Influence of Cloud Platform Utilization on Project Success: Moderating Role of Project Team Size

Li-Ren Yang

***Abstract*—Conceptualizing implementation of cloud platform in the project management context is still rudimentary. The primary objective of this study is to examine the moderating role of project team size in the relationship between innovation capabilities and project and market performance. This study empirically investigated a sample of projects in the Taiwanese industry. The structural equation modeling (SEM) approach was used to validate the research model. In testing the moderation effect, a multiple-group analysis was used. The results show that project team size has a moderating effect on the relationship between innovation capabilities and performance outcome.**

***Index Terms*—Cloud platform, customer relationship management, innovation capability, project management.**

I. Introduction

Due to the increasing importance of IT in product development settings, a number of studies have paid attention to examine the effect of IT on the performance of new product development (NPD). Prior research suggested a positive relationship between the use of particular IT tools and time to market [1]. Some previous studies on the use of IT tools found that IT utilization may not contribute to time to market [2]. Moreover, Kessler and Chakrabarti [3] contended that IT tools have a negative effect on time to market. However, Barczak *et al*. [2] has shown that a positive relationship exists between IT adoption and market performance. This lack of clear evidence regarding the business value of IT may be why the usage of IT, particularly for business processes such as NPD, appears limited [4].

On the other hand, the literature supports IT adoption as a means to create competitive advantage for firms and IT application may positively relate to organizational performance [5]. However, while some researchers promoted the adoption of IT practice and argued that IT has improved firm's performance significantly, others found that IT does not provide benefits for firms.

Several scholars have emphasized the need for better theoretical models that trace the path from IT investment to business value [6]. IT is not simply a tool for automating existing processes, but is more importantly an enabler of organizational changes, such as in communication and coordination, that can lead to improve firm's performance [6].

Innovations in technology have changed the way new product development activities are performed. Cloud computing is one of the most popular trends in information technology. It is the latest paradigm of information technology and substantially influences the IT landscape. In the wake of the economic slowdown, organizations are increasingly looking for ways to do more with the same resources; articulate differently - to make every penny, input and contribution count [7]. In such situations, cloud computing is becoming increasingly important in gaining and maintaining a competitive edge [7]. Thus, cloud-based information management platform is the new way to create new business processes, to enhance the base of knowledge available to a NPD team, and to improve coordination, communication, and cooperation among team members. Rather than implementing expensive and complex software on-site, the cloud-based information management platform runs in the cloud. Cloud platform enables convenient and on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [8].

Previous studies implied that project team size plays an important role in the relationship between innovation capabilities and the outcomes of NPD [9]. Thus, the objective of the study is to assess the moderating role of project team size in the relationship between innovation capabilities and NPD performance.

II. Literature Review and Research Hypotheses

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. Cloud computing customers do not own the physical infrastructure. They can avoid capital expenditure by renting usage from a third-party provider. They pay only for resources that they use. Cloud computing is the latest paradigm of IT. IT can be defined as "those technologies engaged in the operation, collection, transport, retrieving, storage, access presentation, and transformation of information in all its forms" [10]. Additionally, IT adoption is defined as application of Information and Communication Technologies (ICT) tools including computer hardware, software, and networks required for connecting to the internet [11]. The infusion of information technologies in product development has raised the importance of IT in NPD [12]. IT has been widely recognized important to organizational performance. In addition, previous research evaluated the effects of IT on intermediate business processes. Hammer and Champy [13] argued that IT influences firm level performance variables via intermediate process variables. Ray *et al*. [14] also

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suggested that impact of IT can be measured only through the intermediate level contributions. In addition, Barua *et al.* [15] found that the impact of investment in IT is captured at lower organizational levels by intermediate variables and then, in turn, affects output measures.

Innovation capability is an intermediate process between IT and performance outcome. Innovation is defined as "any idea practice or object that is perceived to be new by an individual or other unit of adoption" [16]. Innovation capability refers to the implementation or creation of technology as applied to systems, policies, programs, products, processes, devices, or services that are new to an organization [17]. It is the ability of firms to assimilate and utilize external information for transfer into new knowledge [18]. Innovation is a multi-dimensional concept where manufacturers focus on product, process, and service to implement gradual modification [19]. Crossan and Apaydin [20] identified two dimensions of innovation: innovation as a process and innovation as an outcome. Innovation as a process considers where the innovation process takes place, what are the internal and external drivers of innovation, and what are the sources of innovation [21]. In addition, innovation as an outcome focuses on the type of innovation, the magnitude of innovation (radical or incremental), and the referent (firm, market, industry) used to assess the degree of novelty [21]. On the other hand, innovation capability is composed of technical innovation and administrative innovation [22]. Technical innovations refer to products, marketing, services, and the technology used to produce products, product sales, or render services directly related to the basic work activity of an organization [23]. Moreover, administrative innovation pertains to organizational structure and administrative processes, indirectly related to the basic work activity of the organization and is more directly related to its management [23].

While innovation capability is an intermediate process between IT and performance outcome, customer relationship management plays an important role in innovation capability. Customer relationship management (CRM) is defined as "activities that manufacturers practice for understanding customer demands and improving customer satisfaction" [24]. It is an enterprise approach to developing full knowledge about customer behavior and preferences and to developing programs and strategies that encourage customers to continually enhance their business relationship with the company [25]. CRM process can be divided into initiation, maintenance, and termination from the perspective of process [26]. On the other hand, CRM content pertains to various activities to improve customer relationships. Moreover, CRM involves activities that manufacturers practice to satisfy customer needs, identify customer preferences, resolve customer complaints, provide after-sale service, and establish long-term relationships with their customers [27].

The moderating effect of project size has been reported in the literature, in particular, the moderating effect of project size on the relationship between practice use and project performance. According to Pheng and Chuan [28], the size of a project affects the complexity of the project. In the literature, project complexity seems to have a direct and moderating impact to project success [9]. Evidence also suggests that a large project usually involves multiple contracts, suppliers, outside agencies, and complex coordination systems and procedures. In addition, availability of facilities, expertise, resources, and management know-how are a few potential sources of risks associated with large projects [28]. In a large project, the complex coordination between the sub-projects is itself a potential risk, as a delay in one area can cause a ripple effect in other areas [28]. Large projects may have a different set of rules and guidelines from those of smaller and simpler projects [29]. In addition, resource constraints may increase the difficulty in managing large projects because the rescheduling and coordination of the resources could create potential problems in project success [28]. Hence, the size of a project affects the complexity of the project, which in turn, adversely affects project success. The literature also implied that the impact of innovation capability on new product performance becomes weaker for large projects [30]. This study extends previous research by addressing the moderating effect of project team size on the relationship between innovation capabilities and NPD performance. Therefore, it is hypothesized:

H: The association between innovation capabilities and NPD performance will be more strongly evident for small project teams.

III. Methodology

A. Research Instrument

The survey instrument was developed to measure implementation of cloud-based information management platform and new product development performance in the Taiwanese industry. Study participants were first asked to identify a recent project that they were familiar with for assessment. The survey was composed of five sections: 1) cloud platform implementation, 2) customer relationship management, 3) innovation capabilities, 4) project and market performance, and 5) project and personal information.

B. Sampling Method

Individuals interested in participating in the study were identified by a search from various industry associations. A survey of NPD projects was conducted in the Taiwanese industry. The data collection tool was developed to collect project-based data. The targeted respondents were identified as the senior individuals who were familiar with implementation of cloud platform, customer relationship management, innovation capabilities, and project performance. In order to obtain a truly representative sample, the geographic mix of projects was intentionally diverse. Additionally, a specified mix of project type was targeted in order to obtain a representative sample of the industry.

All of the companies were contacted via phone or email to identify the person involved in projects by name and title. The investigators then contacted the respondents to confirm their participation in this study. This approach helped the investigators select the right respondents who possess adequate knowledge to properly evaluate the subjective

project and are capable of answering all of the survey questions. Project responses were collected via paper and online surveys. The projects were examined to ensure that no duplicate project information was collected. Table I presents characteristics of sampled projects. In addition, profile of respondents is shown in Table II.

TABLE I: CHARACTERISTICS OF SAMPLED PROJECTS

Characteristic	Class	Number	Percent
Industry sector	Optoelectronics	32	11.3
Industry sector	Consumer electronics	92	32.4
Industry sector	Communication equipment	112	39.4
Industry sector	Computer hardware and peripheral	48	16.9
Product newness	New innovations	120	42.3
Product newness	New product lines to the firm	52	18.3
Product newness	Line extensions	92	32.4
Product newness	Improvements/revisions to existing products	20	7.0
Number of team members	5-10	56	19.7
Number of team members	11-15	52	18.3
Number of team members	16-20	52	18.3
Number of team members	21-25	24	8.5
Number of team members	26-30	16	5.6
Number of team members	>30	80	28.2
Number of team members	Not available	4	1.4
Percent of company revenue on marketing	<1%	12	4.2
Percent of company revenue on marketing	2-3%	28	9.9
Percent of company revenue on marketing	4-5%	68	23.9
Percent of company revenue on marketing	6-10%	88	31.0
Percent of company revenue on marketing	11-15%	52	18.3
Percent of company revenue on marketing	16-20%	32	11.3
Percent of company revenue on marketing	>20%	4	1.4
Percent of company revenue on R&D	<1%	4	1.4
Percent of company revenue on R&D	2-3%	24	8.5
Percent of company revenue on R&D	4-5%	60	21.1
Percent of company revenue on R&D	6-10%	76	26.8
Percent of company revenue on R&D	11-15%	96	33.8
Percent of company revenue on R&D	16-20%	8	2.8
Percent of company revenue on R&D	>20%	16	5.6

TABLE II: PROFILE OF RESPONDENTS

Variable	Category	Number	Percent
Role in NPD	Marketing	76	26.8
Role in NPD	R&D	120	42.3
Role in NPD	Supervision	44	15.5
Role in NPD	Analysis	44	15.5
Age	26-30	64	22.5
Age	31-35	76	26.8
Age	36-40	104	36.6
Age	41-45	32	11.3
Age	>45	8	2.8
Education	Associate's degree	40	14.1
Education	Bachelor's degree	164	57.7
Education	Master's degree	64	22.5
Education	Ph.D. degree	8	2.8
Education	Not available	8	2.8
Position	Managers/deputy manager	24	8.5
Position	Assistant manager	12	4.2
Position	Director	80	28.2
Position	Specialist	76	26.8
Position	Engineer	92	32.4

C. Survey Design and Measurement

Multi-item scales were developed for each of the variables included in the theoretical model. The items used to measure implementation of cloud platform were based on Cooper and Kleinschmidt [31]. This study evaluates implementation of cloud platform in six important areas: product idea, preliminary assessment, conceptual design, product development, product test, and mass production. On the other hand, the scales developed by Lin *et al*. [32] were adapted to evaluate customer relationship management and innovation capabilities. This study focuses on the three most important types of CRM activities in NPD: joint problem solving, long-term partnership, and customer involvement. In addition, this study examines the four most important innovation capabilities in NPD: product innovation, process innovation, administrative innovation, and marketing innovation. Questions from Atuahene-Gima [33] were adapted to measure new product development performance, including market performance and project performance. The survey used these items because the literature and recommendations of five NPD practitioners have shown that these items are closely linked to new product development projects. Each item was rated on a 7-point scale, where 1 represented strongly disagree and 7 represented strongly agree.

D. Content Validity

Content validity refers to the extent to which a measure represents all facets of a given concept. The content validity of the survey used in this study was tested through a literature review and interviews with the five NPD practitioners. The refined assessment items were included in the final survey. Finally, copies of a draft survey were also sent to three professors in the NPD discipline to pre-test for the clarity of questions. Their insights were also incorporated into the final version of the survey.

IV. RESULTS AND ANALYSIS

A. Measurement Model Test Results

Prior to estimating the structural model, a confirmatory

factor analysis (CFA) was conducted to verify the measurement model. Multiple fit criteria were used to assess the overall fit of the model. In the proposed model, implementation of cluster platform, customer relationship management, innovation capabilities, and NPD performance are a second order construct. The data were analyzed using the AMOS/SPSS statistical package. The model refinement was performed to improve the fit to its recommended levels. Based on several trials resulting in elimination of some of the items, all of the scales met the recommended levels. Furthermore, the composite reliability for all constructs was above the 0.7 level, indicating adequate reliability for each construct. Thus, the results provide evidence that the scales are reliable.

All of the factor loadings are statistically significant at the five percent level and exceed the 0.5 standard. In addition, all constructs have an average variance extracted (AVE) greater than 0.5. Thus, these constructs demonstrate adequate convergent validity. Discriminant validity evaluates whether the constructs are measuring different concepts. The procedure requires comparing the set of models where each pair of latent constructs has a constrained correlation of one with the correspondent models where such pairs of constructs are freely estimated. The results show that the chi-square values are significantly lower for the unconstrained models at the five percent level, which suggests that the constructs exhibit discriminant validity.

B. Testing the Moderating Effects of Project Team Size

Hypothesis was concerned with the moderating effects of project team size on the relationship between innovation capabilities and NPD performance. In testing the moderation effect, a multiple-group analysis within AMOS was used. In order to evaluate the significant effect of the moderator, a two-stage procedure was undertaken. First, the parameter linking innovation capabilities and NPD performance was estimated simultaneously for the two subgroups (team members $\leqq 20$ and team members > 20). The resulting model is commonly referred to in the literature as the "baseline" or "unconstrained" model as the estimate of the direct path was allowed to differ across two subgroups [34]. In the second estimation, the parameters were constrained to be equal across groups [35]. The second model is referred to as "constrained" model in which subgroups was specified as invariant [35]. The goodness of fit statistics indicated an acceptable fit for the models (see Table III). To evaluate the chi-square difference between the "baseline" and the "constrained" models, comparison was made between the two models. Table IV indicated that project team size significantly moderates the relationship between innovation capabilities and NPD performance ($p < 0.01$).

Interestingly, the regression weight was significant and in the expected directions ($\beta = 0.509$, $p < 0.001$) for projects with more than 20 members (i.e., large project teams), whereas the link between innovation capabilities and NPD performance was also significant ($\beta = 0.961$, $p < 0.001$) for those with fewer than 20 members (i.e., small project teams). Although both the regression weights were significant, the regression weight for small project teams ($\beta = 0.961$) is substantially higher than that for large project teams ($\beta = 0.509$). This finding suggests that the link between innovation capabilities and NPD performance is moderated by project team size. Thus, it can be concluded that hypothesis was confirmed and accepted. It is evident that innovation capabilities have stronger effects on NPD performance for small project teams compared to large project teams.

TABLE III: GOODNESS OF FIT STATISTICS FOR BASELINE AND CONSTRAINED MODELS

Model	χ^2	*df*	NFI	CFI	RMSEA
Baseline	397.452	46	0.916	0.927	0.068
Constrained	407.267	47	0.908	0.919	0.071

TABLE IV: CHI-SQUARE DIFFERENCE TESTS FOR THE MODERATING EFFECT

Baseline model		Constrained model		Chi-square difference test		
χ^2	*df*	χ^2	df	$\triangle\chi^2$	$\triangle df$	*p*
397.452	46	407.267	47	9.815	1	< 0.01

V. CONCLUSIONS AND DISCUSSION

A. Major Findings and Research Implications

According to the data analysis results, the influence of innovation capabilities on NPD performance increases in small project teams, due to the moderating effect of project team size (the hypothesis is supported). The moderating relationship is in line with previous findings [30]. In other words, the influence of innovation capabilities on NPD performance, for small project teams, is more than the same effect in the case of large project teams.

B. Managerial Implications

This study has clear implications for cloud platform implementation. This approach confirms the importance of adopting cloud platform to improve NPD performance. It is expected that implementation of cloud platform, particularly in conceptual design and product test, contributes significantly to customer relationship management and innovation capabilities in terms of process and administrative innovation. For conceptual design, cloud platform can be used to assist in creating new product development plan and designing new products with customers. It can also be used for industrial design. To improve product test, the cloud platform can be used to assist in performing functional verification and inquiring about historical data from previous projects. It can also be used to keep the departments updated on project status. Furthermore, results support that attention should be given to three important types of CRM activities in NPD: joint problem solving, long-term partnership, and customer involvement. For joint problem-solving, project teams should work with their key customers to overcome difficulties (such as inventory management, delivery delay, and logistics management) and to help solve each other's problems (such as funding, production, and management). With respect to long-term partnership, for example, project teams should be committed to improving management of whatever customers suggest. They should systematically provide customized products and services to their key

customers and care about long-term development and successes with customers. To improve customer involvement, key customers should be involved with a project team in modifying products, evaluating market, and reviewing operations.

It is also clear that small project teams are more likely to be successful in NPD when they experience a high level of innovation capabilities than large project team. As mentioned previously, the size of a project team affects the complexity of the project. Evidence also suggests that a large project usually involves multiple suppliers, outside agencies, and complex coordination systems and procedures. In addition, availability of facilities, expertise, resources, and management know-how are a few potential sources of risks associated with large projects [28]. In a large project, the complex coordination between the sub-projects is itself a potential risk, as a delay in one area can cause a ripple effect in other areas [28]. Large projects may also have a different set of rules and guidelines from those of smaller and simpler projects [29]. Large projects usually involve diverse and complex information and knowledge. It is not easy to manage the knowledge for projects with high complexity and uncertainty. These may be the reasons why the impact of innovation capabilities on new product performance becomes weaker for large project teams.

C. Limitations and Suggestions for Future Research

While this study offers important insights into implementation of cloud platform, there are some limitations. First, results are obtained from only one industry (i.e., high-tech industry). Thus, generalizations should be drawn with care. It would be helpful to conduct similar studies in traditional manufacturing industry. Additionally, it would be interesting to reexamine the moderating relationship between innovation capabilities and NPD performance for other environmental factors such as salary, job satisfaction, working hours, information availability, time availability, team relationship, and project duration. Finally, this study focuses on external customer relationship management. The effect of internal CRM mechanisms, such as organization and knowledge management [32], need to be examined in the future.

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