SYSTEM RESOURCE THEORY APPROACH AND ITS APPLICATION IN THE STUDY OF INFORMATION TECHNOLOGY INVESTMENT AND FIRM PERFORMANCE A CONCEPTUAL PAPER

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ABSTRACT

This research was carried out mainly to find out the conceptual linkages on the relationship between IT investment and multidimensional performance measurement in electrical and electronic manufacturing setting in Malaysia. The focus on IT investment as the independent variable was made because of the huge amount allocated for it annually and the amount keeps on increasing over the years. Further to that, the issue of 'productivity paradox' which has been an ongoing debate for quite a number of years was another pulling factor of why this research was carried out. In addition to that, this research presented the study on the use of multiple measures of performance in the electrical and electronic (E&E) manufacturing firms in Malaysia. To be more specific, it examines how IT Investment which is categorized into four types according to its IT investment objective; namely infrastructure, transactional, strategic and informational, affects a firm's multidimensional performance measurement system represented by the balanced scorecard approach which has four perspectives; namely financial, internal business process, innovation and growth, and customer perspective. The objectives for this research are to establish the conceptualizations of IT investment and multidimensional performance measurement and to gauge on the extent of conceptual relationship between IT investment and manufacturing firm performance. The aims and objectives of this research were accomplished when the conceptualizations of each of the dimensions namely IT investment and multidimensional performance measures in use are established and the linkages are clearly explained.

Keywords: *multidimensional performance measurement, infrastructure, transactional, strategic, informational, financial, internal business process, innovation & growth, customer perspective*

1.0 Introduction

Most empirical studies on the issue of productivity paradox consider IT as a single homogeneous asset (Bharadwaj, 2000), divide IT investment into labor and capital stock (Brynjolfnsson & Hitt, 1996; Bharadwaj, 2000), and investigate IT investment to productivity (Mariela & Conception, 2009). Although most studies divide IT investment to reflect strategy and firm performance, only a few divide it into different asset class. This problem of

homogeneously treating the IT spending into one category needs to be discussed further because according to Woodward (1959), categorizing task technology into small batch proved to be more effective in determining firm effectiveness. To encounter this problem of homogeneously treating the IT investment and to further enhance the firm performance based on the different IT asset classes which will bring different benefits to the company (Weill & Aral, 2004), this study applies the categorizations of IT investment according to four asset class namely infrastructure, transactional, strategic and informational (Weill & Aral, 2006). Within this study, the four categorizations of IT assets class were introduced where firms need to segregate their IT spending according to these four IT segregations.

Another point to note is that the expenditures incurred for IT investment is enormous that lead to serious managerial concerns over the business value of IT (Lee**,** Chunhui & Siew**,** 2010). The rising trend in Firms' IT investment on hardware and software increased from 5% in 1978 to 22% in 2005, approaching investments in land and structures (Bureau of Economic Analysis, 2007) further justify the need for this research to look at the amount of IT investment in Malaysian setting since it is such a huge investment in other countries. This fact also justified the need to better assess the payoff from high IT investments so that the high investment will bring the added benefits to the firm.

The linkage between IT investment and performance (productivity paradox) had been studied but most of the studies used the traditional financial measurement as the basis to measure performance. Normally, firms will try to measure the payoff from the IT investment by using the financial ratios, just like they do when they want to measure capital expenditure e.g. payback period, net present value, and internal rate of return (Marthandan & Tang, 2010).

However, not all the benefits can be measured by using financial ratios and this resulted to the arguments about the effectiveness of financial ratios to measure the benefits of IT investments since it is different from other capital investments – especially when we cannot estimate hidden, intangible, and non-financial benefits (Ballantine & Stray, 1998; Irani & Love, 2000/2001). This problem of looking mostly on the financial ratios will become one of the focuses of this study that is to measure the financial as well as non-financial benefits from IT investment.

Thus, in line with the background discussed above, this study identified a few problems that deserve further research attention that formed the basis for problem statement of this study. This current research seeks to investigate how the problems as discussed above such as the issue of homogeneity in IT spending, the problems of high IT spending and the issue of whether a more comprehensive performance measure perspective as used in the BSC perspective are more suitable avenues to investigate on the issue of IT productivity paradox.

This research contributed to the extension of body of knowledge by investigating conceptually on the inadequacies of homogeneous conceptualizations of IT investment (Irani & Love, 2000/2001), increase in IT spending (Karyn & James, 2010), multiple performance measurement in the form of BSC for the manufacturing sector (Gomes, Mahmoud & Joao, 2004), and the IT productivity Paradox (Lee, Chunhui & Siew, 2010). The system resource theory (Yuchtman & Seashore, 1967) is being used as the background theory for this study where this theory is expanded, elaborated and conceptualized within the context of IT productivity paradox.

2.0 IT Investment

The business benefits of IT were highly important but controversial issue had drawn intense research endeavors in the past two decades (Winston & Benjamin, 2006). The studies of potential returns in IT investments had been researched by various scholars (Brynjolfsson & Hitt, 1996; Bharadwaj, Bharadwaj, & Konsynski, 1999; Dewan & Kraemer, 2000; Im, Dow, & Grover, 2001). However, research attempted to demonstrate the value of investment in IT had not provided a clear indication of how IT spending provides a pay-off (Walter, Sheri, & Robert, 2007). Although the benefits from IT investment has long been argued and debated, there is no clear consensus reached (Gang**,** Hongjiao**,** Linyan & Amrik, 2009).

Conceptual explanations of the term productivity paradox are as follows. The term productivity is basically the amount of output produced per unit of input. While it is simple to define, but it is difficult to measure it; for example, the measurement used for output will not just include the physical products produced from the production floor but rather the value created for consumers and in today's economy, value depends increasingly on product quality, timeliness, customization, convenience, variety, and other intangibles (Brynjolfsson & Hitt, 1993).

In view of conflicting findings on this issue, it was noted that the understanding of how IT affects productivity either at the level of the firm or for the economy as a whole is extremely limited (Mariela & Concepción, 2009); thus further justifying the need for this research to be carried out to gain a better understanding of IT investment to perform in different organizational settings.

A series of studies by Weill and Aral (2003, 2005) found that different management objectives in IT investments would lead to different performance effects. A pioneer study on the effect of different management objectives of IT investment on financial performance was made in a study by Weill (1992) who found that transactional IT investment was significant and positively associated with high performance as measured by financial ratio. However no significant association was found for informational IT investment with regard to financial performance. The same result applied for strategic IT investment which found that strategic IT investment was negatively correlated with manufacturing firm performance.

However, this pioneer study was limited in scope in the sense that it did not explore the effect of IT investment segregated by different management objectives on the effectiveness of a firm. A later studies by Weill and Aral (2003), Weill and Aral (2004), Weill and Johnson (2005), and Melinda and Guynes (2001) found that categorizing IT investments according to different management objectives would lead to different performance effects, which included both financial and non-financial measurements.

According to Weill and Aral (2004), the four IT asset classes had different risk return profiles in comparison to what a personal investment portfolio with cash, bonds, equities etc. Personal investments such as cash, bonds and equities would bring different risk return profiles on its own. By using the same justification, IT investment would also bring different risk return profiles when it was categorized into different management objectives. This approach worked because it highlighted the importance of the use of technology instead of focusing on the technology itself (Weill & Aral, 2006).

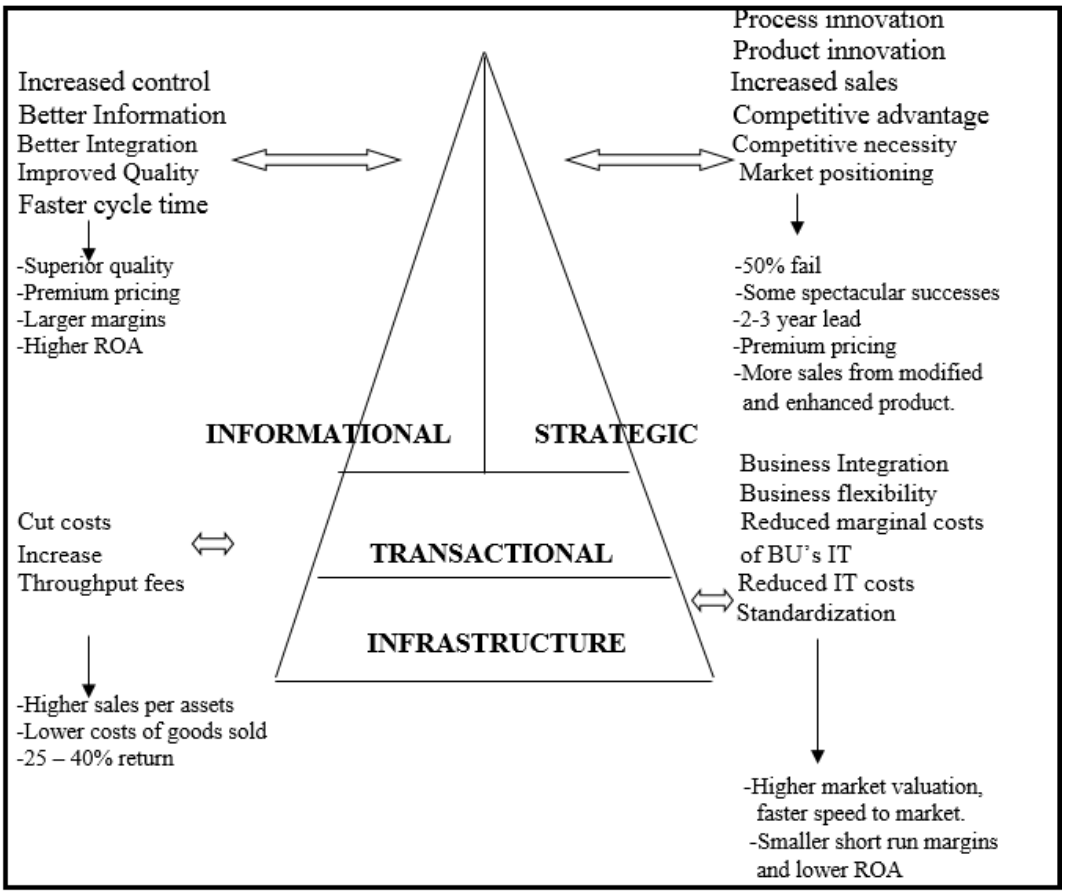

Figure 1: Returns from the four asset classes in the IT portfolio.

(Source: MIT CISR study by Weill & Aral using 1999-2002 data from 147 firms and P. Weill & M. Broadbent "Leveraging the new infrastructure: How market leaders capitalize on IT." Harvard Business School Press, June 1998. All relationships are statistically significant. 2004 MIT Sloan CISR – Weill & Aral. (Adapted from: Weill & Aral (2004). Managing the IT Portfolio : Returns from the different IT asset classes. CISR Research Briefing, Sloan School of Management, MIT)

Based on Figure 1 above, it shows the relationship among the four categories of IT Investment and multidimensional firm performance in a study conducted in the United States. The figure was illustrated in a triangle and the infrastructure IT investment became the foundation of all IT investments since on average, firms allocated 54% of its total IT investment each year to infrastructure (Weill et al., 2002).

The transactional IT investment sits above the infrastructure IT investment since the transactional IT system utilized the IT Infrastructure system and it constituted 13% out of all IT investment on average (Weill & Aral, 2004). Finally sitting on the top are the informational and strategic systems which utilized both transactional and infrastructure IT systems and comprised of 20% and 13% of average IT investment respectively (Weill & Aral, 2004).

3.0 Firm Performance

The term performance measurement has been conceptualized by several authors. Mia and Patiar (2001) conceptualized performance as the quantification of activities which will lead to effectiveness. Otley (1999) stated that performance measurement is related to the efforts to achieve organization's objective in the environment that it is in.

The evolution of performance measurement has changed as situation changes. According to Ghalayini and Noble (1996), in the beginning of the 1880s, the concerns of the day were of how to minimize cost in the production. This cost accounting approach was of importance since it could help managers to monitor their operating costs although later on some other elements of financial measures such as profit and ROI were also introduced to better measure the performance of the firm.

However, the growth of global activities during the 1980s and changes associated with it has drawn criticism on performance measurements using financial measures as its sole indicators. Previously the mass production with homogeneous products was order of the day but when foreign competitors were able to bring in more quality and variety products, local manufacturers began to suffer losses. Customers now have more variety and quality of products to choose from at competitive prices brought in by foreign competitors and as a result of this, local manufacturers began to lose out (Ghalayini & Noble, 1996).

In order to counter these unfavorable situations, they began to focus more on quality, variety, delivery, flexibility and also introduced technology such as Computer Integrated Manufacturing (CIM) and Flexible Manufacturing System (FMS) (Ghalayini & Noble, 1996). During this period, the disadvantages of focusing on financial measurements only had become apparent where criticisms were made of its inability to measure non-financial indicators. The focus on solely using financial measurement seemed insufficient to include on all factors critical to firms success (Kaplan, 1983; 1984). The implementation of these changes showed that traditional performance measures as used before had many drawbacks and needed to be updated to cope with the changing situations.

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According to Ghalayini and Noble (1996), the following will present the most commonly cited limitations:

i. Lagging indicators
Financial reports are the output of past transactions which is closed normally at the end of the month. Thus, it has become outdated for day to day operating decisions especially for non-financial employees like the supervisors and operators.

ii. Lacking of non-financial indicators
Not all of the critical success factors can be measured using financial indicators. Other performance indicators especially related to non-financial measurements cannot be captured using financial performance. With the globalization in world trade and stiff competition from foreign competitors offering more quality products at competitive prices, it is very important for firms to have all round performance measurement systems which have non-financial criteria such as lead time, quality and efficient delivery.

iii. Lacking of strategy
Traditional performance measurement has focused mainly on minimization of costs rather than continuous improvements. Strategy is not incorporated in the designing of traditional performance measurement system unlike in BSC which incorporates strategy.

Due to the wide ranging acceptability of the need to use non-financial indicators alongside financial measurement, some forms of new integrated performance measurement systems were suggested. The purpose for developing integrated performance measurement system was that it will show an overall view of companies' performance and to guard against sub-optimization (Ghalayini & Noble, 1996).

There were many methods introduces to integrate both of the financial and non-financial indicators to measure the firm performance and among them are performance measurement matrix (Keegan, Eiler, & Anania, 1989), balanced scorecard (Kaplan & Norton, 1992), and integrated dynamic Performance Measurement System (Ghalayini, Noble, & Crowe, 1997) and among all of the performance measurement systems, it appears that balanced scorecard (BSC) is the most used and widely generally accepted among practitioners and scholars (Gomes et al., 2004).

The advantages of using BSC and the justifications for using BSC as the performance measurement system that integrates both of the financial and non-financial indicators are explained below:

i. BSC encompasses both financial and non-financial benefits of firm performance, thus it will be able to capture the financial and non-financial benefits accrued from the IT investment.

ii. It incorporated together the elements of strategy, financial and non-financial measurements into it. It was a technique that allowed firms to translate their strategic objectives into a coherent set of performance measures (Kaplan & Norton, 1993).

iii. BSC incorporates strategy as an element used by a firm to link with firm performance. The conceptualization of IT as a strategy by a firm to achieve organizational effectiveness has been mooted by authors such as Edwards (2001).

iv. BSC has been acknowledged as the most frequently implemented performance measurement system showing its usability and acceptability in the market (Gomes et al., 2004).

Manufacturers recommended the use of non-financial measures in managing production activities. Non-financial measurements like customer service, quality, flexibility, delivery time, competitive position, and production process time were mentioned in literature on manufacturing performance measures (Kaplan, 1985).
According to Kaplan (1983), non-financial measurements were needed to monitor and control the manufacturing process. McNair, Lynch, and Cross (1990) also stressed on the importance of relying on both financial and non-financial measurements. The point raised for the usage of non-financial indicators alongside financial indicators in manufacturing was that financial measures were not relevant to shop floor operators. Most of the metrics of relevance to shop floor operators were those which were not normally measured using dollars and cents such as lead time reduction, delivery schedule, customer satisfaction and product quality (Ghalayini & Noble, 1996).
McNair and Mosconi (1987) proposed the usage of integrated performance measurement applying both the financial and non-financial measures according to the business strategy. This explanation fits well with the concept of BSC where it was established earlier that BSC incorporates both financial and non-financial indicators and at the same time stressed on linking the strategy to firm measurement and performance. Furthermore, BSC was the most widely used method to measure performance in manufacturing (Gomes et al., 2004).

4.0 System Resource Theory

System Resource Approach (Yuchtman & Seashore, 1967) was chosen to be used in this study as the underlying theory in studying the issue of productivity paradox. Within this framework, financial and non-financial performance measures were considered for use in this study. In this theory, organizational effectiveness looked at the firm itself as the main reference and it would generally explain the variables which were related to organizational effectiveness (Mahmood & Mann, 1993).

Based on the classic ideas (Yuchtman & Seashore, 1967), this theory puts it that organizational effectiveness would depend very much on how organizations could acquire and use valued resources. In this study, effectiveness would be on multidimensional assessment and the acquisition of resource would be on the acquisition of IT investment. According to the model, as applied in the study by Katz and Kahn (1966), the process took the form of input output transactions.

According to this theory, there were three main phases in explaining organizational effectiveness, those were input, process and output. The input of resources was the resources used to generate output, the process phase was the allocation and processing of resources to generate output, and the output was the final products or services and their exportation in some output form (Yuchtman & Seashore, 1967).

Several authors such as Mahmood and Mann (1993) and Brynjolfnsson and Hitt (1993) had conceptualized their IT investment as factor input and in line with this approach, this study also applied the same conceptualizations. Factor input was defined as the acquisition of resource so that it will help firm in attaining organizational effectiveness. IT had previously been regarded as a resource to a firm by many authors (Barney, Wright & Ketchen, 2001; Wu, Yeniyurt, Kim & Cavusgil, 2006).

According to Katz and Kahn (1966), the definition of organizational effectiveness should include the "maximization of return to the organization by all means" and furthermore in this theory, it stated that the highest level of organizational effectiveness was reached when the organization maximized its ability and optimized its resources.

In this study, it was proposed that firms would optimize its IT investment when they segregated it into different entity instead of single homogeneous entity. This argument was supported by Woodward (1959) who found that by segregating the task technologies into several categories helped in predicting firm effectiveness.

In this theory, it was proposed that organizational effectiveness must not be assessed using single criterion only, but must include an open ended multidimensional set of criteria (Yuchtman & Seashore, 1967). The issue of organizational effectiveness had been much researched by previous scholars especially from researchers in the social science discipline (Cameron, 1986, Katz & Kahn, 1966). According to Yuchtman and Seashore (1967), effectiveness was conceptualized in terms of resource viability rather than in terms of specific task objectives. Organizational effectiveness as defined here were the maximization of ability and optimal use of resource in order to derive the maximum benefits from it.

Hamilton and Chervanny (1981) explained the distinction between goal centered view and system resource view when evaluating effectiveness where in the goal centered view, the way to measure effectiveness is by determining the task objectives and to develop criterion measures to assess how far the objectives have been achieved and the effectiveness is determine by comparing between performances to objectives. An example given was to compare between actual benefits and costs with budgeted figures.

As for the system resource view, effectiveness is attained when achieving standards of good practices and these view systems fulfill other functions and have other consequences besides accomplishing official objectives (Hamilton & Chervanny, 1981). To clarify, different conceptualizations exist for different departments. In the human resource department for instance, the effectiveness in this department would be assessed by looking at the nature of communication and conflict between MIS and user personnel, user participation in system development, or user job satisfaction and for the technological resources, the quality of the system or service levels might indicate the level of system effectiveness (Hamilton & Chervanny, 1981).

To conclude, system resource approach stated that there were other functions and consequences which needed to be fulfilled instead of focusing solely on achieving official objectives and these needs had to be taken into account when measuring effectiveness (Hamilton

& Chervany, 1981). In short, the summary of Organizational Effectiveness as explained in System Resource Theory is shown in Table 1.0 below.

Table 1.0
Summary of system resource theory

Organizational Effectiveness Model	**Organizational Situation**	**Central Focus or Purpose**	**Assumption**	**Limitations**
Systems Resource Approach	Evaluation of Organizational Performance	Determine decision maker's efficiency in acquiring and utilizing resources for fulfilling various system needs.	An organization, in order to survive, one must satisfy some basic needs: 1.Acquiring resources 2.Maintenance of day to day internal activities 3.Production of outputs 4.Coordinating relationships among the various subsystems 5. Responding to feedback 6. Evaluating the effect of its decision 7. Accomplishing goals	Measures of all system needs are difficult to develop.

Adapted from Cunningham J. B. (1977). Approaches to the Evaluation of Organizational Effectiveness. Academy of Management Review.

There were several studies which explained the use of System Resource Approach. A study by Cunningham (1978) proposed the needs for an organization to use its resources to produce outputs. According to him, an organization must also be able to optimize its use of resources, so that a firm will be able to derive the maximum benefits from it.

Further to that, Cunningham (1978) also explained that firm uses resource to produce output and to maintain and restore system. According to Cunningham (1978), organization is looked as a system with a network of interrelated subsystem. In this theory, it emphasizes on the organization's ability to bargain and optimize use of resources with a number of decision makers, each with different objectives where optimality is the key word (Cunningham, 1978).

According to Cunningham (1978), what counts is the balanced of distribution of resources among the subsystem's needs, not maximum satisfaction of these needs. For example, if the IT budget is $1 million, thus it cannot be allocated to infrastructure IT investment only. It must be allocated to the other types of IT investments categorized by different management objectives as explained in the earlier section, so that maximum benefits can be derived from the optimal use of those resources.

According to Cunningham (1978), efficiency was part of the criteria used to measure effectiveness. This concept was also applied for "productivity" whereby it was stated to be as one of the indicators of organizational effectiveness (Macy & Mirvis, 1976). This was further supported by Mott (1972) who stated that productivity was one of the aspects of effectiveness. Thus in this study, efficiency and productivity would be conceptualized as part of the criteria in measuring organizational effectiveness.

With regard to the study of productivity paradox, Mahmood and Mann (1993) used the System Resource Approach theory as the framework for their study. However, effectiveness in their study was measured using the key financial ratios which were extended in this study by using financial and non-financial indicators in assessing organizational effectiveness.

5.0 Conclusion

This study has managed to explain theoretically that the issue of IT Productivity Paradox can be conceptually explained using the System Resource Theory approach in terms of categorizations of IT asset classes and multidimensional performance measurement. For a firm to achieve the maximum benefits from its resources, it depends on how organizations could acquire and use valued resources and the application of efficiency, effectiveness and productivity dimensions within the firm. Finally the multidimensional measurement approach must be used in order to capture all the benefits emanating from the IT investment.

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