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Evolutionary Model of e-Procurement Adoption: A Case of the Vietnam Construction Industry

Quangdung Tran[1*], Steve Drew[2], Rodney Anthony Stewart[3]

[1]School of Civil and Industrial Construction,
 National University of Civil Engineering, 55 Giai Phong, Hanoi, 100000, VIETNAM

[2]Tasmanian Institute of Learning and Teaching,
 University of Tasmania, Hobart 7005, AUSTRALIA

[3]School of Engineering,
 Griffith University, Gold Coast Campus, Queensland, AUSTRALIA

*Corresponding Author

Abstract: In order to propose more effective solutions to improve the diffusion of e-procurement technologies in the construction sector, it is very important to get a better understanding on the practical evolutionary process of e-procurement adoption at the enterprise level. This cases-study seeks to investigate the strategic evolution of e-procurement adoption in construction companies. Data collected from in-depth semi-structured interviews was analyzed by within-case and cross-case analyses to understand well the similarities and differences between the company cases regarding the way e-procurement technologies have been adopting and implementing. The present study found out a six-stage evolutionary model of e-procurement implementation specific for the context of Vietnamese construction industry. Further, it also proposed the best practical solutions for the cases studied as well as for the general context toward more collaborative e-procurement environment. Although this study is based on the experience of the construction section in a specific country, it is believed its results may be applicable to other developing countries. Using the evolutionary model developed, construction companies are able to self-assess and locate their e-procurement adoption level, and so that establish appropriate practical solutions to move forward a higher level of e-procurement applicability.

Keywords: e-Procurement, evolutionary model, adoption, construction companies, Vietnam

1. Introduction

Information and communication technology is an essential resource in conceiving, managing, and delivering construction projects. In particular, e-procurement technologies play an important role in helping enterprises gain the coordination and collaboration of all the partners involved in construction supply chains. The advantages of e-procurement in the construction sector have been well documented in many previous empirical studies (Stewart and Mohamed, 2003, Alarcón, Maturana et al., 2009, Eadie, Perera et al., 2011). However, the construction sector is criticized to be relatively slow in adopting e-procurement as compared to other industries (Eadie, Perera et al., 2011, Ibem and

Laryea, 2014). Additionally, it was found that most construction companies adopted disjointed elements of e-procurement technologies and only at a very simple level in both developing and developed economies (Issa, Flood et al., 2009). Extant literature reveals many reasons for this. The first relates to the industrial nature of the construction sector, such as fragmentation in terms of geography, business relationships, and information technology applications, as well as the conservative nature of the industry, the one-off nature of the products, and in particular, the complexity in the construction supply chains (Grilo and Jardim-Goncalves, 2011, Hardie and Newell, 2011). The second is related to environmental factors, such as weak IT infrastructure and ineffective legal and regulation system (Tran, Zhang et al., 2014). The third involves technological interoperability, a major challenge to ICT implementation and integration in the sector (Ibrahim, 2013). Finally, the lack of industry experience and inputs, were also argued as the main constraints on the diffusion of collaboration-based technologies in the context of developing economies (Gu and London, 2010).

In order to propose more effective solutions to improve the diffusion of e-procurement technologies in the construction sector, it is very important to get a better understanding on the practical evolutionary process of e-procurement adoption at the enterprise level. Although there have been many the evolutionary models of the development of IT and e-business technologies (see (McKay, Marshall et al., 2000, Miller, Nelson et al., 2001, Rao, Metts et al., 2003, Stone, 2003, Muffatto and Payaro, 2004)) but the existing literature is limited understanding of how the e-procurement technologies are actually implemented by individual construction companies (Ibrahim, 2013). Ibem and Laryea (2014) argued that "there has been very little attempt in the literature to identify and articulate the various innovative ways in which web-based technologies and applications are used to support the execution of construction procurement activities" (p.105). The present study bridges the acknowledge gap by identifying and analyzing the evolution of e-procurement strategies in the construction companies within developing countries. The two key research questions including: (1) how e-procurement is actually adopted and implemented in the construction companies in the context of Vietnam? (2) Whether or not differences exist between construction SMEs and large companies regarding the evolutionary path of e-procurement adoption?

This study focused on five case studies of the Vietnamese construction companies. Based on the literature review and the analysis outcomes of the case studies, a six-stage evolutionary model of e-procurement development is developed. This model shows how digital tools can evolve from simple technologies of communication toward the strategic instrument for integration and collaboration of construction procurement processes. Using the evolutionary model, the study also proposed the best practical solutions for the cases studied as well as for the general context toward more collaborative e-procurement environment. The findings contribute to the literature a specific insight into e-procurement implementation in construction sector and it is believed they may be applicable to a range of industries and the contexts with similar development challenges.

2. Theoretical Background

2.1 Procurement Activities in Construction

Construction procurement is a process with a wide range of activities and steps to acquire specified goods or services related to construction works within a given period of time, cost and agreed terms (Ibem and Laryea, 2014). In the early phases of a project, the procurement activities have to do mainly with the tender invitation for the project team and consultants; and then followed by the procurement of contractors in terms of construction materials, equipment, and subcontracting services. The European Union Directive on Procurement defines the elements of construction procurement including: need identification, specification of requirement, tender process and award of contract, management of contract, and termination of contract (European-Union, 2004). ISO-10845 (2010) defines the construction procurement process into the six principal procurement activities: (1) establishment of a list of things should be procured; (2) establishment of procurement strategies involving packaging, contracting, pricing and procurement procedure; (3) soliciting for tender offers; (4) evaluating tender offers; (5) awarding of contracts; and (6) administrating contracts. Accordingly, this point of view considers an e-procurement process including all the stages in creating, managing and delivering construction projects. In the present study, the ISO 10845 framework was adopted to identify and analyze the evolution of e-procurement adoption in the study cases.

2.2 E-procurement Technologies

According to Ibem and Laryea (2014), currently, there are about 36 digital technologies available for executing the basic construction procurement activities. Accordingly, there are ten tools used across the whole procurement process, four technologies for establishing things should be procured, four for soliciting tender offers, one for establishing a procurement strategy, two for the tender evaluation, two for the awarding of the contract, and thirteen for the contract administration (Ibem and Laryea, 2014).

Furthermore, four categories of the e-procurement technologies were identified based on their principal functions (Ibem and Laryea, 2014). The first category represents the technologies for data acquisition, such as cameras, sensor tools. The second involves technologies used in data processing and storage, such as Microsoft Office and CAD software. The third category relates to communication technologies which are used to exchange project data among the participants

involving the procurement process; for example, electronic data interexchange (EDI), e-mails, static websites, Enterprise Resource Planning (ERP), Human Resource Management (HRM), Financial Resource Management (FRM), Building Information Modeling (BIM), Supply Chain Management (SCM), Material Resources Planning (MRP), Customer Relationship Management (CRM), intranet, extranet, project portal, drop box, wireless technology...These computer-based technologies make communications easier, faster and cost effective. Finally, the fourth category is the Internet-based intelligent systems (i.e. artificial intelligent systems, Internet-based transaction platforms, Web-based ERP/BIM/HRM/FRM, Web-based e-procurement software packages, and cloud computing technologies), which are used in the strategic planning of projects, estimating, tendering, and the different project management functions. Besides facilitating communications, these technologies also enabling collaborations, integration the players in the same supply chain as well as coordination of works at the various stages of the procurement process.

In order to reach a higher degree of real-time communication, collaboration, and integration across the construction supply chains, construction companies can use the model of e-marketplace to integrate together the various technologies or applications within an enterprise, as well as with its external project partners (Grilo and Jardim-Goncalves, 2013). E-marketplaces are a Business to Business relationship model in which multiple sellers and buyers can communicate, collaborate, and make commercial transactions by means of a Web platform. According to Alarcón, Maturana et al. (2009), there are three main categories of the e-marketplace including: (1) Independent Trading Exchange - a many-to-many model managed by third parties; (2) Private Trading Exchange - a one-to-many model directly owned by a large company; and (3) Collaborative Community Exchange - a one-to-many or many-to-many vertical model managed by a number of companies having close partnerships in a certain industry.

2.3 Evolutionary Models of Information Systems (IS) Adoption at the Company Level

In recent times, numerous attempts have been made to develop models of the IS adoption at the company level across industries (Versendaal, van den Akker et al., 2013). Generally, these models are based on the idea that the IS adoption is a progressively iterative multi-phase process; the process reflects the evolution in planning, organizing, controlling, and integrating an organization's IS systems. However, for each of model, the evolutionary development of specific innovations was viewed under different perspectives (Versendaal, van den Akker et al., 2013). Firstly, Rao, Metts et al. (2003) studied the evolution of e-commerce adoption in terms of the level of transaction integration and the level of information integration. Stone (2003) presented a model of e-commerce development with three stages, including early, integrating, and advanced stages. These three stages again subdivided into six states under a view of evolution in both internal process integration and external network integration. Muffatto and Payaro (2004) proposed an e-business strategy evolution model on two key dimensions including network integration and technology integration. McKay, Marshall et al. (2000) developed the stages-of-growth e-business model for Web-based innovations under four layers: e-business strategy, e-business system, staff arrangement, and business processes. Besides, Rai, Tang et al. (2006) and Klein (2012) used the term of assimilation to describe the evolution of e-procurement adoption in terms of the degree of management commitment and degree of internal usage. Organizations should consider the assimilation of a certain e-procurement innovation as a seven-stage process: aware, interest, evaluation/trial, commitment, limited deployment, partial deployment, and general deployment.

In general, the existing literature has acknowledged the IS evolution mainly in terms of technology, information, and business management within both the internal and external environments of a company (Raymond and St-Pierre, 2005, Búrca, Fynes et al., 2006, Salleh, Jusoh et al., 2010). This present study adopted the idea that the evolution of an e-procurement development is on three key dimensions: internal technology integration, external network integration, and (process) management integration. Network integration is a company's ability in sharing of resources and co-participating in a common environment in which the supply network relationships are coordinated using information networks (Muffatto and Payaro, 2004). Technological integration is a company's ability having information systems to control many different organization functions as well as interact with each other to allow different business systems to communicate (Muffatto and Payaro, 2004). Process management integration is a company's management ability in re-engineering business processes to gain strategic business-IT alignment and strategic inter-organizational alignment in supply chains. Strategic business-IS alignment is considered as a strategic alignment between information systems and business strategy and process, organizational structure, and socio-culture environment; while strategic inter-organizational alignment is considered as strategic alignments between inter-organizational information systems in supply chains (Grilo and Jardim-Goncalves, 2011, Versendaal, van den Akker et al., 2013).

Additionally, although the models of IS innovations were considered under different perspectives, they have a common point in attempting to describe the continuous evolution of innovation development in organizations as being progressive concrete stages. The advantage of this approach is that it may be helpful for a certain company trying evaluate and position its maturity status of a technology innovation, so that it may make practically possible solutions for sophistication of IS. The present study adopted this approach with a focus on e-procurement adoption in terms of internal technology integration, network integration, and management integration.

3. Research Design

This exploratory study used the multiple-case study method. First, a literature review of contemporary e-procurement technologies and the exploration of different evolutionary models of IS adoption were conducted. The researchers then explored and compared among Vietnam case studies to analyze how to adopt e-procurement systems by construction companies.

To solve the issue of the high visibility of the case studies (Pettigrew, 1990), the selection process of the case studies was conducted through many steps. First, a sampling frame consisting of construction companies having their own websites (referred to as they implement e-procurement activities at the initial level) was established from the Hanoi construction business yellow-pages at http://yellowpages.vnn.vn. Next, twenty case studies were selected randomly from the sampling frame and asked to participate the research project; ten of these 20 companies agreed. Then, the researchers used an e-procurement status assessment framework, which was previously developed as a result of the same project (Tran, Anthony Stewart et al., 2020), to conduct an assessment of e-procurement status in these ten companies. Finally, the top five companies with the highest scores were selected for further data collection. This selection process was believed to provide the most appropriate case studies to meet the aim of the present study.

A wide range of data, for each case, was needed for the current study, namely: e-procurement status, the technology solutions deployed in the companies, future plans for e-procurement, and demographic information. The data was gathered through face-to-face semi-structured interviews and other sources such as archives and websites. The participants were the top managers having good experience and knowledge related to their companies' e-business activities, such as senior management board members, IT managers, marketing managers, and purchasing managers. As a result, a total of 16 interviews from the five companies were conducted. The characteristics of the five cases were summarized in Table 1.

Table 1 - E-procurement technologies implemented in the companies studied

Firms[*]	Size	Type of enterprise	E-procurement technologies implemented		
			Data acquisition, processing and storage	Communication technologies	Intelligent management systems
CDCD	Medium	Construction consultant	CAD, ETABS, and SIGMAZ	Internet, e-mail, wireless technology, video conference, Dropbox, wikis, Skype, Facebook, intranet, interactive website	Human Resource Management (HRM)
HUDI	Large	Developers, contractor, consultant	Multimedia and project cameras, sensor networks, CAD, office software packages	Internet, e-mail, wireless technology, static website	Financial Resource Management (FRM), (HRM)
FECN	Large	Contractor	Multimedia and project cameras, sensor networks, CAD, office software packages	Internet, e-mail, wireless technology, SharePoint, drop box, project portals, intranet, EDI, interactive website	FRM, HRM
HXD	Medium	Construction consultant	Designing software packages (e.g. CAD, ETABS)	Internet, e-mail, wireless technology, intranet, static website	
POSO	Large	Contractor	Multimedia and project cameras, sensor networks, CAD, office software packages	Internet, e-mail, wireless technology, project portals, intranet, EDI, transactive website	BIM, HRM, FRM, Enterprise Resource Planning (ERP), private e-platform

Note: (*) Names of the five companies were changed.

In order to assess the e-procurement status of each companies studied, the study used the framework of e-procurement assessment that was developed and previously published in Tran, Anthony Stewart et al. (2020). Accordingly, the framework considered the e-procurement status of a company under three main perspectives: Internal e-procurement resources (IntePR), Operational clusters' e-procurement resources (OCePR), and Industrial e-procurement

resources (IndePR). These three perspectives are assessed through thirteen factors as showed in Figure 1. The relative weights were established using the AHP technique (Tran, Anthony Stewart et al., 2020).
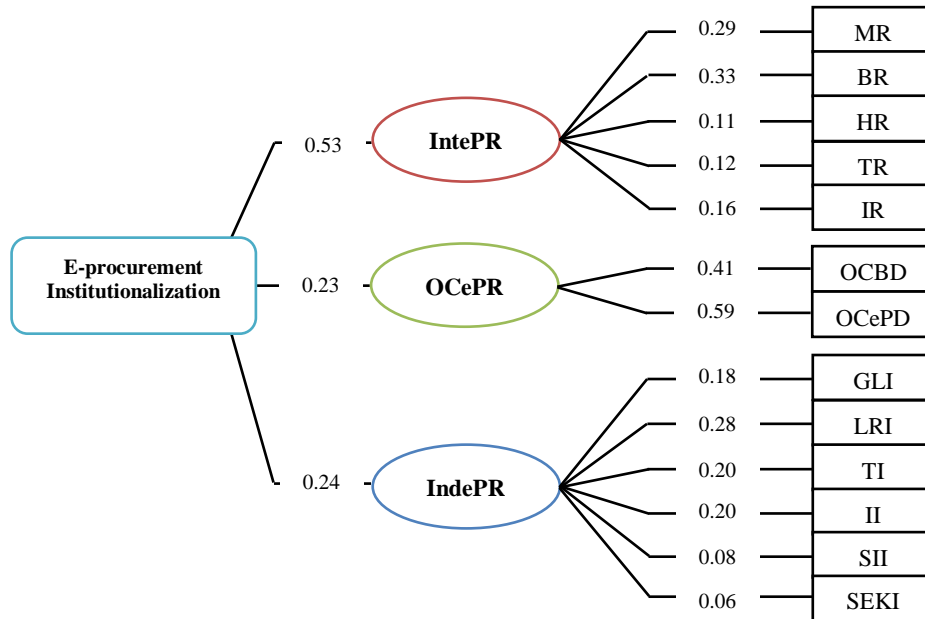
Hint: The factor of MR stand for Internal management resource, BR-Internal business resource (BR), HR-Internal human resource, TR - Internal technology resource (TR), IR - Internal information resource, OCBD – Perceived business dynamics of operational cluster, OCePD - Perceived e-procurement diffusion of operational cluster; GLI - Perceived government leadership infrastructure, LRI - Perceived legal and regulatory infrastructure, TI - Perceived technology infrastructure, II - Perceived information infrastructure, SII - Perceived supporting industries infrastructure, SEKI - Perceived socio-economic and knowledge infrastructure.

Fig. 1 - The assessment framework of e-procurement institutionalized adoption with the perspectives and factors' relative weights defined in the context of Vietnam construction industry (source Tran, Anthony Stewart et al. (2020))

Using this framework, the level of e-procurement institutionalized adoption of each company in terms of the thirteen factors was calculated and showed in Figure 2.
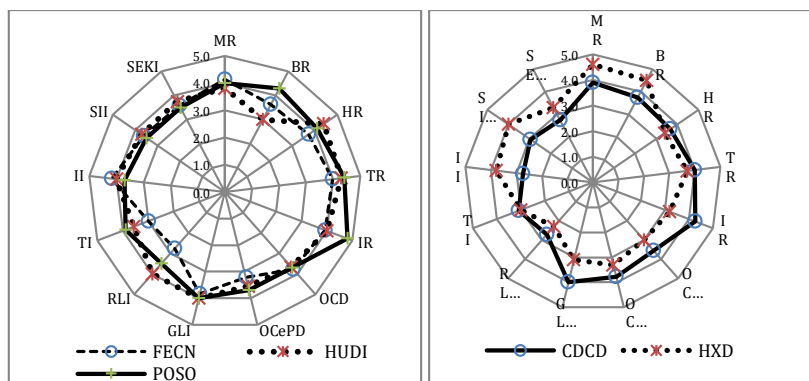

Fig. 2 - E-procurement institutionalized adoption of FECN, HUDI, POSO, CDCD and HXD

Semi-structured questions were used to collect the data related to current e-procurement technologies, and future e-procurement strategy; these questions were based on the categories of digital technologies available for the six main construction procurement areas, including: "creation of list of products need to be procured," "development of procurement strategy," "invitation for tenders," "evaluation of tenders," "award of contract," and "administration of

contracts" (Ibem and Laryea (2014)). Other organizational information was also collected thorough a range of sources, such as interviews, websites, and brochures.

4. Case Studies

The acronym of each company is changed different from the real ones.

4.1 Cases 1 - FECN

Evolutionary Picture of e-procurement Development of FECN

FECN is one of the leading large construction contractors in Vietnam; it specializes in foundation engineering and underground construction. It is a private enterprise established in 2004. Its business partners include both domestic and international companies.

From the beginning, FECN implemented many digital technologies to support different procurement activities. For example, CAD, 3D scanner, and professional designing software packages were used for production of drawings, data acquisition, and data processes. The company mainly used telephone, fax, and email to communicate with the partners. Since 2008, it established a website to introduce information about its products and services, contact information, and the release and update of other relevant operational news in a static manner without any interactivity. Also, at that time, the company adopted a number of business management systems, such as FRM, HRM. The website was upgraded between 2012 - 2103 to support interactive communications. The e-payment portal using a Geotechn system and the Web-based Project Portal were developed to exchange of information, data, drawings, and payments among the project participants.

From 2014 to the present, FECN has been developing an internal collaborative and integrated enterprise environment to effectively manage construction supply chain and organizational resources. For this purpose, it adopted the Web-based ERP provided from a Vietnamese provider. The company's leaders expressed their desire for a future collaborative e-platform where all their main partners could access, integrate, and share information and data related to construction activities. Recently, the company also participated in some bidding packages available on the public e-procurement system managed by the government.

Level of e-procurement Institutionalization of FECN

The result of FECN's e-procurement institutionalization assessment is presented in Fig. 1. FECN was assessed to be good at MR, TR, IR, GLI, and II but very weak at OCePD, TI, and RLI.

4.2 Case 2 - HUDI

Evolutionary Picture of e-procurement Development of HUDI

The HUDI is a large state-owned cooperation with multiple disciplines, such as investment, constructor, and consultant operating mainly in the area of urban and resident works. Currently, the HUDI still uses traditional communication systems, such as the telephone, fax, email, wireless technology, and intranet to manage its information and data flow between the company and its partners. The wireless sensor networks, such as LADAR (laser distance and ranging), are used in monitoring and collecting the data on the physical and environmental conditions of construction sites. The virtual private network – based EDI was used from 2002 to exchange of information and data between the sub-contractors and the material suppliers. To support enterprise information management, the HUDI adopted many enterprise systems, such as HRM and FRM. The firm's website was established in 2004, however, it still only supports for one-way communication. The HUDI usually publishes bidding invitations on the public e-Procurement system. Currently, the company does not have any future plans for the development of a private e-platform; but it was willing to actively participate in the public e-procurement system managed by the government.

Level of e-procurement Institutionalization of HUDI

As shown in Fig.1, HUDI is good at HR, TR, GLI, RLI, and II but very weak at BR. Especially, the level of e-procurement diffusion (OCePD) and trading dynamics (OCBD) of HUDI were very low.

4.3 Case 3 - POSO

Evolutionary Picture of e-procurement Development of POSO

The POSO is a large construction contractor operating in both the international and domestic markets. Professional software packages and technologies for mining, collecting, processing, storage, and transferring data and information were adopted and used across the company to support procurement activities at the contact administration stage. Internet-based intelligent enterprise systems (e.g. e-tendering, e-catalog, HRM, FRM, and ERP) were adopted and highly integrated into multi-component systems to effectively manage internal activities and help managers in the strategic planning of construction projects, as well as in the estimation, tendering, and other project management functions. In addition to traditional communication technologies such as the fax, telephone, and VAN-based EDI, the POSO adopted

the web-based technologies to facilitate the sharing of knowledge, data and ideas among those involved in construction procurement activities; for example, the Internet, e-mail, project portal, drop box, wireless technology and others.

Recently, POSO developed and used a private e-platform following the one-to-many model to exchange project data and information among the participants in construction procurement activities. The firm's leaders expressed their hope to upgrade their e-platform to a many-to-many e-marketplace in future to improve effectiveness in trading strategy in general and particularly the procurement activities.

Level of e-procurement Institutionalization of POSO

As seen from Fig. 1, the POSO was assessed to be good at internal organizational resources (e.g. MR, BR, TR, and IR), TI, and GLI; however, it has been receiving little support of other external environmental factors (e.g. SEKI, SII, and RLI).

4.4 Case 4 - CDCD

Evolutionary Picture of e-Procurement Development of CDCD

The CDCD is a medium-sized construction consultant established in 1991, in which the stated holds 51% of shares. From the beginning, the CDCD has implemented many digital technologies to support different procurement activities. For example, the professional designing software packages (e.g. CAD, ETABS, and SIGMAZ, etc.) were used for drawings production, data acquisition and processes. In 2010, in order to more effectively manage their business activities, the company adopted the FRM. Besides the traditional digital technologies to support external communications (e.g. the telephone, fax, and email), the web-based tools were increasingly adopted, such as the company website, project portal, drop box, Skype, and Facebook; all served as on-line transactions, and the exchange of data, or the medium for the transmission of drawings and documents. Recently, its website was upgraded to support interactive communications.

From 2013, the CDCD implemented a special software programing that was developed by its R&D office to integrate the professional designing software packages. Additionally, the company is an active member of the public e-procurement system managed by the state. Although the firm's leaders are aware of the benefits of a collaborative e-procurement system, they did not have any plan to develop a future private e-platform.

Level of e-procurement Institutionalization of CDCD

As shown in fig.1, the CDCD's e-procurement institutionalization was assessed to be good at internal organizational resources (e.g. MR, BR, HR, TR, and IR); however, it was very weak at the remaining factors.

4.5 Case 5 - HXD

Evolutionary Picture of e-procurement Development of HXD

The HXD is a private medium-sized construction consultant company operating, mainly, within industrial and civil works. The HXD implemented professional designing software packages (e.g. CAD, ETABS, etc.) for drawings production, data acquisition and processing. In 2012, the company adopted the HRM. Besides the traditional digital technologies(e.g. telephone, fax, and email), to support external communications, the Web 2.0 tools were also increasingly adopted, such as the company's website, drop box, and Facebook that serve for on-line transactions, as well as the exchange of information or the medium for the transmission of drawings and documents. However, the HXD's website is still operating in a static manner. The HXD has been conducting e-tendering activities through the public e-procurement system managed by the State. Although the firm's leaders are aware of the benefits of Internet-based technologies, they do not have any future plan to develop sophisticated business and procurement activities.

Level of e-procurement Institutionalization of HXD

The HXD was assessed to be good at MR and BR only and however, it was weak at almost every other factors (see Fig.1).

5. Case Study Analysis

In this study, the analysis process was carried out in two steps: (1) within-case analysis and (2) cross-case analysis (Eisenhardt, 1989). Since the data collected from the "low e-procurement institutionalization" companies seems being not much valuable to the particular aim of the present study, the authors has only focused on the "high e-procurement institutionalization" companies. A within-case analysis took into consideration the level of e-procurement institutionalization of the individual company. The consideration was used to create a map which describes the present situation of each of the companies studied; the situations were then compared. The comparison results in the relative locations of companies as shown in fig. 3.

Fig. 3 locates the five companies studied in the same diagram to make sense the similarities and differences. The level of network integration/alignment of a company (the x axis) is mainly reflected by the firm's OCePR and IndePR. The level of internal integration/alignment (the y axis) is majorly reflected by IntePR; and the level of management

integration/alignment (the diagonal axis) is mostly reflected by IntePR and IndePR. Therefore, based on the result of e-procurement institutionalization assessed for the individual company, the relative locations of companies were positioned. The lower left-hand corner in the evolutionary model (also called "Initial Adoption") represents a low integration level in all three dimensions. This stage is characterized by using traditional communication technologies to support construction procurement activities. The upper right-hand corner in the evolutionary mode (also called "Institutionalization") represents a high integration level in all three dimensions. This stage is characterized by using collaborative e-platforms for procurement activities. The arrows represent the evolutionary path which takes companies strategies towards the Institutionalization of e-procurement.

The cross-case analysis also found that four of the five companies studied (the exception being the POSO) only implemented simple procurement technologies. However, they all expressed a desire for an integrated e-platform whereby many players in the supply chain, and members in projects, can become involved, and collaborate and cooperate together. While medium-sized companies (i.e. the HXD and the CDCD) tended to connect with, and participate in public e-platforms, managed by third parties or the state, the large companies (i.e. the FECN, the HUDI, and the POSO) implemented, or had plans to build, their private e-platforms following the Private Trading Exchange model. It is expected that these companies will be moving more and more towards the institutionalization of e-procurement in the future.

In relation to the type of operation, it seems that different disciplines in the construction sector are undertaking similar evolutionary progress towards e-procurement institutionalization. Construction companies are first improving their internal integration, and, then their external networks integration; while management integration is improved continuously along with the whole evolutionary process.

6. The Proposed Evolutionary Model of E-Procurement Adoption in Construction Sector

Based on the result of the case studies, an evolutionary model of e-procurement adoption in construction sector was defined. As noted in fig. 2, the model involves three variables: network integration, technological integration, and management integration.

The model presented here proposes two paths for initial e-commerce adopters toward the institutionalization of e-procurement (see fig. 2). Both the paths 1 and 2 have the same first four stages; however, at the more advanced level of e-procurement adoption, these paths have the notable differences. Small and medium companies tend to follow the path 2, while large companies tend to follow the path 1. More details are presented as the following.

Stage 1: Initial Adoption

In the first stage with the network integration, a company is connected to the Internet and has its own website that provides, primarily, one-way communication to any potential user. Their website is used only to introduce their company brochure, information about their products and services, contact information, and the release and update of other relevant operational news in a static manner without any interactivity (Timmers, 1999, McKay, Marshall et al., 2000). The information between the company and the various players in the supply chain is managed and transferred through traditional communication tools, such as the telephone, fax, email, wireless technology, intranet, virtual private network–based EDI (Muffatto and Payaro, 2004). These technologies are used to facilitate the sharing of knowledge, data and ideas among project participants and make communications easier, faster and more cost effective (Ibem and Laryea, 2014). In this case, an individual company's information systems are mainly used to manage internal organizational processes rather than external business communications.

Further, within this stage, construction companies implement less complex technologies for project data acquisition, processing and storage (and mostly at the contract administration stage) (Ibem and Laryea, 2014). Therefore, during this stage, internal technology integration and management integration are very low.
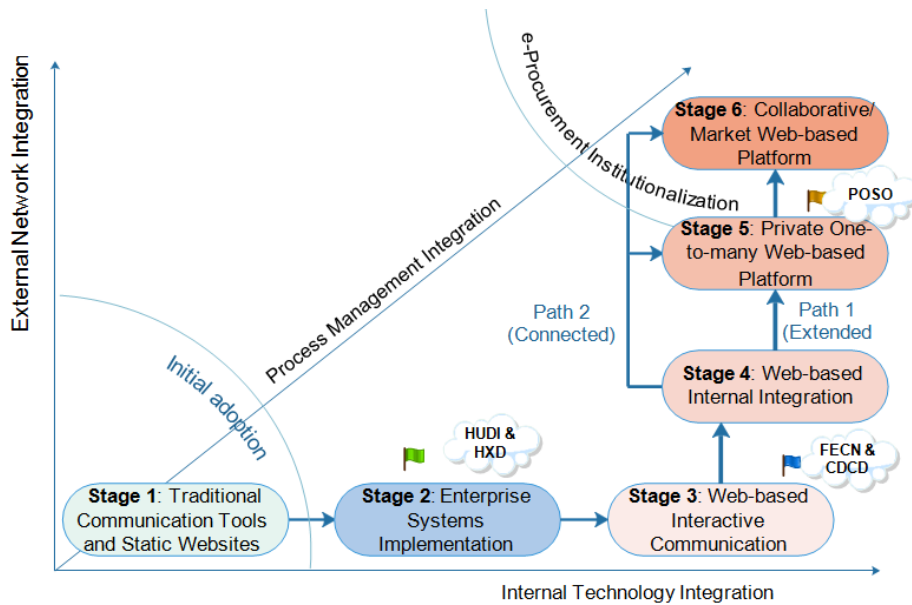
Fig. 3 - Evolution of e-procurement technologies implementation

Stage 2: Intra-organizational Enterprise Systems Implementation

In the second stage, construction companies focus mainly on the improvement of their intra-organizational information and data flows by implementing enterprise-wide back-end technologies. The companies select and implement one or many enterprise management information systems, such as HRM, FRM, ERP, SCM, MRP, and CRM. The type and extent that the applications are implemented into a company depends on the business nature and resources of the company (Miller, Nelson et al., 2001, Brewer and Gajendran, 2009). While large companies can simultaneously implement many enterprise systems in various departments or offices, small and medium companies tend to selectively implement specific systems that are considered to be critical to their business, as well as suitable for their business strategy and organizational characteristics.

At this time, these systems are not integrated with the Internet environment and, thus, are mostly used to manage and enhance internal processes rather than communicate externally. Moreover, such information systems take a lot of time and money to implement, and they can change a company's culture (Muffatto and Payaro, 2004). Therefore, during this stage, companies must learn, accumulate, and improve their management ability, IT infrastructure, and human resources to effectively manage and use such complex systems.

The end of this stage, companies' external network integration has not yet improved much, but its organizational environment has had many extensively positive changes in management and processes. Most importantly, a large amount of information within the company has been formatted electronically. The biggest existing challenges faced by the company are integration among these enterprise systems, and the issue of business-IS alignment.
HUDI and HXD are in this stage of the e-procurement implementation.

Stage 3: Web-based Interactive Communication

After the second stage, construction companies tend to take a greater effort to improve their external communications by implementing Web-based customer-and-partners-facing front-end technologies or applications. In the third stage, regarding network integration, the companies improve the communication power of their website to make an interactive environment where they can receive queries, e-mail, and form entries from their users. Additionally, communications between internal and external environments are developed through Web 2.0 technologies or public Internet-based communication means (e.g. Dropbox, wikis, blogs, project portals, Skype, SharePoint, Facebook, etc.). Through these technologies, initial adopters sometimes carry out Internet-supported simple business activities, such as e-advertisements, e-notices, and e-discussions or e-negotiations. Further, an enterprise database needs to be built to enter, record, process, monitor, and report the business transactions. However, traditional communication tools and Internet-based means are still used in parallel to communicate with multiple the project players.

At the same time, simple e-procurement innovations or components (e.g. e-tendering, e-ordering, and e-catalog) are able to be implemented. Customers can access a series of forms allowing them to place orders. In this case, the codes are very effectively transferred without the unexpected mistakes which can occur if the telephone and fax are used. However, financial transactions are still not conducted electronically. These solutions are particularly appropriate for small suppliers and retailers because they do not require a significant investment in terms of technology and skills.

By the end of this stage, in general, external network integration has improved much while internal technology integration and process integration tend not to have changed, when compared to the previous stage. Additionally, the

enterprise information management system is, usually, still not yet completely integrated with the customer-and-partners-facing front-end technologies. FECN and CDCD are in this third stage.

Stage 4: Web-based Internal Integration

In the fourth stage, a construction company emphasizes mainly on the integration of the current internal information subsystems into one multiple-components system in terms of management, technology, and information. Such incorporated information systems provide a more unified organizational environment and facilitate interdepartmental cooperation and coordination.

The adoption of these systems is difficult and expensive. Interoperability and technology standard are the main challenges that may expend a lot of money, time, and other company resources (Ibem and Laryea, 2014). Additionally, in this stage the alignment between the system with organizational structure, business strategy, and business process is also critical. Further, the management procedure and business processes are very likely refined and improved to meet the alignment. Generally, the role the IT managers play is extremely important.

By the end of this stage, it is expected that the organizational environment is comprehensively integrated into one or several multi-components systems formed by different information sub-systems. The interfacing activities among the various information sub-systems are conducted electronically. Although these systems may be connected with the Internet environment, they used mostly to manage the internal processes rather than to communicate externally. In general, internal technology integration and process management integration are improved significantly as compared with the previous stages; however external network integration is still not yet much improved.
None of the five cases studied were in this stage.

Stage 5: Web-based One-to-Many e-Procurement Platform

After the fourth stage, many construction companies seek to conduct two-way communications with external partners in a more dynamic and transactional manner. The fifth stage is to involve more integration between a company's internal management system and the Web environment (Miller, Nelson et al., 2001). However, there is a significant difference between the large versus small and medium companies regarding the way they develop e-procurement infrastructure to integrate.

Large-sized companies, with a strong resource capability and a significantly influential contract power in the supply chain, can develop and manage their own private e-platform (considered as a Private Trading Exchange model (Alarcón, Maturana et al., 2009)); this model allows the main partners and customers to access and make transactions in real time. Conversely, the SMEs tend to not develop such a private e-platform, but they may use servers to connect their customer-and-partners-facing front-end solutions with external e-platforms (e.g. Independent Trading Exchange or Collaborative Trading Exchange (Alarcón, Maturana et al., 2009)). These connections are developed and managed by third parties, such as large and powerful companies in the supply chain, or the state.

A private web-based platform is a one-to-many model; it is an inter-organizational information system to help leading companies improving cooperation, collaboration and efficiency. Such a platform is expected to facilitate the exchange of information in a multi-model environment that supports the various applications such as design tools, analysis tools, document management systems, facility management tools, and so on (Lou and Alshawi, 2009, Shafiq, Matthews et al., 2013). By connecting with such e-platforms, SMEs can conduct online selling and purchasing of products and services. At this stage, the various e-procurement applications can be implemented and integrated to support collaborating players in the same supply chain. To be successful, there needs to be radical changes in the host company's management processes; for example, the management process should be integrated to improve technical infrastructure that supports the collaboration (Abuelmaatti and Ahmed, 2014). Additionally, the host company needs to encourage main suppliers, partners, and customers to participate in the platform. However, access to the system and relationships are defined by rules and contracts directly established and controlled by the host company. At the end of this fifth stage, the company is completely integrated with its suppliers and customers; and most of the business transactions are conducted electronically. POSO is in this stage of the e-procurement implementation.

Stage 6: Web-based Many-to-Many e-Procurement Platform

At the sixth stage, large companies are directly developing their own e-platform from a one-to-many model to a many-to-many model by integrating with other partners' e-platforms to make a Collaborative Community Exchange (Alarcón, Maturana et al., 2009). Alternatively, these host companies may also integrate their one-to-many e-platform with existing Independent Trading Exchanges (Alarcón, Maturana et al., 2009). For convenience, large companies tend to use these two systems in parallel, and so gain many the benefits, both in transaction costs and improvements in the partnerships.

In general, a many-to-many e-platform will bring together various players in the construction industry; this complete collaboration makes the procurement processes more efficient (Lou and Alshawi, 2009). In fact, at this level, almost the logistic flows are redefined; and there is a significant movement toward creating a ''supply network'' to optimize all the construction procurement activities. The players involved in these networks can create new products and services together and reach new markets or new customer segments (Muffatto and Payaro, 2004).

The largest barriers to the adoption of e-platforms relates mainly to the people-related issues, such as the lack of awareness, limited skilled workers, poor cross-disciplinary communication, fragmented supply chain, and poor industry standards for information interchange (Lou and Alshawi, 2009).

At present, no company was in this stage; however, the specific need to integrate more and more of the players in the construction supply chain was expressed during the interviews.

7. Recommended Development Strategies Toward E-Procurement Institutionalization

Based on the current e-procurement status of each company, and the challenges identified for each of the stages in the evolutionary model, a group focus study was conducted to discuss and suggest the best practical solutions for the five case studies. The following is to present the recommended development strategies for the two companies, namely the FECN and HXD, to successfully move toward e-procurement institutionalization. The solutions suggested are based on the gaps between the current e-procurement status and the necessary competences of the targeted stages in the evolutionary model.

The participants in a group focus study included one manager from FECN, one manager from HXD, and one IS expert. First, the researchers presented a report on the current status in terms of e-procurement and resources of each company as well as a set of the respective challenges and the potential development strategies referred from the literature; then, the participants have analyzed and discussed to draw out the best practical recommendations for each company. The following is the findings.

7.1 Company FECN

FECN is presently in Stage 3 of the evolutionary process, namely, Web-based interactive communication technologies. The company is suggested to be heading towards Stage 4 - Web-based enterprise systems integration. Based on the literature, the main challenges in Stage 4 relate to interoperability, skilled personnel, the business process, project experience, and change management ability (Lou and Alshawi, 2009, Abuelmaatti and Ahmed, 2014, Chien, Wu et al., 2014, Ibem and Laryea, 2014). These are often highly interrelated, such that developing competence in one element must be accompanied by improvement in the others (Lou and Alshawi, 2009). The result of the e-procurement readiness assessment of the FECN showed that this company was weak in its BR and HR, but it was quite strong in its MR, TR, and IR (see Fig.1). Also the company's location within the industry was not favorable towards the e-procurement institutionalization, as the company had not received the appropriate support from the external environment regarding technology infrastructure, legal and regulation infrastructure, and especially e-procurement diffusion within its business partners in the supply chains (see Fig.1). Therefore, the following solutions are suggested for the FECN to improve its current situation, both internally and externally.

Possible solutions for internal organizational integration:
- Hire or build a team of e-procurement specific experts to develop e-procurement strategy and actions plans (Abuelmaatti and Ahmed, 2014);
- Orient business strategy strongly toward e-commerce activities;
- Improve and standardize operational procedures and rules;
- Provide training programs to improve IT skills, working experiences within web-based environment, legal knowledge, and positive organizational culture across the firm;
- Distribute a financial resource specifically for IT infrastructure and e-procurement project.
- In order to address the issue of interoperability in the use of e-procurement technologies, FECN can follow one of several ways identified in the literature; for examples, the use of Web 2.0 services, BIM, the use of XML documents with the adoption of industry-specific interoperability standards, and the use of the Groupware or Oracle systems to integrate hard-ware/software applications and develop a fully collaborative e-enterprise environment (Miller, Nelson et al., 2001, Ibem and Laryea, 2014).

Possible solutions for external network integration:
- Cooperate with partners in the industry to build a knowledge portal for historical data on performance and lessons learned to determine the most effective methods for adopting e-procurement (Chien, Wu et al., 2014).
- Lead initiatives to improve e-procurement diffusion and establish trust within its business partners, especially SMEs that are key players in supporting the FECN. Collaborative e-procurement environments are very much concerned with the collaboration across the project life-cycle (Abuelmaatti and Ahmed, 2014).
- Need be more active in taking a bigger role in building and operating non-profit business associations serving lobby groups in order to: (a) move further toward e-procurement institutionalization; (b) lobby the government

and business partners to promote common industrial issues (such as technology infrastructure, legal system); and (c) collaboratively develop a comprehensive e-procurement roadmap and action plan for the Vietnamese construction industry (Chien, Wu et al., 2014).

7.2 Company HXD

The HXD is presently in Stage 2 of the evolutionary process, namely: enterprise systems implementation. The company is heading towards Stage 3 – Web-based interactive communication technologies. Based on the literature, the main challenges of Stage 3 are related to electronically formatted information, technology resources (e.g. database, high-speed Internet), and financial resources to maintain the e-infrastructure. The assessment result of the e-procurement situation of the HXD showed that it was weak in technology resource (TR), information technology (IR), and human resource (HR), but it was quite strong in management resource (MR) and business resource (BR) (see Fig.2). Further, its location within the industry showed it was not motivated towards e-procurement institutionalization as the company had not received appropriate support from the external environment regarding technology infrastructure, legal and regulation infrastructure, and industrial culture within its supply chain. Specifically, the HXD's operational cluster (i.e. those companies that have solid business relationships with HXD) expressed a very low level of e-procurement diffusion and dynamics that are critical for collaborative e-procurement activities (see Fig.2). Consequently, the following solutions are suggested for the HXD to improve its current e-procurement situation, internally and externally.

Possible Solutions for internal organizational integration:
- Make much effort to transfer the firm's data and information into electronic format.
- Invest much more in IT infrastructure.
- Provide training programs to improve IT skills, working experiences within web-based environment, legal knowledge, and positive organizational culture across the firm.
- Distribute a financial resource specifically for IT infrastructure and e-procurement project.
- Most importantly, need a strong top-level management commitment to an e-procurement strategy, since the HXD is a medium enterprise with limited resources.

Possible solutions for external network integration:
- Cooperate with partners in the industry to build a knowledge portal for historical data on performance and lessons learned to determine the most effective methods for implementing e-procurement (Chien, Wu et al., 2014).
- Need be more active by participating in initiatives led by large companies to improve e-procurement diffusion in the industry. So that, a collaborative e-procurement environment can be established.
- Need, like other companies, to be more positive and take a bigger role in building and operating non-profit business associations serving lobby groups in order to: lobby the governments and business partners to promote common industrial issues and collaboratively develop a comprehensive e-procurement roadmap and action plan for the Vietnamese construction industry (Chien, Wu et al., 2014).

7.3 General Recommendations

In Vietnam, only few construction companies have adopted or institutionalized e-commerce and e-procurement systems. One outcome would be to push their partners in the supply chain to also adopt and implement such systems. Nor are these systems widely used in the industry to adopt and implement the technologies. In other words, there is a serious lack of industrial experience and or lessons from which to learn. Therefore, the role of the state is extremely important regarding this particular aspect. A previous empirical study in Vietnam by the same authors revealed that the government has a stronger impact on the initial adoption than does the institutionalization of e-procurement in individual construction companies, specifically, in terms of: commitments and supportive policies, provision of legal and regulatory frameworks, and development of IT and supportive industry infrastructure (Tran, Zhang et al., 2014). In order for companies to implement sophisticated e-procurement system, the government needs to pay specific attention to the development of IT infrastructure, including e-government initiatives and special policies and incentives for SMEs. Furthermore, the government may need to promote the development of common standards that are crucial for the interfacing systems and institutionalizing e-procurement (Huang, Tran et al., 2014).

8. Conclusions

This study was a part of a broader research project with two major objectives:

(1) Development of an e-procurement institutionalization assessment framework; and
(2) Identification of an evolutionary model of e-procurement adoption in construction companies in Vietnam.

There are three main conclusions drawn in the present study:
(1) A six-stage evolutionary model of e-procurement implementation in the Vietnamese construction industry was identified.
(2) A difference between SMEs and large companies regarding the evolutionary paths at the more advanced stages in the adoption process was found out.
(3) Practical solutions, especially for the cases studied as well as for the general context, were proposed.

Although this study is based on the experience of the Vietnamese construction industry, it is believed its results may be applicable to other developing countries. Using the e-procurement institutionalization assessment framework and the evolutionary model, construction companies are able to self-assess the level of their maturity of e-procurement, and then establish practical solutions to move forward by comparing their current situation with the stages of maturity described in the model. This is a possible way towards this goal of further e-procurement applicability.

It is worth noting that there were not found significant differences between the construction consultant units, the contractors, and the developers, in terms of the intended process of e-procurement adoption, it is posited that various disciplines in the industry seem to follow similar evolutionary paths. Additionally, based on the results of the present study, and those of Ibem and Laryea (2014), it seems that the evolutionary process of the e-procurement adoption by construction companies is similar to the evolution of the development of e-procurement technologies. However, these propositions need to be empirically tested in future studies. The present study has also the limitation related to the data.

The past status and future plans of a company were observed via the key managers' memories and ideas, but not from official documents. This leads to questions about the reliability of the data. A qualitative, interpretive approach can be given more reliability by involving other data sources. Future research should use with a lager sample of case studies and interviews; more respondents from the same case would ensure the greater reliability of the study. Additionally, the sample was a combination of multiple company types (e.g. developers, contractors, and consultants), which was considered as a homogenous group; thus, the research result may be reduced in terms of practical applicability of the study. More extensive studies might break down the results by each sub-group. Finally, the study was undertaken only as a snap shot time; hence, future research might carry out a longitudinal assessment of a company, so that a better understand of its e-procurement evolution process can be gained. A longitudinal case study may be the most appropriate research design for testing hypotheses related to the certain evolution within specific events.

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