

Information Technology Infrastructure Flexibility: A Review from Previous Studies and Implications for Research

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Abstract

New technologies, demands from the customers or clients, changing of procedure and/or business direction give new insight and impact to the organizations. Whether they are ready or not, the organizations need to respond and follow the trends and updates. Thus, it is important for the organizations to ensure that the Information Technology (IT) structure and respective systems application meet those changes. The organization's IT infrastructure should well design and works accordingly so that it be able to support the organization's operational and transactional processes. A number of studies conducted in measuring IT infrastructure flexibility. The researchers and scholars have taken into account to measures it either as the dependent variable, mediating variable or independent variable. The determination and justification of its selection were referred to its functionality and case of sturdy. Therefore, this current study has reviewed several studies on IT infrastructure flexibility across fields, scopes, and contexts in getting grown view the use of IT infrastructure concept.

Keywords: IT Infrastructure, Flexibility, Human, Technical, Process, Literature Review, Information Management

Introduction

In ensuring the organization business products or services remain competitive in the market, able to face their competitors, and compete with their rivals in a wise manner is not that easy in today's business environment. There are challenges, obstacles, and circumstances that need to be faced by these business organizations. These will lead to the complexity and competitiveness among them in their own business environment (Ward, 2012). The organizations should have the ability to adapt any changes required in terms of infrastructure (i.e. management skills, technical resources, technical capabilities, tremendous resource planning) (Duncan, Sherrod & Weill, 1998) in order to maintain or sustain the competitive advantage (Syler, Cegielski, & Byrd, 2002). Furthermore, an organization that has IT

infrastructure flexibility can enable customer service process, process resources (compatibility, modular and interconnected IT infrastructure) throughout the units or departments, and data sharing for making the organization to come out with new products or services (Benitez-Amado & Ray, 2013).

This article is performing a literature review on the state of the use of IT infrastructure flexibility in any studies either as the dependent variable, mediating variable or independent variable. The first section began its discussion with an introduction and followed with the dimension of IT infrastructure flexibility. Discussion continued with IT infrastructure flexibility as the dependent variable, mediating variable, and independent variable. Section six will elaborate on methodologies approaches that have been used in measuring IT infrastructure flexibility. This article ends with the conclusion.

Dimension of IT Infrastructure Flexibility

There are a number of studies carried out conceptually and empirically on the IT infrastructure flexibility concept. The dimensions, characteristics or elements that have been used to measure IT infrastructure flexibility across studies is different from one another according to the nature of the research. Duncan (1995) explored and introduced the components and characteristics of IT infrastructure and flexibility respectively. Compatibility, connectivity, and modularity are the three (3) components of IT infrastructure flexibility introduced by Duncan (1995). A number of alternative components and characteristics have been developed and introduced (e.g., Byrd & Turner, 2000 & 2001; Chanopas, Krairit & Khang, 2006). Byrd and Turner (2000) assessed IT infrastructure flexibility which consists both technical (which are integration: comprises of IT connectivity and IT compatibility, and modularity) and human components (which are technology management, business knowledge, management knowledge, and technical skills). The findings of the study show that the technical component was supported and all dimensions in human component were viewed as a single component. The evolvments of this concept by researchers and scholars have grown to a bigger scale. An updated component for assessing IT infrastructure flexibility was produced by Chanopas, Krairit and Khang (2006). The components extended into nine (9), namely, IT personnel competency, scalability, continuity, compatibility, connectivity, rapidity, modularity and facility modernity. Until to date, the used of these components, i.e. either three (3), four (4) or all nine (9) depend on the suitability of the context of the studies.

IT Infrastructure Flexibility as Dependent Variable

Little studies have used IT infrastructure flexibility components as the dependent variable. For example, Joachim, Beimbom and Weitzel (2011) investigated the impact of different Service-Oriented Architectures (SOA) governance and management mechanisms for leveraging SOA's potential in increasing the organization's IT infrastructure flexibility. Modularity, integration, and scalability were used as IT infrastructure flexibility components in measuring its determinants which are SOA governance and management mechanisms (structure, processes, and employees). Limited studies found taking IT infrastructure flexibility as the dependent variable until to date. Fink and Neumann (2009a) investigated the organizational impacts on the Web Services Application (WSA) implementation. In their study, the components of IT infrastructure that have been used were IT integration, IT modularity, the range of physical capabilities, and range of managerial capabilities and all these are the dimensions of technological impact. The results indicated that WSA implementation positively affects IT integration and IT modularity was supported and WSA implementation

positively affects the range of physical capabilities and the range of managerial capabilities was partially supported.

IT Infrastructure Flexibility as Mediating Variable

There are not many studies conducted using IT infrastructure flexibility as a mediating variable. A study by Kim, Shin, Kim and Lee (2011) used connectivity, compatibility, and modularity in measuring between IT management capability and IT personnel expertise with process-oriented dynamic capabilities (PDCs) and firm performance. The selection of these dimensions to represent IT infrastructure flexibility are from Duncan (1995), Keen (1991) and Byrd and Turner (2001). Through their literature review, IT infrastructure flexibility capable to become a source of a strategic ability for the organization which led to better business processes. The results of the study indicated that IT infrastructure flexibility is workable to become partial mediating variable between IT management capability with PDCs and IT personnel expertise with PDCs. The study had brought the role of IT management capabilities in bridging the gap between IT personnel expertise and IT infrastructure flexibility.

IT Infrastructure Flexibility as Independent Variable

Looking into the use of IT infrastructure flexibility as the independent variable is quite a lot in previous studies compared its usage as the dependent or mediating variable. Some of researchers or scholars that used and empirically tested IT infrastructure flexibility as independent variable such as Byrd and Turner (2000 & 2001), Chung, Rainer and Lewis (2003), Ness (2005), Fink and Neumann (2009b), Masrek and Jusoff (2009), Masa'deh (2013) and much more. Byrd and Turner (2000) used IT infrastructure flexibility in measuring it against IT investment and competitive advantage. They classified IT infrastructure flexibility into two (2) components, which are technical IT infrastructure and human IT infrastructure. The technical IT infrastructure consists of IT connectivity, applications functionality, IT compatibility, and data transparency. For human IT infrastructure, the dimensions are technology management, business knowledge, management knowledge, and technical skills. The study found that there is a solid relationship although not spectacular between IT infrastructure flexibility and IT investment. A good relationship found between IT infrastructure flexibility and competitive advantage. Another finding that they found is a merging of dimension in both components, i.e. integration: is a combination of IT connectivity and IT compatibility, modularity: is a combination of application functionality and data transparency, and IT personnel flexibility: viewed as one instead of four (4) dimensions. Byrd and Turner (2001) conducted another study using IT infrastructure flexibility with the competitive advantage. This time around, the dimensions used to represent IT infrastructure flexibility are modularity, integration, and IT personnel flexibility. The chosen dimensions are based on their previous finding. The dimensions used in competitive advantage are different from their previous study, i.e. innovativeness, market position, mass customization, difficulty to duplicate. The results of the study indicated that all three (3) dimensions of IT infrastructure flexibility were positively related to all dimensions in competitive advantage. These both studies by Byrd and Turner (2000 & 2001) had been referred and used quite extensively by several researchers and scholars when involves IT infrastructure flexibility.

A study from Chung, Rainer and Lewis (2003) had also used IT infrastructure flexibility as the independent variable in looking towards strategic alignment and applications implementation. They used compatibility, modularity, connectivity, and IT personnel to represents IT infrastructure flexibility. The variables selection was identified based on the

work from Duncan (1995) and Byrd and Turner (2000 & 2001). Their study found that three (3) out of four (4) variables, i.e. connectivity, modularity, and IT personnel are significant and have a positive impact on strategic IT-business alignment. The other one, i.e. compatibility was not had significant impact on strategic IT-business alignment. Another study that also used IT infrastructure flexibility as independent variable conducted by Ness (2005). He took three (3) components to represent the IT infrastructure flexibility which are connectivity, modularity, and compatibility. The purpose of the study was to measure the relationship between IT flexibility, strategic alignment, and IT effectiveness. Ness (2005) also used strategic alignment as independent variable besides of IT infrastructure flexibility. The result of his study found that IT flexibility was positively correlated with strategic alignment and IT effectiveness. On top of that, IT flexibility was a higher positive correlated to IT effectiveness compare to strategic alignment.

A slightly different way of plotting the IT infrastructure flexibility components in his framework was done by Fink and Neumann (2009b). The intention of the study was to explore the perceived business value of the flexibility enabled by information technology infrastructure. The different that they had made in their study are: (1) classified the components of IT infrastructure flexibility, and (2) proposed and tested new component of IT infrastructure flexibility, namely process IT infrastructure. The dimensions of competitive impacts are strategic alignment and IT-based competitive advantage. They had classified the IT infrastructure flexibility into three (3) clusters which are human, technical and process IT infrastructure with its dimension, for example, human IT infrastructure consists of business, behavioral, and technical knowledge/skills, technical IT infrastructure consists of IT modularity, IT compatibility, and IT connectivity and process IT infrastructure consists of range of managerial capabilities and range of physical capabilities. However, human and technical IT infrastructure was not connected to competitive impacts but process IT infrastructure. All three (3) dimensions in human IT infrastructure were significant toward the range of managerial capabilities and range of physical capabilities except for behavioral business/skills towards the range of physical capabilities. For technical IT infrastructure, only IT connectivity was turned out to be significant affects range of physical capabilities and the rest are not. The range of managerial capabilities was significant affects strategic alignment and IT-based competitive advantage. However, the range of physical capabilities turns out to be no significant affect to both dimensions of competitive impacts.

Masrek and Jusoff (2009) conducted a study on the effect of IT infrastructure flexibility on intranet effectiveness. Four (4) components of IT infrastructure flexibility have been used which are compatibility, connectivity, modularity, and skilled IT personnel and three (3) dimensions used to represent intranet effectiveness such as operation, culture, and facilitation. Only three (3) out of four (4) components of IT infrastructure flexibility found to be significantly related to the intranet, i.e. connectivity, modularity, and skilled IT personnel except for compatibility. These three (3) components also denoted a higher degree of intranet effectiveness. A study by Masa'deh (2013) used all nine (9) components in IT infrastructure flexibility in measuring its impact towards firm performance. There is mediating variable in between IT infrastructure flexibility and firm performance which is the IT-based competitive advantage. The results indicated that IT infrastructure flexibility was positively related to IT-based competitive advantage and has no direct effect on firm performance.

Methodological Approach

In the field of IT infrastructure flexibility, there are several approaches taken by researchers and scholars which either through quantitative or qualitative method. The exploration and

investigation vary from one to another. Several studies were found to investigate the concept of IT infrastructure flexibility in this quantitative method. Normally, the studies that used this method is due to defining the construct, to develop a reliable and valid instrument, to explore the relationship between certain concepts, to examine the impact and much more. Across the years, some of the studies found using this method are Byrd and Turner (2000 & 2001), Chung, Rainer and Lewis (2003), Chung, Byrd, Lewis and Ford (2005), Ness (2005), Fink and Nuemann (2009), Zhang, Li and Ziegelmayer (2009), Gholami, Kaviani and Zabihi (2009), and Wali and Iruka (2013).

One of the prominent and earlier studies on IT infrastructure flexibility is from Byrd and Turner (2000 & 2001). The study started in the year 2000 with the intention to develop a reliable and valid instrument and the study continued in the following year with an exploration relationship between flexible of IT infrastructure and competitive advantage. Both studies emphasize the importance of flexibility and its benefits of IT infrastructure in an organization. Whenever the flexibility element is absorbed in existing IT infrastructure, thereby, its gives advantages and benefits to the organization itself in giving capability and ability to accommodate any business processes change at any time. A year later, Byrd and Turner (2000 & 2001) used the quantitative method and emailed the instrument (questionnaire) to approximately 1,000 organizations listed in FORTUNE 2000. Respondents that represented each of the organization were among senior IT managers. Beforehand, the study underwent a pre-test and followed by the pilot test. During the pre-test, Byrd and Turner (2000 & 2001) trimmed the items from 132 to 97 items. Meanwhile, the pilot test also reduced the number of items to 74 with three (3) different industries: mass retailer, textile manufacturing, and financial institution. For both respective tests, an IT managers were invited and appointed to review and answer the questionnaire.

A study from Chung, Rainer and Lewis (2003) examined the impact of flexibility in IT infrastructure towards the extent of IT implementation and strategic IT business alignment. The study used four (4) components of IT infrastructure flexibility that consisted of connectivity, compatibility, modularity, and IT personnel even though there were varieties of components. Chung, Rainer and Lewis (2003) distributed the questionnaire to senior IT managers via email. The list of organization involved was taken from the directory of top computer executives which was published by Applied Computer Research. In term of the sample size selection, the study used proportionate stratified random sampling to represent the population.

Using the same components of IT infrastructure flexibility, a second part of the study was then conducted by Chung, Byrd, Lewis and Ford (2005). The study decided to combine two (2) components, which are compatibility and connectivity and it is represented as integration, while the remaining two (2) components remain unchanged. The other difference of this study is it measured the components on the business performance and mediating variable, mass customization. The respondents of the study were IT managers that listed in FORTUNE 2000 organizations in the United States. There were about 12 industries responses to the questionnaire that was sent via email, i.e. communications, banking, government, financial, manufacturing, health services, real estate, insurance, transportation, retail, and wholesale. To see the extent to which IT flexibility influenced IT effectiveness compared to strategic alignment was done by Ness (2005). The study took three (3) components of IT flexibility, namely, connectivity, modularity, and compatibility. In the case to measure and answer the research objective, Ness (2005) has chosen senior IT executives and CIO of the organization listed in Applied Computer Research, Inc. to response the questionnaire. The researcher has

use questionnaire as a primary method in doing the study data collection. Throughout the data collection activity, the study has sent memo all over 3,080 respondents to fill-up the electronic form of the questionnaire (using survey monkey). In addition, the respondents would only require to tick or choose one that closely represents their thought or feelings out of 7-point Likert Scale.

A new insight was reported from the findings of the study that was conducted in Israel by Fink and Nuemann (2009b). The study empirically tested multidimensional components of IT infrastructure flexibility, which comprising of three (3) main elements, human IT infrastructure, technical IT infrastructure, and process IT infrastructure. Based on extensive literature review analysis, they classified the elements accordingly and measure the framework via the qualitative method. Like studies discussed previously, the study also used a 7-point Likert Scale in their questionnaire. For the data collection process, they used web-based survey and an inviting e-mail was sent to 8,000 respondents who are the IT managers. The study conducted by Zhang, Li and Ziegelmayer (2009) measured the same components of IT infrastructure flexibility as the study conducted by Chung, Rainer and Lewis (2003) and Chung, Byrd, Lewis and Ford (2005). However, the study classified the components into two (2) elements that are resources (comprising of compatibility and connectivity) and capabilities (comprising of modularity and IT personnel competency). Zhang, Li and Ziegelmayer (2009) investigated IT infrastructure flexibility components in response to IT responsiveness. A total of 233 small to medium-sized (SME) companies gave their response to answer the questionnaire. The owner or managers represented the organization and answered the questionnaire with the selection of 5-points Likert Scale with 1 as very responsive while 5 as not responsive at all.

A continuous study in measuring IT infrastructure flexibility is still current across fields and contexts. For an organization to compete globally, Gholami, Kaviani and Zabihi (2009) stated that IT infrastructure flexibility is becoming an essential element. The literature review analysis supported assess to this component even though the context of the study is in the area of Web 2.0. This time around, Gholami, Kaviani and Zabihi (2009) took nine (9) components to be measured which are IT personnel competency, scalability, continuity, compatibility, connectivity, rapidity, modularity, facility, and modernity. The researchers conducted the survey with probability sampling. The potential respondents were those who had experience in working with distributed groups or with any of collaborating circumstances. The data collection was via a web-based survey, where the respondents presented their views based on the Likert scale provided by choosing the awareness level of six (6) popular Web 2.0 technologies, i.e. (1) wiki, (2) social network, (3) blog, (4) social bookmark, (5) really simple syndication (RSS) feed, and (6) web mashup.

A study by Wali and Iruka (2013) emphasized IT infrastructure as a key element in the development of the national economy of Nigeria. The intention of the study was to examine elements influencing marketing effectiveness. The study was done in the Nigeria banking sector. Wali and Iruka (2013) decided to distribute the questionnaire with simple random and judgment sampling technique among 10 banks out of 21 banks in Nigeria. Looking into the respondents, 100 staff were selected from these 10 banks and about 80 copies of the questionnaire were returned for data analysis. In answering the questionnaire, the respondents could choose one from the five-point Likert scale provided.

A few studies were found exploring and measuring the components of IT infrastructure flexibility using the combination of qualitative and quantitative research (also known as mixed methods), such as Chanopas, Krairit and Khang (2006) and Masa'deh (2013). There were no

rules of thumb mentioned about which method should go first, however, the normal practice and suitability of a certain study was to undergo qualitative research first and then followed by quantitative research.

The main objective of the study conducted by Chanopas, Krairit and Khang (2006) was to define and assess the other components of IT infrastructure flexibility. Most of the previous studies took three (3) or four (4) components, however, the study by Chanopas, Krairit and Khang (2006) addressed the other five (5) components of it. A complex and comprehensive literature review was done along with expert interviews in order to determine other components. Based on all other related components highlighted by the expert, the researchers then proceeded with the development of the questionnaire. There were about 74 questionnaires distributed at each of the 20 organizations invited to respond to the questionnaire randomly and 388 IT personnel from 20 organizations (i.e. the Office of Security and Exchange Commission, the Bank of Thailand, and the Department of Insurance at the Ministry of Commerce). The study only did descriptive statistics analysis rather than inferential statistics analysis because they only wanted to know the level of each IT infrastructure flexibility component.

The other research that also did mixed methods is a study conducted by Masa'deh (2013). The study consistently took the same nine (9) components of IT infrastructure flexibility that has been assessed by Chanopas, Krairit and Khang (2006). The difference here is the study empirically tested the components relationship between IT-based competitive advantage and the organization performance. The researcher conducted semi-structured interviews with three (3) MIS academic professors and IT managers. A set of questionnaires was distributed via airmail. The selection of respondents was Jordanian public shareholdings organizations (i.e. insurance, banks, manufacturing, and services). Out of 180 questionnaires distributed, 98 were returned for further analysis process.

IT infrastructure flexibility can be investigated through either qualitative research, quantitative research or mixed research. Nevertheless, the selection of which research methods adopted depends on the purpose of the study.

Conclusion

Looking into the capability, suitability, and important of IT infrastructure flexibility, this concept has been measured extensively either as the dependent variable, mediating variable or independent variable. Not only that, this concept also proved appropriate to be conducted using quantitative or qualitative methods. As most of the studies discussed in previous point, it is clearly that IT infrastructure flexibility's dimensions supported its determinants or factors towards or against their measurement. However, not much researchers or scholars out there measure IT infrastructure flexibility as the dependent variable and mediating variable compared as the independent variable. This could due to the role, suitability and functionality of IT infrastructure flexibility itself in the organization structure. Factors that may influence IT infrastructure flexibility and become as the dependent variable such as an impact or effect on budget allocation spending, the design of IT infrastructure, and the technologies movement. More explorations on IT infrastructure flexibility as dependent variable are required by researchers and scholars in order to have a better understanding and new findings may be gained.

Seeing the benefits of IT infrastructure flexibility to an organization, this drove the researchers and scholars to measure it as a factor or independent variable. Results in previous studies shown that IT infrastructure flexibility strongly supported the organization's performance,

organization's strategic alignment, competitive advantage, competitive impacts, IT investment, application implementation, IT effectiveness and much more (Joachim, Beimborn & Weitzel, 2011; Fink & Neumann, 2009a & 2009b; Kim, Shin, Kim & Lee, 2011; Byrd & Turner, 2000 & 2001; Chung, Rainer & Lewis, 2003; Ness, 2005; Masrek & Jusoff, 2009; Masa'deh, 2013). The usage of IT can be seen in helping the organization to increase the bargaining potential (with their respective suppliers and customers) apart from raising up entry barriers among the competitors and offering new services and products. The evolution has evolved such as tangible, shared, technological resources (including the platform technologies: operating systems and hardware), data, software applications, and networks and communication. The lacking of flexibility in the rise of IT-based competitive advantage (on how IT drives the inside and outside change) will lead to the future cost incurred, delays in new products introduction and projects, increasing the customer dissatisfaction, and decreasing the organization's performance (Masa'deh, 2013).

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