Information Technology (IT) Barometer Review in Construction Industry

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Abstract

This review aims to 1) examine the logic and steps undertaken in order to survey the level of IT use in the construction industry using the IT Barometer tool, 2) understand the reasons behind each question/step in order to apply this tool appropriately, 3) monitor any changes due to advancement in technology, process, or procedure in later studies, and 4) review and examine other IT Barometer surveys in Southeast Asia and Taiwan. Differences in each study affecting the integrity of the study are also identified.

The reviewed results could help researchers to understand and appropriately apply this tool to investigate how well the construction industry uses IT and compare with the neighbor countries.

Keywords: Information Technology (IT) | Information Technology Barometer | Construction Industry

การทบทวนการใช้ ไอที บารอมิเตอร์ ในอุตสาหกรรมการก่อสร้าง

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บทคัดย่อ

การทบทวนวรรณกรรมฉบับนี้มีวัตถุประสงค์เพื่อ 1) ศึกษาถึงตรรกะ วิธีการและขั้นตอนต่าง ๆ ที่มีผลต่อการสำรวจระดับการใช้เทคโนโลยีสารสนเทศ (Information Technology (IT)) ในอุตสาหกรรมการก่อสร้าง โดยใช้เครื่องมือที่เรียกว่า ไอที บารอมิเตอร์ (IT Barometer) 2) ศึกษาหลักการและเหตุผลที่ใช้ในการออกแบบ ที่ผู้คิดค้นเครื่องมือชิ้นนี้ใช้ เพื่อความเข้าใจที่ถูกต้องเมื่อต้องนำเครื่องมือนี้ไปประยุกต์ใช้ 3) ศึกษาถึงการปรับปรุง/เปลี่ยนแปลงต่าง ๆ ที่เกิดขึ้นกับเครื่องมือนี้ อันเป็นผลสืบเนื่องมาจากการเปลี่ยนแปลงในด้านเทคโนโลยี ขั้นตอน กระบวนการการทำงาน ซึ่งจะพบในการศึกษาที่เกิดขึ้นในภายหลังของกลุ่มผู้วิจัยชุดเดียวกัน 4) ทบทวนและตรวจสอบการใช้เครื่องมือ ไอที บารอมิเตอร์ ในการศึกษาอื่น ๆ ที่เกิดขึ้นในกลุ่มประเทศเอเชียตะวันออกเฉียงใต้และไต้หวัน โดยศึกษาความแตกต่างของขั้นตอนการใช้งาน ไอที บารอมิเตอร์ที่มีผลต่อความเที่ยงตรง หรือความต่างของหลักการการใช้เครื่องมือที่ผู้ออกแบบเครื่องมือนี้ต้องการ

ผลจากการทบทวนวรรณกรรมชิ้นนี้ จะช่วยให้นักวิจัยที่ต้องการประยุกต์ใช้เครื่องมือนี้ เข้าใจถึงหลักการและเหตุผลของคำถามหรือกลุ่มคำถาม เมื่อทำการสำรวจโดยใช้แบบสอบถาม เพื่อที่จะตรวจสอบความพร้อมของอุตสาหกรรมก่อสร้างในด้านการใช้เทคโนโลยีสารสนเทศ และสามารถนำผลสำรวจที่ได้เปรียบเทียบกับประเทศหรือกลุ่มประเทศข้างเคียงได้ด้วย

คำสำคัญ: ระบบสารสนเทศ | เครื่องวัดระบบสารสนเทศ | อุตสาหกรรมการก่อสร้าง

1. Introduction

Construction and Information Technology

The construction industry in most countries is considered as a growth engine of the economy. It is a distinct industry, comprised of phases, parties, and teams, with a unique output produced within specific contexts, conditions, and requirements. The industry is highly fragmented with numerous businesses and workforce involved. The complexity of construction outputs and processes and numbers of participants involved results in an extensive and complicated information flow throughout construction processes (Perera and Rodrigo 2017). Therefore, it is important to continually innovate its practice and process to get the best output (Perera, Ruikar et al. 2017). One way to infuse the innovation into the construction industry is through the adoption of Information Technology (IT).

Information Technology plays a major role as a mean to improve the competitiveness of companies and efficiency of project delivery. Internationally, the construction research and practice are seeing a strong shift toward the use of Building Information Modeling (BIM) and Integrated Design and Delivery Solution (IDDS) (Owen, Amor et al. 2009, Davies 2010). The underlining motivation for the move is to improve productivity, product quality, and sustainability through the use of IT and associated processes. To be successful in the transition, changes in focuses and processes are necessary within the construction industry and other sectors involved: building owner, designer, builder, and product manufacture.

Kubicki and Boton (2014) suggested that it is imperative to understand the maturity of IT use in the sector. In their study, they found that there is a push to use IT in project management for innovation and competitiveness from public and private sectors. Even though some new technologies are currently gaining traction (BIM, national project standard platform), there are still some resistances among practitioners possibly due to the heterogeneity of IT competencies or a lack of understanding in IT collaboration. The findings are relevant to the claim by Marsh and Finch (1998) that the construction industry is infamous in adopting new technology. Kang, O'Brien et al. (2013) reported in their paper that construction industry is one of the most backward sectors in term of IT adoption and use. Many barriers exist in implementing new IT applications in the AEC/FM (Architecture, Engineering, Construction, and Facility Management) sector. The fact that many practitioners are generally not aware of new technologies and are not sure about potential benefits (Marsh and Finch 1998) also exacerbates the problem. It is, therefore, a challenge to inventory the use and impact of IT in construction industry not only as an individual country or territory but the globe as a whole.

2. Why IT Barometer?

In recent studies, it was found that there were many surveys carried out on the use of IT at the different time, time intervals with a wide range purpose. The results of these surveys, unfortunately, were uncomparable or misleading (Howard, Kiviniemi et al. 1998). They depicted only the state of IT use in an individual industry or country within a defined time frame. Comparison of the use, both domestic or international, to portray the growth and its successes of IT use were unreachable. This resulted in a loss of interests by the users to complete similar surveys subsequently or commercially use of data only for marketing purposes (Howard, Kiviniemi et al. 1998). IT Barometer, introduced in 1997, was created in the hope to eliminate this discrepancy and use as a tool to make unprecedented IT use comparisons.

One of the IT Barometer's important goals is to be repeatable. Similar questionnaires help to measure the increase in awareness and use of IT (Howard, Kiviniemi et al. 1998). However, this tool is not employed to see which countries or industries spend the most on IT, but to study national differences and successes, and help benchmark the take-up of new applications (Howard, Kiviniemi et al. 1998). For many countries, to make an informed decision making in IT investment, development, and education, they need information regarding their current state of IT use (Davies 2010).

3. What is IT Barometer?

IT Barometer is a survey performed to measure the use of information technology in the country. (Samuelson 2002) The main purpose is to provide information and an in-depth analysis of internal and external resource's capacities of each individual (industry or country) (Technology 2016). In the construction industry, IT Barometer was introduced in 1997 by Olle Samuelsson as an initiative to study the use of IT under the Swedish R&D program, "IT BOF" (IT in Construction and Facility). At that time, the aim of the project was to create an IT measuring tool for the construction and facility management sector. (Samuelson 2002). The researcher wanted to measure the access and use of hardware and software, the effects of the use, and future plans for investments. Not only for measuring the use, IT Barometer was also aimed to compare the results by intervallic repeating the process to gain a perspective of the IT-use growth, success, and awareness in each country (Howard, Kiviniemi et al. 1998).

4. Methodology (IT Barometer Formats/Questionnaires)

4.1 The first IT Barometer survey (Sweden in 1998)

IT Barometer in its simplest form is a closed, structured, paper-based mail survey to gather information regarding the use of IT applications from involved parties in the construction industry. The ways 1) the questions are framed, 2) population and desired respondents are identified to represent the industry, and 3) response rates received, are all important factors to make this tool valid and produce usable results.

For the last decade, various research on IT in the construction industry has been conducted. Both qualitative and quantitative forms, undoubtedly complementing each other, were evidenced in many publications. The original IT Barometer questionnaires, developed at KTH, Stockholm in 1997, as a part of a Master's thesis study, were divided into two parts. The first part was questions regarding the company profile (business, company's size, employee, location). The second part asked about IT use, management, and investment in the company and was divided into six subparts. In its original form, IT Barometer was intended to:

1. Be repeatable and comparable over time
2. Be comparable between countries
3. Cover all categories of companies in the construction industry, which was defined as architects, technical consultants, contractors, facility managers, and material industry. The comprehensive view of the participants who should be included in the survey was relevant with Owen, Amor et al. (2009).

In 1998, the first IT Barometer survey was implemented. There were three issues to be considered before the study took place:

a. Definition of firms in the construction industry - how to define and who are included in the construction industry.

b. Principle for selection - within the industry, how to select the representative to portray the use of IT.

c. Weighting – how to account for each answer to represent a correct proportion and to depict a true picture of IT use in the industry.

1. Definition of Firms in the Construction Industry

In the first study, the construction companies were defined as companies registered with Statisticals Sweden (SCB). It counted all companies' workplaces in the categories in order to be inclusive of all relevant parties in construction. The main focus firms were: architecture, engineering, construction, property owner, and manufacturing/trade.

In later studies, official or national organizations collecting nation's facts and figures or relevant professional organizations in construction were used as a starting point to define the construction companies in the study. In a case where such institutes did not exist, the personal network of contact was used. This by no means could represent the industry (Pamulu and Bhuta 2004).

2. Principles of Selection

In the first survey, two interesting aspects of whom to be selected to answer the survey had arisen. The first issue was regarding the quality of information to be obtained. The question was to whom can provide more accurate information regarding the IT use: users or suppliers? Suppliers, unarguably, know the numbers of volume sale, but the users, being an active part, can provide more accurate information regarding the use of technology in their workplace. This approach, therefore, was used in the IT Barometer survey (Howard, Kiviniemi et al. 1998).

The second issue considered before starting the research was how to identify each respondent. There were two possibilities either on the basis of companies or workplaces. In the survey, the basis of workplaces was chosen for two main reasons. The first reason was that many companies may have different types of business under one name. Different businesses, in turn, could belong to different categories classified by the researcher and may use or need IT in different extent. The second reason was, if selected based on the companies, the disproportion to the result would occur. Since the research outcome was weighted regarding the number of employees; if a bigger size company was misrepresented by only one set of the questionnaire; it could yield a misleading result. By choosing a workplace as a basis for selection, it opened up an opportunity to truly detail IT use and management situation. In this research, the workplace was defined as an address where the company carries out activities (not the home address).

Furthermore, to capture the truth of how different business types and their sizes plays a role in the IT use in the industry, the two-step population selection was adopted. The first step was dividing the population into groups based on a certain characteristic or "stratified selection". In this research, two aspects of respondents were of interest; business categories and sizes. In terms of business categories, the population was divided into five groups: architects, engineers, contractors, property owners, and manufacturers/trades. The company's size, based on the total numbers of employees, was divided into four groups: 1-9 employees, 10-49 employees, 50-199 employees, and 200 or more employees.

In the second step, within each group based on the company's sizes and categories, the population were freely selected. With this two-step method, not only could be seen the overall use of IT in the construction industry, but also the use of IT in each category of business/size of the workplace.

The majority of later studies partially followed the steps described above. Some research (Pamulu and Bhuta 2004, Chien 2010, Gaith, R. et al. 2011, Olarika 2011), depending on their study aims, were only interested in a specific category or business's characteristics regardless of their sizes. The selection principle was the factor most modified to suit each study purpose but consequently make them uncomparable.

3. Weighting

The next critical step in conducting the survey, after the result was tally, was the weighting method. To both understand how the construction industry use IT as a whole and in each subgroup, a way to portray a real situation in IT use is needed to be identified. In the first IT Barometer survey, the researcher was interested in how different sizes and categories use IT in their businesses (as described in the principle of selection section). Typically, in the construction industry all around the world, it composes of few large and lots of smaller companies. Even though smaller in the number, many large construction companies have a high impact on the industry since they employ a large number of workers. On contrary, there are plenty of smaller size companies with few people hiring and each individual firm has a little impact on the industry. Therefore, responses from both groups are important and need to be under consideration for this purpose. If each company is given the same importance in the analysis, it could skew the results, due to the fact that each company cannot represent equally important in the industry.

In the weighting process, the researcher applied a two-step activity to prevent mis-representing of the firm to happen. In the first step, the answers were multiplied by the number of employees in each workplace. Then, they were, again, multiplied by a factor (a number represented the workplace with the right impact on the industry), in the second step. The right impact factor was the division of the total number of workplaces in the stratum by the number of workplaces answered.

In this study, the personal interviews and mailed surveys were employed. The postal survey was aimed to collect answers regarding what and how (quantitative); while an interview study was aimed to explain why (qualitative). Postal questionnaires were intentionally used in order to reduce the bias of users who may regularly use electronic tools. This was

due to the fact that, a user survey with only one topic tended to receive responses from those who involved in the topic. This was particularly true for the question regarding IT (Howard, Kiviniemi et al. 1998). The first survey was targeted on the representative from Swedish construction industry, especially the company with IT managers and regular users. The personal interviews, on the other hand, were not mentioned or described in details in this study.

Later on, the same questions with few local variations were used in Danish and Finnish surveys. Apart from the questionnaires, two postal reminders were sent and remainder calls via telephone were also employed to get the higher return rate of the survey. The response rate of the first survey was 23%.

Since then, there were multiple IT Barometer surveys based on the initial format and modified versions conducted around the globe. However, for the IT Barometer survey originated by this research team, the three key concepts were always strictly upheld.

4.2 The second IT Barometer survey (Sweden in 2000)

The IT Barometer survey was repeated in Sweden in the year 2000 to measure the use and compare to the 1998 survey's result. The respondent selecting method in the two surveys was identical; the only difference was the selection size. The first survey focused on the combination of categories and sizes of the workplace. To be statistically significant, it required a bigger sampling size. The year 2000 survey, however, was critically emphasized more on the answering rate. It aimed to capture a significant number of answers to portray the industry's true use of the IT than the results derived from an uncertainty conclusion from a combination of categories and sizes. This resulted in a smaller group of sampling. The majority of questions asked and other aspects of this survey were similar and most of the questions were comparable directly with the previous survey.

4.3 The third IT Barometer survey (Sweden and Finland in 2006)

The third IT study, with the same purpose, was conducted in Sweden and Finland in 2006. The aim of this research was to complete an eight-year-long study of the IT use in construction and FM by comparing the result overtime within and among the country. This study was hoped to enlighten the industry about different system adoption processes.
In this study, the questionnaire was modified from the year 2000 with some questions were removed and some were added. The obsoleteness, advancement in technology, and changes in perception of technology from the practitioners were main reasons for the

modification. The obvious shreds of evidence were the capability to access to a faster internet, the way to communicate project information and a long-awaited standardization of electronic trade being put in place (Samuelson 2008). Development of software regarding building information model as well as the knowledge and awareness of BIM had also increased. This resulted in new categories and questions asked.

The changes found in this survey were 1) less focus on the access to hardware and common software and 2) focus on three areas: BIM, e-business, and Electronic Data Management (EDM). The survey employed ordinary mail to request for the answer. However, this time, the questions were not included in the mail but the instructions on how to complete the survey via a web form. The survey had the least response rate, standing at 13% (Samuelson 2008).

4.4 The fourth IT Barometer survey (Sweden in 2011)

The latest survey was conducted in Sweden in Spring 2011 to study and compare the results with the earlier studies (longitudinal study). In this survey, the extra interview-based study focusing on the adoption of Electronic Document Management (EDM), Electronic Data Interchange (EDI), and Building Information Modelling (BIM) technologies was added to supplement the original quantitative questionnaires. In this survey, ordinary mail was employed in the same fashion as in the third survey. However, only four parts of questions were to be answered and the study received 20% response rate (Samuelson and Bjork 2014). Again, similar to the previous paper, how the interviews were set up or how interviewees were chosen were not mentioned in the study.

5. IT Barometer Studies in Southeast Asia Countries (Singapore, Indonesia, Taiwan, Malaysia, and, Thailand)

5.1 Singapore (2003)

The IT Barometer survey had been conducted in Singapore in 2003. It was aimed to 1) examine the levels of general adoption of IT in the Singapore's construction industry and 2) compare the results among various IT Barometer surveys especially in Sweden, Finland, and Demark. The second aim was accomplished based on the claims that the construction industry characteristics in Singapore were similar to the ones in Sweden, Finland, and Denmark (Hua 2005). The third objective was to ascertain key differences in the level of IT adoption and the last point was to draw an important lesson for the countries intending to adopt IT on a large scale.

In this study, the format and question asked were similar to the original IT Barometer survey and mailed out to a total of 754 companies in the five identified businesses.

They were companies registered with well-respected professional organizations and were claimed to be able to adequately represent the industry. In each organization, the study purposively selected categories especially with numerous large companies. The researcher claimed that this pre-selection process could eliminate the impact of the company size discrepancy while interpreting the survey results. Therefore, no weighting factor was used in the study. The lack of smaller size companies input could mislead the result of the overall picture of the IT use in Singapore. The total questionnaires returned were 84 or 11.1%.

5.2 Indonesia (2003)

In Indonesia, a modified version of the IT Barometer survey was conducted in the year 2003 (Pamulu and Bhuta 2004). The study was aimed to investigate the current state of IT in the construction industry and the general view of IT applications in Indonesia. The questions were very similar to the original IT Barometer survey used in Sweden which divided into two big parts. The last section of the question, nevertheless, was highly different from the original IT Barometer survey.

This study was conducted between December 2002 and April 2003. The researcher employed both questionnaire surveys and personal interviews to gather information needed. The questionnaires were sent via a postal service; while the interviews were conducted as an additional step targeted to collect information that was limited via postal surveys. Nevertheless, the descriptions of how many interviews were set up or to whom the interview was targeted was not clear.

The respondent's names were obtained from the mailing list of the National Construction Industry Development Board (CIDB). The organization listed and classified its members into many different categories; however, only the B group or a large company mainly located in Jakarta was targeted. There were 247 companies (under the specified condition) listed with the CIBD, representing companies operated throughout the nation. Out of 247, 130 companies were randomly selected and questionnaires were sent.

No details of how the companies were randomly chosen or how up-to-date the list was. The numbers of employees in each so-called large company were not explicitly mentioned on the onset of this research either. The numbers of employees in each establishment were one of the important factors considered by the original IT Barometer survey. The result of this survey suggested that there was a wide range of companies from one to more than 200 employees responded to this survey. The deficiency of the employee size information from the beginning could lead to an unbalance of the industry's representa-

tives or could undoubtedly be questionable regarding the finding results to portray the real uses of IT in the industry. 20 out of 130 (15%) questionnaires were returned (undelivered or declined to participate). Approximately 44% of the delivered was returned and were analyzed.

The last set of questions in the survey, the level of IT use in business processes was newly introduced in this study and considered additional questions from the original IT Barometer survey. This question intended to find a means to classify the role of IT that played within organization business processes. In this research, the business process in the construction industry was divided into 10 categories ranging from business planning to design, construction to human resources. The results suggested that in Indonesia's construction industry, the scores of IT use in each category ranged from 4.58/5.00 to 0.73/5.00.

5.3 Taiwan (2008)

An altered version of the IT Barometer survey was implemented in Taiwan in the year 2008. The aim of this survey was to examine the current state of Information and Communication Technology (ICT) use by small and medium Taiwanese construction companies. This survey was initiated to respond to the Taiwanese emphasized the use of ICT to support the design and construction processes and to improve its quality and effectiveness (Chien 2010).

The survey was conducted during April – June 2008. A purposive sampling of 100 small and medium construction companies from the researcher's network of contacts was used in this study. This, by no mean, could be used to represent the industry but the argument from the author was that it could provide some indications in the industry. The author decided to use both open and closed-ended questions in the questionnaires. The closed-ended questions were sent via postal to ensure the consistency of the respondent's feedback. The total of seven multiple choices was included in the survey but the total numbers of questions were not known. The open-ended questions, however, was used later in an interview with a small and purposive sample to collect descriptive data after the questionnaire's result was processed analyzed.

A pilot study was employed to validate the questionnaire's reliability. Two different construction firms with different turnover rates were selected for this purpose. The pilot study was intended to test the wording, identify ambiguity and measuring time spent to complete the survey. Also, before the questionnaires were sent out, the researcher made a telephone call to identify a person who will answer the questions. The survey was

intended for the person who in charge in the company's ICT, but in construction firms in Taiwan, it found out that the majority firms did not have a designated ICT manager per se. The person in charge usually had other responsibilities apart from ICT.

A total of 51 valid responses was received which equal to 51%. This response rate was higher when compared to other previous surveys in other countries. It could contribute to the fact that the respondents were from the author's network and could be easier to convince them to answer the questions. After all questions were return, the author analyzed the result based on the company's turnover value (below TWD 0.1 billion and between 0.1 to 2 billion). The one-way ANOVA analysis was implemented to test the difference of opinion between the two groups and the results were confirmed. The researcher, therefore, conducted interviewed to further investigate the reasons. However, only two companies with different categories of turnover values were interviewed to confirm and reason for the differences.

This study was different in many aspects from the original IT Barometer. It focused on a specific sector of the industry whereas the original wanted all-inclusive players. The samples in this research were selected from the pool of the author's network and analyzed the data based on the company's turnover value instead of sizes or categories. The author may assume that the turnover rate a company accomplished might correlate with the numbers of employees employed. The additional steps, a pilot study, was nice to make sure that the survey questionnaires were relevant and not wordy.

5.4 Malaysia (2011)

Malaysia also conducted an IT Barometer survey in the year 2011. The aims of the study were to investigate the current extent of IT usage, availability, and its perceived impact in the construction industry (Gaith, R. et al. 2011). The researcher hoped that the results could provide directions in research, development, training, and strategies the industry needed.

The questionnaires employed were the improved version from Canadian IT Barometer survey (Rivard 2000). There were five different sections containing questions to be answered. The population, construction firms, were obtained from lists of Construction Industry Development Board (CIDB) directory which classifies and registers construction firms in different levels.

In this study, only three grades of construction firms with a certain limited job values were selected. The research suggested that, in Malaysia's construction industry, the grade

of the firms played a crucial role in the economy. Especially it helped generate employment. Nevertheless, the researcher was not concerned with the impact of different firm sizes (numbers of employees) in this study. Without company's sizes, the impact of active users in each company could not be portrayed. As a result, the study could only show the status of IT usage on a macro scale. The lack of company's size could be because the author might believe that the firm's size was directly related to the ability to work on different value projects (company grade). A better grade firm might employ more staff to handle a higher values project. Also, it was not clear that the study only focused on the construction firms with different specialties or other related firms as well. No future followed up survey to compare the result with this study was mentioned. This, again, was different from the three main principles of the IT Barometer.

In this study, there were no weighting or respondent selection strategies. The samplings were selected randomly from the CIDB directory. The target respondents were the companies' owners, project managers, and general managers. A total of 48 or 38% valid responses were received out of 250 names.

5.5 Thailand (2011)

There was a study by a Master's student using IT Barometer in Thailand in 2011 (Olarika 2011). The main goals of this study were to investigate the current use of IT tools in construction firms located in the Bangkok metropolitan area and to compare the study results with other countries. This study closely followed the first IT Barometer survey's procedures.

The population of the study was retrieved from the list of registered construction companies with the Thai Contractor Association (TCA). The TCA divided the firms into nine categories but only one category "building construction contractor" was selected. A random call according to the list was performed to verify the existing of the firms. There were 310 firms in this category.

The questionnaires were developed by adapting the original IT Barometer with consideration of the Thai construction industry's norms and practices. The principle of adaptation was by investigating previous studies and selecting questions asked by most countries in order to compare the result later. The draft of questionnaires was then validated by experts. This step was to be sure that the questions were relevant and up to date. A pilot study was performed before the final draft was sent out.

The researcher used the closed-ended questionnaires to ease the computation and comparison. At the same times, additional space was provided to capture extra information in the case the respondent thought the answer choice was too narrow. In this research, the questionnaires were divided into two parts with four subparts (six subparts in the original IT Barometer survey). The last two subparts were eliminated due to the fact that they were not relevant to the researcher's study aim. On one hand, when comparing the questionnaires in this research with the study in Finland and Sweden, it was clear that the questions in this research were identical to the first IT Barometer (1998). However, the advancement of technology in the year 2011, make some questions somewhat out of the context. This, on the other hand, maybe appropriated due to the fact that the construction industry in Thailand was a bit far behind in adopting IT than the construction industry in the Scandinavian countries.

In this research, the researcher chose a wide range of personnel to be the company representatives: business owner, administrative board, head of the construction department, construction staff, human resource staff, and supply officers. This had undoubtedly raised a question of the appropriateness of the person who should provide company's information, direction, and decision making and how many people were answered the question in each firm was not clear.

The researcher employed two methods to deliver questionnaires: 1) Hand deliver (60 firms) and 2) By post (250 firms). The researcher waited for one month and made a reminder call to each firm. The response rate was 12.5%. Another aspect that this study was different from the Finland and Sweden version was the variety of firms answer the questionnaire. In this study, the researcher only concerned about the constructors while the original IT Barometer survey was focused five different businesses involved with the construction industry. The company's size and the way the answer was weighted were also not considered. This clearly could skew the result.

Even though this study used the original IT Barometer as a model, there were many issues that were not aligned. The weighting, the categories of respondent, and the proportion of the firm size were some samples.

6. Lesson learned

This paper has reviewed what IT Barometer is and the importance of this tool. The followings are issues learned from the review and should be a bullet point for those who want to use this tool in their future study.

1. Three key factors: repeatable, comparable, and inclusive, are what IT Barometer survey intended to be accomplished.

2. Another three main issues needed to be clarified before the IT Barometer should start are definitions of the construction industry, principles of selections, and weighting criteria.

3. From the review, there are changes in society, technology, industry, and work process and It will continue to happen as witnessing in the study. Therefore, the IT Barometer conducted later needs to consider these factors and reflect or prepare to reflect them in the future questionnaires.

4. From the review of IT Barometer in Southeast Asia, it is clear that none follows the three-key factors that IT barometer is intended. Moreover, many studies only imitate the questionnaires and the structure of the questions. The three main issues (definition of industry, selection principle, and weighting criteria) are, sometimes, partially considered. This could due to the fact that each research has a specific aim to find an answer for a particular set of questions the researcher established.

5. It is clear from the review that comparing the result of IT Barometer survey among countries is very difficult, if not impossible. The fact of the matter is that each country may have incentives or interests to conduct a research for a particular group. Also such country may have different processes, procedures, mindsets, and methods used in asking questions. Therefore, a longitudinal (compare to its own) maybe the best suit for this type of study.

6. From the review, it can be seen a various aim to conduct IT Barometer survey, however, the majority will include at least, to see the current state of IT use and applications, in its purpose.

Future studies of IT use in the construction industry can benefits from this study by using the review as a starting point to frame a new IT survey that is both met the aim of the inventor and, at the same time, applicable for individual construction industry context and practices.

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