconfigure their governance, knowledge and relationship resources and its associated processes or routines (i.e. intangible capabilities) toward their ERP system implementation success. The Partial Least Square (PLS) estimation shows that the direct effect of relationship capability to ERP implementation is more ubiquitous and significant than knowledge and governance capabilities. The mediation effect shows that governance capability mediates and enhances the effects of knowledge and relationship capabilities toward effective ERP system implementation. The empirical result suggests that successful ERP implementation lie at the firms' capacity to integrate and reconfigure their intangible capabilities to create synergistic effects.

***Keywords**: Enterprise resource planning, dynamic capabilities, intangible capabilities, PLS*

1. Introduction

Global socio-economic milieu has been changing unprecedentedly in the past few years. Issues such as global warming, terrorism, health pandemics and financial crisis brings forth new challenges in the pursuit for economic prosperity. For an enterprise, the search for business opulence entails employment of varying strategies. Technology led growth policy has become one of the most popular stratagems in most enterprises around the globe. The term technology adoption is defined as use of information technology in support of business activities [1]. To this end, enterprise resource planning (ERP) system is one of the most widely used technologies in a business work system [2]. ERP is characterized as a tool that integrates diverse business processes, thus improving vertical and horizontal information flows in adopting firms [3]. Adoption of ERP

system by enterprises across the world has been spectacular. Research findings by [4] highlighted a significant rise in global ERP vendors' sales revenue by 14% in the year 2005. During this period, small sized enterprises (annual revenue of less than $30 million) seem to be the major adopters of the system (27% penetration rate), while large enterprises (more than $1 billion annual revenue) grew at 18% [4].

Despite the pervasive ERP adoption reports, there are also reports on ERP adoption problems and failures. Krumbholz et al. [5] for instance reported that ERP projects often overrun project budget by 178%, exceeds project schedule by two and half time longer and reaps just 30% of the anticipated business benefits. Further, Ragoswsky and Somers [6] highlighted that even long established and high profile companies such as Aerogroup, Boeing, Dell, Mobil and Foxmeyer have experienced significant ERP project implementation failure.

The ERP implementation failure cases gave rise to numerous academic publications exploring the reasons and strategies for successful ERP implementation. The extant of ERP literature have reported various organizational factors contributing to ERP project implementation failures [e.g. 7, 8, 9, 10]. Some of the commonly identified success factors are project teamwork and composition, monitoring and evaluation of performance and knowledge management [11]. While the pertinent organizational factors are identified, there seems to be little provisions on how these organizational factors need to be deployed and managed in order to heighten ERP project success. Such provision is important as adoption of 'a technology led business growth strategy' needs to be compensated by implementation of the technology on scheduled time, within budget [12] and targeted post-implementation usage [13]. A firm planning to adopt an ERP system needs to understand the adverse dimension of the system implementation that is entangled with non-completion within the targeted schedule, budget and non-acceptance by the intended users. Successful ERP implementation and usage may not only reside in possession of adequate and necessary firm resources but also entails the firm's ability to build, integrate and reconfigure their resources as and when needed to address inherent and unexpected problems. In short, ERP project is characterized by the dynamic relationships amongst various firm resources in accelerating and/or magnifying successful ERP implementation.

The rest of the paper is organized as follows. Section 2 presents a discussion on the theoretical background and the hypotheses developments. Section 3 highlights the research methodology while Section 4 discusses the results of the empirical estimations. Finally, Section 5 provides the conclusion, limitations and future research directions.

2. Theoretical background and hypotheses

The dynamic capabilities view as envisaged by [14] is enveloped within the resource based view of firm growth [15, 16]. The resource based view, rooted in the Ricardian economic

perspective, suggest that ownership of valuable, rare, inimitable and non-substitutable internal resources can assist firms in rent creation. Followers of the Schumpeterian economic perspective [e.g. 17, 18, 19, 20, 21] however criticized the resource based view as being static in nature as attainment of competitive advantage is proposed for one point of time only [22]. Such criticism led to development of the dynamic capability view.

The dynamic capabilities view is defined as 'firm's capacity to *deploy resources*, usually *in combination*, using *organizational processes* to achieve a desired end. They are information-based, *tangible or intangible processes* that are firm-specific and are developed over time through *complex interactions among the firm's resources*' [19, p.35]. The dynamic capability definition seems to have a clear segregation of the term resources and capability. As pointed by [23], a capability or the capacity to carry out organizational processes is inherent within a firm's work culture and practice, and not easily transferable to another party. Cease of the firm's operation would dissolve the existing capabilities [21]. An ordinary resource on the other hand is easily transferable, especially a tangible resource such as physical infrastructure. Cease of the firm's operation often entail a change of ownership of the resources.

Employment of the dynamic capabilities theoretical lens in the context of ERP is scarce. Much of the research works were focused on the role of tangible and intangible capabilities (such as IT infrastructure, human IT skills and relationships between IT department and others in an organization) towards business performance [24, 25, 26, 27, 28]. There exist studies that have linked the dynamic capabilities view with relationships [29] and knowledge capability [30] individually. Karimi et al. [31] are one of the first to use the dynamic capabilities view to examine the associations between of tangible (IT infrastructure) and collective intangible capabilities (i.e. relationships and knowledge capabilities) in ERP system implementation in a sample of US manufacturing firms. The authors found that knowledge, relationship and IT infrastructure mutually reinforces ERP building, subsequently leading to positive business process outcomes.

As at the time of writing this paper, we are not aware of any research that has exclusively explored the role and strength of intangible resources and its associated processes or routines toward ERP project success. To this end, we have focused on three intangible capabilities: governance, knowledge and relationships. We selected these three intangible capabilities on the following basis. First, technology adoption in current business landscape requires adherence and utilization of various governance mechanisms [32, 33]. As ERP is known to be a complex system that adheres to 'best-practices', facilitation of effective governance processes are essential to safeguard the system's reliability and success [32]. Thus, we are in the opinion that assessment of governance capability effects would indicate on the role and support of governance mechanisms in successful adoption of ERP system.

Second, one of the core functionality of an ERP system is to facilitate management of knowledge flows within the using firm [34]. The implementation process of an ERP system also

entails extensive knowledge creation, sharing and dissemination activities, both from external consultant to project members, as well from the project members to system users [35, 36]. In line with the suggestions provided in ERP- knowledge management intersection literatures [e.g. 37, 38], we argue that effective management of these knowledge are essential in ensuring successful ERP implementation. Third, implementation of a complex and time consuming ERP project requires strong cooperation and relationship building between all those involved in the project. Most critical success factor studies [e.g. 39, 40] have identified effective management of the cooperation and bonding amongst the ERP project members are essential for ERP success.

2.1 Hypotheses

One of the most enduring problems faced by organization undertaking innovative activities is governing their technology functionalities as well as the processes and activities pertaining to financial issues. Having a sound governance strategy will provide better monitoring and control mechanisms to achieve the intended goal as efficient as possible. In IS literature, the term 'governance' has been used to broadly describe the policies, structures, and processes involved in managing technological functions [41, 42]. Governance is perceived to be critical in the case of ERP implementation as it involves adaptation to the 'best practices' of global business operation standards [43]. Adhering to the best practices entails compliance to several standards, such as the Sarbanes Oxley Act (SOX), Section 302 (disclosure of internal controls), Section 404 (annual assessment of internal control effectiveness), Section 409 (disclosure to the public on material changes to firm's financial condition) and Section 802 (authentic and immutable record retention).

In recent years, new governance frameworks have emerged to induce greater control and adherence to best practices. In this context, the Control Objectives for Information Technology (COBIT), the Institute of Internal Auditors Research Foundation's Systems Electronic Security Assurance and Control – eSAC, and the IT Infrastructure Library – ITIL stands out [43, 44]. The literature recognizes the COBIT standard as one of the best governance standard for technology implementation [45, 46]. The COBIT standard governs most aspects of technology implementation good practices that a business must follow in order to reap expected pay-offs from technological investment [46]. Our perspective in this study is that successful ERP implementation requires effective coordination and deployment of governance mechanism that entails adherence to guidelines or standards such as COBIT and Sarbanes Oxley. Following this contention, we hypothesize:

H1: Governance capability has a direct effect in ERP implementation success

There is a growing interest on knowledge as a critical source of competitive advantage in the

literature [e.g. 47, 48]. Firms are giving significant attention on effective management of knowledge in undertaking innovative activities [49]. The importance of knowledge capability in ERP implementation has been explored in several studies [50, 51, 52, 36, 53]. While one of the primary aims for firms to implement ERP system is to improve knowledge sharing activities within the firm [36], ERP implementation requires effective knowledge management capability [34]. Successful ERP implementation requires engagement of a variety of expertise from both within and outside the firm, cross-functional and cross-divisional knowledge transfer [54]. Possession of skilled employees is also critical in ERP implementation [36] as their tacit and explicit knowledge will be valuable in the process of getting the system up and running [55].

Within the realm of this study, knowledge capability facilitates successful ERP implementation in the context of knowledge acquisition, conversion, transfer and dissemination [56]. An ERP project demand the adopting firm to acquire significant extent of knowledge from external parties such as the consultants and vendors. Proper acquisition of new knowledge is vital to ensure that the knowledge is utilized effectively. Further, throughout the system implementation process, new tacit knowledge will emerge through discussions, communication, and practice between various interested people. The emerging new knowledge needs to be converted into internal information to be used by all other parties, especially by the ERP project team and the end users. In addition, ERP implementation creates knowledge gaps due to different understanding or absorptive capacity between vendors, consultants, internal experts and end users. Firms need to ensure that ERP knowledge obtained is successfully transferred between these parties. Apart from transferring the knowledge, firms also need to have adequate processes to facilitate access to important and relevant knowledge. Effective management of organizational processes relative to these knowledge activities could become a conductive platform for successful ERP implementation. Hence, we propose:

H2: Knowledge capability has a direct effect in ERP implementation success

Relationships capability is defined as the ability to coordinate and engage communication and cooperation between IT and business groups [31]. Engagement of different parties, primarily the IT business unit and other management units also entails sharing of risk and responsibilities relative to ERP project. Good relationship is also about trust emerging through interactions between different people [57]. Effective implementation of technology is chiefly associated with the quality of relationship between different user/implementer groups [58]. Appreciation and understanding of different parties' environment can help to deliver expected IT implementation business value [59].

Apart from internal relationship (between people within the firm), successful technology implementation is also dependent on external partnership with vendors and consultants. This notion is vital in the context of ERP implementation as the project involves cooperation and participation of internal staffs as well as external people. Good relationship management ensures efficient

knowledge sharing and trust building between involved parties [26, 60]. Such commodity is not easily tradeable as it needs to be created upon trust and cooperation between different people within and outside the firm, and often involves a long period of time [31]. Organizational processes enabling relationship building and maintenance could play pertinent role in ERP implementation success. We thus propose:

H3: Relationships capability has a direct effect in ERP implementation success

Organizational capabilities (tangible and intangible) represent strategic framework that assist in successful completion of intended tasks [31]. Past studies highlights that firms' organizational capabilities that mutually reinforce each other will generate better opportunity to outperform competitors than firms that focus exclusively on individual capability [27]. Successful completion of complex projects often requires significant collaboration of different capabilities in synch [61, 62, 63]. Studies by Powell and Dent-Micallef [64], Ray et al. [63] and Ravichandran and Lertwongsatien [58] for instances have found that complementarities between different capabilities such as IT, human resource and shared knowledge contributes significantly to firm performance. Karimi et al. [31] argued that organizational capabilities with mutually reinforcing effects can have a combined impact on successful ERP system implementation. This is because complementarities between different organizational capabilities create significant synergies, thus becoming a critical enabler for achieving desired business goals [28]. Following a similar line of argument, we theorize that the co-presence of the three intangible capabilities would complement or mediate one another, leading to a greater effect toward successful ERP project. Hence, we propose:

H4: The three intangible capabilities complement or mediate the effects of one another in ERP implementation success

2.2 Research model

The above proposed research hypotheses depicts path analyses for direct and mediating effect models. The direct effects of governance capability (GC), knowledge capability (KC) and relationships capability (RC) on ERP implementation is graphically represented in Figure 1. The mediating effect (i.e. the assessment of Hypothesis 4) will be evaluated by running a series of tests to identify the optimum mediating paths between the different constructs (that will be determined from the statistical strength of the tested paths). The research model that represents such analysis is given in Figure 2 (The dotted line indicates the mediating paths).

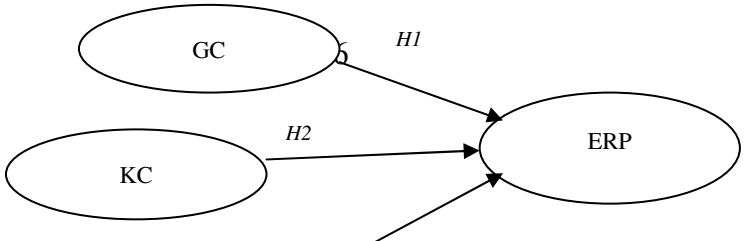

Fig 1: Direct effect model in support of H1, H2 & H3

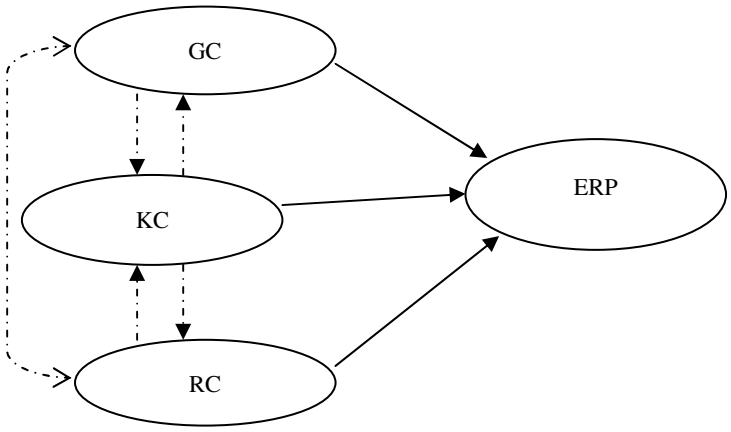

Fig 2: Mediating effect model in support of H4

3. Methodology

A field survey of 488 service firms operating in Malaysia was conducted to test the research model. The sampling frame was obtained from a local ERP consulting agency. The primary respondents were senior executives in each firm. The prospective respondents were first sent pre-notification email regarding the survey and telephoned two weeks later to solicit participation. Four hundred firms indicated voluntary participation in the study. The survey questionnaire was mailed to the 400 firms in March 2009, with 90 firms responding to the survey, representing a response rate of 22.5% (90/400).

3.1 Construct Operationalization and Scale Development

All the constructs in this study was measured using multi-item, five point Likert scales. The

knowledge scales were referenced from Karimi et al. [31], while the relationships scales were adopted from Stratman and Roth [65]. The governance scales were developed upon several guiding literatures and further refined through a series of interviews with a group of experts consisting of three senior ERP consultants, four managing directors of service enterprise and three ERP project leaders. The dependent variable, ERP, comprised of three items: the geographical scope of ERP implementation, the functional scope of ERP implementation and the operational scope of ERP implementation. These items were adopted from Karimi et al. [31]. Table 1 provides an overview of the key constructs and their final measures.

Table 1: Overview of key constructs and associated measures

Construct	No of items	Items	Representative or guiding references
Knowledge	5	1. Knowledge sharing between departments 2. Project management tools & techniques 3. Engagement of capable and experienced project champion 4. Engagement of experienced consultants 5. Transfer of ERP technical knowledge to project team	Karimi et al. [31]
Governance	5	1. IT infrastructure auditing 2. Operational and financial risks review 3. IT security review 4. Unauthorized access to firm's knowledge 5. ERP project's financial budgets	Benroider [32], Control Objectives for Information Technology (COBIT)
Relationships	5	1. Employee acceptance for ERP system adoption 2. Employee involvement in ERP project 3. Relationship between ERP project team members 4. Interactions between consultants and project team members 5. Relationship with our suppliers and clients	Stratman and Roth [65]
ERP	3	1. Geographical scope of implementation: single site; multiple sites; national; worldwide 2. Functional scope of implementation: Accounting/Finance; Manufacturing; Planning;	Karimi et al. [31]

		Human Resources; Sales & Distribution; Logistics; Others 3. Operational scope of implementation: Department; Division; Entire company; Multiple companies	

4. Results

In order to evaluate the appropriateness of the measurement models for the latent constructs, we leveraged on the recommendations provided by Fornell and Bookstein [66] and employed the Partial Least Square (PLS) modeling approach. PLS was chosen over other structural modeling procedures due to the following reasons. First, the ordinary least squares characteristics inherent within PLS suits well to an exploratory research such as the present study. Second PLS is appropriate in research using new or modified measures. In this study, the governance capability measures were newly developed based from the literature. Third, PLS conducts simultaneous analysis for both the measurement model and the structural or theoretical model. In our study, governance (GC), knowledge (KC) and relationships (KC) capabilities are reflective while ERP is a formative construct comprised of three items.

4.1 Test for common method effects

In this study, we relied upon single respondents from each sample firm to inform on the sought information. Such an approach often constitutes risk of common method biasness [67]. To test for existence of such risk, we employed the Harman single factor evaluation method developed by Podsakoff and Organ [68]. This technique specifies that the individual measures for each construct be loaded into an exploratory factor analysis to identify if the first extracted factor accounts for the majority of the variance amongst all measures [69, p. 228]. If all measures converge into one single dimension, common method bias will be a concern in this study. The single factor test using EFA produced three factors with eigenvalues of more than one. This implies that the presence of common method risk is immaterial in this study.

4.2 Descriptive statistics

The majority of the responding firms represent a variety of industries including financial services, telecommunications, engineering services and IT services. Most of the firms are in business for less than 5 years (56%) with an earning capacity of less than USD200, 000 per annum (53%). Close to 54% of the firms indicated spending an average of USD1.5 million for the ERP project, with a majority of them implemented the software in less than a year (53%).

4.3 Measurement model assessment

In accordance to PLS protocol [70], the robustness of the reflective measurement scales was evaluated by:

a. Assessing the convergence of the scales, with the factor loadings higher than 0.70
b. Measuring the internal consistency of the reflective scales by looking at the composite reliability value higher than 0.60.
c. The average variance extracted (AVE) higher than 0.50 threshold.
d. The discriminant validity of the model. This is done by computing the square-root of the AVE value. If the computed value (AVE^2) is above the correlation values, then the latent variables are statistically valid.

Table 2 and 3 presents the measurement model assessment outcomes for direct effect model while Table 4 and 5 show the outcomes for mediating effect model. The results shown in these tables suggest that the convergence of the scales used in the study is valid as all the factor loadings are above 0.70 in both models. A similar scenario is seen for the internal consistency (composite reliability higher than 0.60) and higher than 0.50 AVE values. The discriminant validity of both measurement models is also satisfactory.

Table 2: Convergence, Internal Consistency Assessment and AVE for Direct Effect Model

Construct	Final items	Valid Scales	Factor loading	Composite Reliability	AVE
KC	2	Q2. Project management tools & techniques	0.76	0.74	0.58
		Q5. Transfer of ERP technical knowledge to project team	0.77		
GC	2	Q2. Operational and financial risks review	0.78	0.71	0.55
		Q4. Unauthorized access to firm's knowledge	0.70		
RC	3	Q2. Employee involvement in ERP project	0.78	0.85	0.65
		Q3. Relationship between ERP project team members	0.84		
		Q5. Relationship with our suppliers and clients	0.79		

Table 3: Discriminant Analysis for Direct Effect Model

Construct	1	2	3

Knowledge capability	**0.74**		
Governance capability	0.63	**0.76**	
Relationship capability	0.29	0.26	**0.80**

Table 4: Convergence, Internal Consistency Assessment and AVE for Mediating Effect Model

Construct	Final items	Valid Scales	Factor loading	Composite Reliability	AVE
KC	2	Q2. Project management tools & techniques	0.64	0.71	0.55
		Q5. Transfer of ERP technical knowledge to project team	0.67		
GC	2	Q2. Operational and financial risks review	0.81	0.73	0.58
		Q4. Unauthorized access to firm's knowledge	0.66		
RC	3	Q2. Employee involvement in ERP project	0.84	0.84	0.64
		Q3. Relationship between ERP project team members	0.80		
		Q5. Relationship with our suppliers and clients	0.76		

Table 5: Discriminant Analysis for Mediating Effect Model

Construct	1	2	3
Knowledge capability	**0.74**		
Governance capability	0.66	**0.76**	
Relationship capability	0.33	0.25	**0.80**

4.4 Structural model assessment

The structural model designed in this study is evaluated using three criterions:

(a) The R^2 of the model. Chin [70, p. 323] suggested that R^2 of 0.67, 0.33 and 0.19 represents substantial, moderate and weak structural model, respectively.

(b) The estimates of the path coefficients need to be statistically significant and done using the bootstrapping procedure.

(c) We also evaluate the t^2 for the effect size. Effects size of 0.02, 0.15 and 0.35 indicates a weak, medium or large effect of the predictor latent variable on the structural model, respectively. This estimation will be done for the mediating model only.

The R^2 of the direct effect model is 0.215, representing a weak structural model. The bootstrapping procedure for this model (refer to Table 6) implies that structural link emerging from GC → ERP is not statistically significant (*β = 0.13; t = 0.78*). The result suggests that the hypothesis of governance capability having a direct effect to ERP implementation success is not supported (H1). A similar result is observable for the path relationship between KC → ERP (*β = 0.12; t = 1.59)*, indicating rejection of H2. The RC on the other hand has a positive and significant structural link with ERP (*β = 0.33; t = 5.73; p< 0.001*), thus H3 is supported.

Similar to the direct effect model, the R^2 of the mediating effect structural model is also weak (0.205). Estimation of the mediating model involved several tests to identify the optimum mediating path relationships between the three intangible capabilities. We found that the structural link emerging from GC to the other two capabilities to be the best achievable outcome. Such decision is supported by the measurement of this path's large effect size of 0.35, which was computed based on the formula: (R^2 *included* – R^2 *excluded*) / (1-R^2 *included*) [71].

As shown in Table 6, there is a significant structural path emerging from GC to KC (*β = 0.66; t = 13.73; p< 0.001*), which reinforced KC's significant effect toward ERP (*β = 0.19; t = 3.57; p< 0.05*). In the direct effect model previously, KC had no significant effect toward ERP implementation success, but mediation caused by GC seems to have a different effect. GC has a significant link with RC (*β = 0.33; t = 3.48; p< 0.001*). The effect of RC toward ERP is significant (*β = 0.36; t = 5.67; p< 0.001*), although the strength is marginally lower than RC's individual effect on ERP. These results suggest that H4 is supported. The final mediating research model based upon the estimations is shown in Figure 3.

Table 6: The structural path model results

Paths hypothesized relationships:	Direct model	Mediating model
	R^2 = 0.22	**R^2 = 0.21**
GC → ERP (H1)	0.13 (1.78)	NA
KC → ERP (H2)	0.12 (1.59)	NA
RC → ERP (H3)	0.33 (5.73)***	NA
GC → KC; KC → ERP (H4)	NA	0.66 (13.73)*** 0.19 (3.57)***
GC → RC; RC → ERP (H4)	NA	0.33 (3.48)*** 0.36 (5.67)***

*Note: *** p < 0.001*

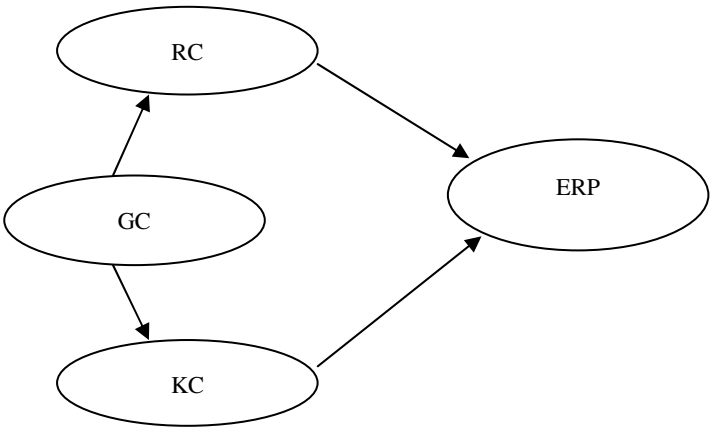

Fig 3: Final mediating model in support of H4

5. Discussion and conclusion

Enterprise resource planning (ERP) system is well-acknowledged as one of the central technological infrastructure that facilitates business operations and growth in a dynamic business landscape. Adoption of the system however is mired with numerous problems, a well cited reality in multitude industrial and academic reports. In this research, we use the dynamic capabilities theoretical lens to investigate the direct and mediating effects of Malaysian service firms' capacity to build, integrate or reconfigure their governance, knowledge and relationship resources and its associated processes or routines (i.e. intangible capabilities) toward their ERP system implementation success. The Partial Least Square (PLS) estimation shows that the direct effect of relationship capability to ERP implementation is more ubiquitous and significant than knowledge and governance capabilities.

The mediation effect shows that governance capability mediates and enhances the effects of knowledge and relationship capabilities toward effective ERP system implementation. The empirical results in this study suggest that achieving successful ERP implementation lie at the firms' capacity to integrate and reconfigure their intangible capabilities to create synergistic effects.

More precisely, in the context of this study, effective management of governance processes relative to operational and financial risks and access to firm knowledge, are important to complement and strengthen relationship management processes between employees, project team members and suppliers and clients. Governance mechanism also reinforces the effectual utilization of project management tools and techniques as well as knowledge accumulation and sharing routines for the ERP project.

The findings of this research have both theoretical and practical contributions. Theoretically, this research is amongst the first to use the dynamic capability lens to explore the individual and combined effects of different intangible resources and its associated processes or routines toward ERP system implementation success. In line with this theory, the results imply that successful ERP adoption is not reliant on exploitation of any one particular firm resource per se. Such a '*static'* technology management practice may not be relevant in the context of a complex and multi-facet system such as ERP. Successful implementation of the system requires a dynamic management focus that leverages on the co-presence and integration of key intangible resources with reinforcing characteristics. A '*non-static'* management approach could strengthen the strategic impetus of leveraging on advanced technological applications such as ERP, to gain improved and sustained business performance.

From the practical standpoint, this study highlights the importance of the processes or routines related to governance, knowledge and relationships, in successful ERP implementation. Service firms adopting ERP system would need to focus and build upon stringent governance mechanism for other intangible resources to play effective role. Without sound governance mechanism, the relationship and knowledge accumulation and sharing activities may not work well, thus leading to poor or failed ERP system implementation.

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