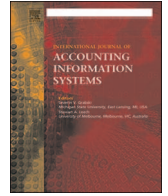


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## Does decentralized decision making increase company performance through its Information Technology infrastructure investment?

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### ABSTRACT

A company's Information Technology (IT) infrastructure is a key factor in its sustainability and ongoing success and profitability. This paper explores the relationship between a company's investment in IT and its performance. Performance is measured, with the help of a Balanced Scorecard (BSC), in four ways; financial, internal business processes, innovation & learning and customer perspective. The relationship between each BSC category serves as indicators of the effect of IT investment on a company's performance. This will help establish the benefits of both financial and non-financial indicators. We focus on the Electrical and Electronic manufacturing performance of companies Malaysia. System Resource Theory (SRT) is used as the background theory to explain the concepts of organizational effectiveness, efficiency, productivity and multidimensional performance measurements and to link the variables used in this study. We conduct an empirical study in order to confirm the moderating effects of decentralized decision making. The results suggest that IT investment produces a significant relationship with all BSC perspectives, but the moderating effect is only significant only from a customer perspective.

### 1. Introduction

Many companies invest heavily in Information Technology, often not receiving the expected return on their investment (Brynjolfsson, 1993; Peppard and Rowland, 1995). These large expenditures have led to managerial concerns over the business value of IT (Lee et al., 2010). The link between IT investment and a firm's performance has been discussed in the scientific literature (Bardhan et al., 2013) and the 'productivity paradox' has been an ongoing debate for a number of years (Barua et al., 1995; Brynjolfsson, 1996; Brynjolfsson and Hitt, 1996; Hitt and Brynjolfsson, 1996; Bharadwaj et al., 1999; Garud and Kumaraswamy, 2005; Thouin et al., 2008; Yuhn and Park, 2010). Managerial proficiency in resource utilization and organizational control is reflected in a firm's productivity and performance (Kohli et al., 2012). These studies provide much of the motivation for this paper.

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## 2. Related work

### 2.1. IT productivity paradox

The benefits of IT investment have received interest among scholars and practitioners. Many studies have investigated the return on IT investment with regard to a company's performance, with conflicting conclusions being reported (Sircar et al., 2000; Barua et al., 1995; Brynjolfsson, 1996; Brynjolfsson and Hitt, 1996; Hitt and Brynjolfsson, 1996; Bharadwaj et al., 1999; Barua and Mukhopadhyay, 2000; Dedrick et al., 2003; Hoadley and Kohli, 2014; Kohli and Devaraj, 2003; Kohli et al., 2012; Barua and Kriebel, 1995; Hitt and Brynjolfsson, 1996). Some noted positive relationships between IT investment and company performance, others did not. Discussions regarding IT productivity and the strategic value IT still continue (Hwang et al., 2015). Despite these uncertainties, companies continue to invest in IT, presumably as they perceive value in doing so, or perceive that they would be at a disadvantage if they did not make these investments.

The term productivity is defined as the output produced for a given input (Brynjolfsson, 2003; Hitt and Brynjolfsson, 1995). While it is simple to define, it is difficult to measure. For example, the measurement used for output will not only include the physical products produced but also the value created for consumers. In today's economy, value depends increasingly on product quality, timeliness, customization, convenience, variety, and other intangibles (Brynjolfsson and Hitt, 1993). Difficulties also exist in measuring the input as there are many factors to be considered, such as capital equipment, materials and other resources consumed (Brynjolfsson and Hitt, 1993). IT is perceived as an enabler to improve productivity, although IT investment comes with no guarantees (Lin and Chuang, 2013). Many companies assume, that by investing in IT, it will create a positive economic returns to them but the inconsistencies reported in the scientific literature have led to the productivity paradox. Within the manufacturing sector, which is the focus of this study, IT-driven productivity growth in the 1990s may have been more pronounced in manufacturing than in the non-manufacturing sector (Stiroh, 2002).

This paradox can be defined as the perception that there is a lack of increase in output, after an investment in IT (Sircar et al., 2000). These findings were later contradicted (Brynjolfsson and Hitt, 1995, 1996; Dewan and Min, 1997; Garud and Kumaraswamy, 2005; Thouin et al., 2008; Yuhn and Park, 2010). One of the most significant gaps in the study of the productivity paradox is too much emphasis on United States (US) firms and the lack of cross-country studies (Melville et al., 2004) and this suggests that further research on this issue is needed outside the US. Some researchers argue that IT investment relates indirectly to a firm's performance through contextual factors (Campbell, 2012), such as country characteristics (Lin and Chiang, 2011). Studying companies from outside the US business environment will provide additional perspectives.

### 2.2. Infrastructure IT investment

IT investment is often a large investment for a firm. On average > 4.2% of revenue is invested in IT (Weill et al., 2002). IT investment also forms a major portion in capital budgets in many organizations (Jeffery and Leliveld, 2004). IT investment is an enormous and significant spending by a firm (Bureau of Economic Analysis, 2007). The average company normally allocates 54% of its IT investment to infrastructure (Weill et al., 2002). IT infrastructure investment is defined as the investment for the purpose of managing shared IT services used by multiple applications such as servers, networks, laptops, customer databases etc. (Weill and Aral, 2003, 2004). A good quality IT infrastructure is a complex fusion of technology, processes and human assets (Barney, 1991). However once in place, it can lead to a competitive advantage because it will take competitors time to emulate it (Weill et al., 2002).

### 2.3. Performance measurement - balanced scorecard

The scientific literature suggests that the use of multiple measures of performance, including both financial and non-financial, are important to capture the non-financial benefits from an investment in IT. Companies are now using performance measurement systems to track non-financial metrics (Banker et al., 2004; Fernandes et al., 2006; Barad and Dror, 2008).

The assessment of organizational performance could be a catalyst for both the present and future success of companies (Kaplan and Norton, 1996). The Balanced Scorecard (Kaplan and Norton, 1992) brings together elements of strategy, financial and non-financial measures. This methodology enables companies to translate their strategic objectives into a coherent set of performance measures (Kaplan and Norton, 1993). The Balance Scorecard links strategy to organizational measurement and is frequently used by managers in their decision making. It is regarded as one of the most significant accounting developments (Tayler, 2010), enabling managers to make decisions that can maximize a company's financial value (Kaplan, 2009).

Technology influences the structure of industries, creates competitive advantage and has the potential to change the rules of competition. Moreover, nearly every function within an organization has technology integrated within it, including production, procurement, distribution, accounting and marketing (Edwards, 2001). Previous studies suggest that IT enables organizational change that leads to productivity gains and it should not only be viewed as a tool for automating current processes (Mithas et al., 2012). The effectiveness of technology, and information processing in particular, are very important to a company's success and it is a misconception to consider IT as just another department within an organization. Furthermore, the application of IT is an integral part of a company's strategy and it affects many parts of the business (Edwards, 2001).

The purpose of the Balanced Scorecard (BSC) is to translate strategy into measures that uniquely communicate vision to the organization (Kaplan and Norton, 1992). BSC was developed to; (1) clarify and translate vision and strategy, (2) communicate and link strategic objectives and measures, (3) plan, set targets and align strategic initiatives and (4) enhance strategic feedback and

learning. It also assists in realizing both tangible and intangible benefits of any investment made (Kaplan and Norton, 1992, 1993, 1996, 2001). Kaplan and Norton's Balanced Scorecard originally developed as a tool for performance measurement at the organizational level (Kaplan and Norton, 1992). This was followed by further developments with regard to concept and applications (Kaplan and Norton, 1993, 1996, 2001). Several researchers have empirically studied BSC (Hoque and James, 2000; Hoque et al., 2001; Maiga and Jacobs, 2003; Fang and Lin, 2006). The details of the empirical studies on BSC are as explained below.

It was posited that BSC usage was related to improved performance, but factors such as organization size, product life cycle, or market position did not significantly influence it (Hoque and James, 2000). The outcome stated the relationship between multi-dimensional performance measurement to businesses facing high competition and making greater use of computer-aided manufacturing processes (Hoque et al., 2001). The study concerned with the complimentary effect of BSC & Activity Based Costing (ABC) on manufacturing performance and the findings suggested the association of ABC & BSC in affecting performance (Maiga and Jacobs, 2003). This study measured ERP performance using BSC approach and a comprehensive set of key perspectives were used to assess the firm's performance using BSC approach (Fang and Lin, 2006).

The main concept outlined in BSC is to translate the company's vision and objectives into strategic actions which can be measured. According to Edwards (2001), a properly developed Balanced Scorecard should have cause and effect relationships, and link to financials, performance drivers and measures that create change. Performance measures should be explicitly linked in hypothesized cause and effect relationship that depicts the company's strategy (Kaplan and Norton, 2004).

For example, training employees should lead to shorter production times, which in turn leads to shorter delivery times. These all lead to a return on the investment made (Ruzita et al., 2006). BSC emphasizes the future performance drivers instead of solely relying on financial indicators. If the indicators are good then these will be reflected in financial indicators. BSC has been found to be suitable to measure business performance due to its success in being able to align competitiveness indicators with business objectives (Oztaysi and Sari, 2009; Öztayşi et al., 2011).

Previous studies on the business benefits of IT investments have found that IT has a range of performance measures including productivity (Brynjolfsson, 1996), market valuation (Dos Santos and Peffers, 1995; Brynjolfsson and Yang, 1997; Bharadwaj et al., 1999), consumer welfare (Hitt and Brynjolfsson, 1996; Brynjolfsson, 1996) and operating performance (Barua et al., 1995; Zhu and Kraemer, 2002). These studies motivate this research to further investigate the potential benefits that can be obtained from IT investments, be that via financial and non-financial indicators, or by using the multidimensional performance measures of the balance scorecard.

### 2.3.1. Financial perspective

Using BSC, and aligning internal business processes, customer and innovation & learning perspectives, should provide a financial return on investment (Trang, 2016). Some of the financial benefits that have been realised include reducing costs (Weill and Broadbent, 1998), increasing productivity (Turner and Lucas, 1985), increasing revenue (Weill and Aral, 2004) and assisting other functions such as accounting and budgeting (Weill, 1992). Operating income has also been used in previous studies (Fang and Lin, 2006), with others focussing on performance (Mabert et al., 2000; Davenport, 1993); sales growth (Stratopoulos and Dehning, 2000) and return on investment (Bradford and Roberts, 2001). The measures used in this study are operating income, sales growth and return on investment.

The use of these measures is consistent with prior research on performance, IT investment and systems (Mabert et al., 2000; Davenport, 1993; Stratopoulos and Dehning, 2000; Bradford and Roberts, 2001; Fang and Lin, 2006). Since this study employs the BSC in the manufacturing sector, it is important to have measures that are recognized in this sector. These measures have been used in this setting (Hoque et al., 2001).

Additionally, the focus of this study is to ascertain the benefits derived from IT investment to manufacturing performance. Operating income and sales growth will be indicative of the financial benefits that could be obtained (Strassman, 1999). This return on investment will measure not only the financial benefits but also increased productivity.

### 2.3.2. Internal business processes

An emphasis should be placed on internal business processes as it is these that creates the product. Managers need to focus on those critical internal processes as it enables them to satisfy customer needs. Internal business processes are concerned with using resources as efficiently as possible and determining their competitive performance for future business endeavours (Hoque et al., 2001). It also ensures that the main processes are generating value and that business objectives are being met (Lawrie and Cobbold, 2004).

Some of the benefits of an investment in IT were greater business processing and management (Weill and Woodham, 2002), leading to increased quality (Weill and Aral, 2006). This study adopts the specific measures used in manufacturing such as material efficiency variance, ratio of good output to total output, labour efficiency variance, manufacturing lead time and rate of material loss (Hoque et al., 2001).

### 2.3.3. Innovation and learning

Innovation and learning aims for continuous improvement so that companies can adapt to changing demands by creating new products that meet the needs of their customers. In order for companies to survive in a dynamically and changing environment, they must always be creating new products, improving existing products and learning to cope/adapt with changing situations. Only when these are done, will they be able to survive in by penetrating new markets, increasing market share and increasing profitability (Kaplan and Norton, 1992).

Organizations are increasingly turning to IT for their employee training (Westerman, 2004). Training of employees is key factor for employee satisfaction as it develops employee skills (Sami, 2010) and provides a process for continuous professional development.

Some of the gains recorded from IT investments enable future IT initiative and flexibility, increased innovation and positioning organizations for growth from modified and enhanced products (Weill and Aral, 2004). IT can also facilitate better business management (Weill and Woodham, 2002), increased productivity (Turner and Lucas, 1985) and better process innovation (Weill and Broadbent, 1998).

Specific measures proposed in previous manufacturing and information system research are the number of new patents (Hoque et al., 2001), the number of new products launched (Grover and Davenport, 2001), the time to market for new products (Hoque et al., 2001) and employee satisfaction (Sami, 2010).

#### 2.3.4. Customer perspective

The purpose of this measure is to assess customer satisfaction. In a competitive market, customers must be satisfied, or market share will drop. Customers are also concerned about price, faster and reliable deliveries, design, quality and service levels (Hoque et al., 2001). In this study customer perspective was conceptualized as the leading measure that included non-financial terms that could help to satisfy customer needs. They may be leading indicators of what the financial measures will subsequently reveal, for example, increases in customer satisfaction would lead to sales growth and hence financial performance.

Some of the benefits of taking into account the customer perspective were IT serving as a source of competitive advantage (Weill et al., 2002), having a shared customer database (Weill and Aral, 2003), reduced time to market for new business initiatives (Weill and Aral, 2004), analyzing customer needs so that better decisions could be made taking into account customer needs (Weill and Aral, 2006) and promote better interaction between companies and their customers.

The measures used in this study are consistent with prior manufacturing and information system research, and include market share (Hoque et al., 2001), customer response time (Grover and Davenport, 2001), on time delivery (Appleton, 1997), number of customer complaints (Hoque et al., 2001), number of warranty claims (Hoque et al., 2001), survey of customer satisfaction (Fang and Lin, 2006), percentage of shipments returned due to poor quality (Hoque et al., 2001) and number of overdue deliveries (Hoque et al., 2001).

#### 2.4. Decentralized decision making

There is a significant positive correlation between IT and a decentralized structure, but when IT and decentralization were measured simultaneously, there was no evidence of causality on the relationship (Andersen and Segars, 2001). There is no direct relationship between decentralized strategic decision making and a company's performance (Andersen, 2005), implying that decentralization cannot be used as an independent variable. Motivated by these observations, it is the objective of this study to suggest that there is an indirect relationship, making decentralization a moderator on the relationship between IT, decentralization and a company's performance. The relationship between IT investment and company performance has produced both positive and negative results, suggesting the need for the moderator to strengthen the relationship. The conflicting conclusions identified earlier provides motivation for additional research. Moderating variables are typically introduced when there is unexpected or inconsistent relationship between a predictor and a criterion variable (Baron and Kenny, 1986).

The control variable of the number of employees is also considered so as to determine whether company size would affect the relationship between IT investment and company performance. This study addresses the following three research questions;

**RQ1.** What is the relationship between a company's IT investment and the company's performance?

**RQ2.** What is the effect of size on the relationships between IT investment and manufacturing company performance?

**RQ3.** Is the relationship between a company's IT investment and the manufacturing company's performance moderated by decentralized decision making?

The primary contributions of this research are as follows. i) It investigates the effects of IT investment and its relationship with the four perspectives of the balanced scorecard (BSC). ii) It explores the moderating effect of decentralized decision making on the relationship between IT investment and a company's performance. The three main areas to be investigated in this study are as follows:

- IT investment tends to be significant and can lead to managerial concerns over the business value of IT (Lee et al., 2010). Evaluating the benefits from IT investment, and ascertaining, whether it will bring the expected benefits is worthy of investigation.
- Investigations into the productivity paradox has had an 'emphasis on United States (US) firms' and has shown a 'lack of cross-country studies'. This has meant that the 'results are conditional on the characteristics of the US business environment' (Melville et al., 2004). In this study, we use samples from outside the US, which enables us to gauge if the finding reflect those from previous US studies.
- This study extends previous studies on decentralization (Andersen and Segars, 2001; Andersen, 2005). Decentralized decision making is conceptualized to act as a moderator to the relationship between categorizations of IT investment and company performance.

## 2.5. System resource theory

A system resource approach (Yuchtman and Seashore, 1967) is utilised in this paper to study the productivity paradox in an effort to understand organizational effectiveness. 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 and Mann, 1993).

System resource theory proposes organizational effectiveness will depend on how organizations can acquire and utilize resources in order to achieve organizational effectiveness (Yuchtman and Seashore, 1967). Organizational effectiveness as defined here is the maximization of ability and optimal use of resource in order to derive the maximum benefits from it and to achieve organizational effectiveness (Yuchtman and Seashore, 1967; Katz and Kahn, 1966). According to this theory, the phases involved in explaining organizational effectiveness are input, process and output (Yuchtman and Seashore, 1967).

Several authors (Mahmood and Mann, 1993; Brynjolfsson and Hitt, 1993) have conceptualized IT investment as an input, in line with this approach. Input was defined as the acquisition of resources, helping the company attaining organizational effectiveness. Previously IT had been regarded as a resource to a company (Barney et al., 2001; Wu et al., 2006).

This theory proposed that organizational effectiveness must not be assessed using single criterion only, but must include an open ended multidimensional set of criteria (Yuchtman and 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 and Kahn, 1966). Effectiveness was conceptualized in terms of resource viability rather than in terms of specific task objectives (Yuchtman and Seashore, 1967).

The distinction between a goal centered view and a system resource view when evaluating effectiveness is in the way effectiveness was measured by determining the task objectives and developing criterion measures to assess how far the objectives have been achieved (Hamilton and Chervany, 1981). An example was given 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 this view fulfils other functions and has other consequences besides just meeting objectives (Hamilton and Chervany, 1981). Different conceptualizations exist for different departments. In a human resource department for instance, its effectiveness could 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 technological resources. The quality of the system or service levels might indicate the level of system effectiveness (Hamilton and Chervany, 1981). As a conclusion, a system resource approach states that there are other functions and consequences which need to be considered instead of focusing solely on achieving objectives and these needs have to be taken into account when measuring effectiveness (Hamilton and Chervany, 1981).

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

## 3. Hypotheses development

### 3.1. Relations between infrastructure IT investment with firm performance

IT infrastructure investment provides a foundation for shared IT services which can be used by multiple applications such as servers, networks, database (Weill and Aral, 2003). Since it is the backbone of any IT initiatives, many advantages are obtained by using it, such as reducing cost through standardization and consolidation (e.g. server or data centre consolidation), providing a platform for delivering companywide initiatives, such as a shared customer database, to enable future IT initiatives and flexibility such as modular architectures and also to reduce time to market for new business initiatives (Weill and Aral, 2004).

Other benefits of infrastructure investments were business integration, business flexibility, reduced marginal costs and standardization (Weill and Broadbent, 1998). IT Infrastructure will facilitate the linkages between the company and its business partners, external infrastructures such as bank payment systems, and to public infrastructures such as the Internet (Weill et al., 2002). Internally, company managers can use the IT infrastructure to facilitate better business processing and management. IT infrastructure is an important factor in determining the speed with which new business initiatives can be implemented (Weill and Woodham, 2002).

Although investment in IT infrastructure can create high up front cost and long benefit time horizons (Duncan, 1995; Weill and Broadbent, 1998), it also enables new applications and functionality and helps achieve long term performance targets (Duncan, 1995).

**Table 1**  
Benefits of IT infrastructure.

Benefits	Performance perspective
1 Reducing cost (Weill and Broadbent, 1998); external linkages with bank payment system (Weill et al., 2002).	Financial perspective
2 Facilitate greater business processing and management (Weill and Woodham, 2002).	Internal business process perspective
3 Source of competitive advantage (Weill et al., 2002); platform for a shared customer database (Weill and Aral, 2004); to reduce time to market for new business initiatives (Weill and Aral, 2004).	Customer perspective
4 To enable future IT initiative and flexibility (Weill and Aral, 2004)	Innovation and learning

**Table 2**  
Other authors linking IT to performance.

Researchers	Benefits
Benjamin, 1993; Broadbent and Butler, 1995; Davenport, 1993; Earl and Kuan, 1994	IT is a potential enabler of change where the capabilities of IT infrastructure are required to integrate capabilities crossing business and functional unit boundaries so that it can enable better business processes which in the end lead to better performance.
Duncan, 1995	Infrastructure IT investment enables new applications and functionality, and lay the groundwork for significant long-term performance improvements.
Brynjolfsson, 1996	Productivity
Bharadwaj et al., 1999	Market valuation
Hitt and Brynjolfsson, 1996	Consumer welfare
Zhu and Kraemer (2002)	Operating performance
Sambamurthy et al., 2003	IT investment to contribute directly to product innovation

The benefits from having an IT infrastructure in the company, and its stakeholders, to its performance can be summarized in the Table 1.

IT investment is the basis for any company's IT initiatives. It is posited that IT investment would improve all perspectives as stated in BSC measures. Various researchers have emphasized the differential performance effects of IT investment and infrastructure IT investment, and this is summarized in Table 2.

Thus, the hypothesis formulated in this study in relation to IT infrastructure investment are as follows:

**H1a.** Company's emphasis on infrastructure IT investment is positively related to the company's financial performance.

**H1b.** Company's emphasis on the infrastructure IT investment is positively related to the company's internal business process performance.

**H1c.** Company's emphasis on the infrastructure IT investment is positively related to the company's innovation and learning performance.

**H1d.** Company's emphasis on the infrastructure IT investment is positively related to the company's customer performance.

### 3.2. Moderating roles of decentralized decision making

The arguments presented in preceding sections support the notion that decentralized decision making would moderate the relationship between IT investment and a company's performance. This section will outline how decentralized decision making moderates the causal relationship between IT investment and a company's performance.

Decentralization provides faster and better responsive actions in situations that could influence the company's strategic path (Mintzberg, 1978; Burgelman, 1983), which may lead to improved decisions, and hence performance. Middle managers, in their decentralized nodes, could provide accurate and relevant insights which are needed in order to deal with changing environmental conditions (Huber, 1990). A decentralized structure will facilitate faster decision-making and better adaptability to conditions prevalent in local markets (Khan, 2012). Therefore, the decisions of lower level management are often based on better information. This further supports that decentralized decision making by way of providing accurate and relevant insights will lead to faster and more informed decisions that will moderate the causal relationship between IT investment and company performance.

The combinations of effective decision making within an electronic communication network will facilitate flexible exchange of information across functional boundaries that can improve innovation and performance (Hency, 1992; Kogut and Zander, 1992; March, 1991). By having improved communication capabilities that can reduce an organization's information processing costs, the organizational procedures can be more cost effective (Andersen and Segars, 2001).

Other ways decentralized structure can influencing or moderate the relationship of IT investment and company performance are through the effectiveness of decentralized decision makers identifying the problems and opportunities faster (Andersen and Segars, 2001). When these are identified, the computerized information system will support the gathering of data and provide a faster reaction to emerging events which should lead to more profitable business decisions and performance (Andersen and Segars, 2001). A decentralized decision structure can make the company more effective and enhance its responsiveness (Fulk and Desantis, 1995).

Decentralized structures will improve access to information and, coupled with enhanced communication in computerized network, lead to an increase in innovative capacity (Nonaka, 1994). Decision makers can easily obtain data and information about business activities and sharing it can result in more effective responses (Andersen and Segars, 2001). The usage of IT can enhance communication capabilities which can lower information processing costs (Clemons et al., 1993) and this can lead to improved financial performance. Thus decentralized decision making can influence the causal relationship between IT investment and company performance by improving access to information and sharing data which leads to more effective responses.

The usage of IT in companies can provide the computer networks necessary for middle managers to instantaneously access relevant information that can help them to make effective decisions faster, using up-to-date information. This is in contrast with a formal approvals process which would move along several hierarchical levels of authority (Andersen and Segars, 2001), where bureaucracies can introduce delays.

**Table 3**  
Moderation of decentralized decision making.

Moderation	Performance perspective
1 Make organizational procedures more cost effective (Andersen and Segars, 2001); profitable business decisions and performance (Andersen and Segars, 2001); lower information processing costs (Clemons et al., 1993)	Financial performance
2 Make effective decision at a faster time using the up-to-date information available to them at that time, in contrast with formal approvals moving along several hierarchical levels of authority (Andersen and Segars, 2001); firm's ability to coordinate actions and this makes the firm's abilities more effective and enhance responsiveness; enhancing the overall organizational effectiveness (Batra, 2006)	Internal business process performance
3 Improve on firm innovation and performance (Hency, 1992; Kogut and Zander, 1992; March, 1991); lead to the increase in innovative capacity (Nonaka, 1994).	Innovation & learning performance
4 Decision makers can easily obtain data and information about the business activities and sharing it in reciprocal information exchanges, that can lead to them to be able to make effective responses (Andersen and Segars, 2001) especially to respond to customer enquiries; to identify the problems and opportunities faster (Andersen and Segars, 2001); enhancing the overall organizational effectiveness (Batra, 2006)	Customer performance

According to Batra (2006), the improvement in the quality of decision making at various levels can result in enhancing the overall organizational effectiveness. The summaries of the above explanations can be seen in the Table 3.

Based on the above representations, it was posited that:

**H2a.** Decentralized decision making moderates the relationship between company's emphasis on the infrastructure IT investment and company's financial performance.

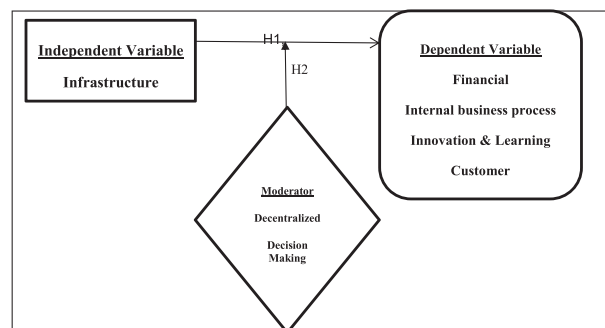
**H2b.** Decentralized decision making moderates the relationship between company's emphasis on infrastructure IT investment and company's internal business process performance.

**H2c.** Decentralized decision making moderates the relationship between company's emphasis on infrastructure IT investment and company's innovation and learning performance.

**H2d.** Decentralized decision making moderates the relationship between company's emphasis on infrastructure IT investment and company's customer performance.

3.3. Control variable – size

To examine the relationship between IT investment and a company's performance, it is necessary to provide a control for the variable that could have an impact on the linkage in the relationship. Previous studies (Lee and Bose, 2002; Libby and Waterhouse, 1996) used company size as the control variable, measured by the number of employees. The reason for controlling size is that studies have found larger companies expended more on IT investment as a percentage of their revenues as compared to smaller companies (Mitra and Chaya, 1996). The impact that a company's size could have on company performance was by deriving greater synergy effects from human and financial resource that could eventually lead to better performance (Wu et al., 2006). For example, a company's size may have a significant relationship with its performance. Thus, by controlling the size of business by controlling the number of employees in the company, the nature of the relationship between IT investment and a company's performance can be ascertained. The research model for this study is shown in Fig. 1.



**Fig. 1.** Research model.  
Control variable: size.

**Table 4**  
Harman's single factor test for common method bias.

Component	Initial Eigenvalues		
	Total	% of variance	Cumulative %
1	2.589	43.153	43.153
2	1.066	17.772	60.925
3	0.815	13.578	74.503
4	0.597	9.950	84.453
5	0.537	8.955	93.408
6	0.396	6.592	100.000

## 4. Methodology

### 4.1. Sample

The data used in this study was drawn from a questionnaire-based survey of Malaysian Electrical and Electronic (E & E) manufacturing companies. Sample companies from the E & E sector were selected from the Malaysian Investment Development Authority (MIDA) listing which became the population frame for the study. The E & E industry was selected because of its importance to employment, turnover and exports. The respondents in this study are represented by personnel in management positions such as Directors, Senior Managers and Accountants. They all have an understanding about company IT, management decisions and company performance. A total of 630 questionnaires were sent out with 102 responding. Of those, only 74 were usable, giving a usable response rate of 12.3%. This relatively low response is quite common in Malaysia and is comparable with similar studies (Ruzita et al., 2006).

Common method bias is a measurement error (Podsakoff et al., 2003; Podsakoff et al., 2012) that will give a bias to the presentation of the statistical results. This bias can be observed when looking at the presence of a systematic variance (Bagozzi and Yi, 1990) that can lead to unsound conclusions.

One of the widely used method to test for the common method bias is Harman's single factor test (Podsakoff et al., 2003). All the variables will be loaded into an exploratory factor analysis (Andersson and Bateman, 1997; Aulakh and Gencturk, 2000) and the unrotated factor solution will be examined to determine the number of factors that are necessary to account for the variance in the variables. When a common method bias is presence, then the unrotated factor analysis will show that a single factor will emerge from the factor analysis or one item accounts for the majority of the variances in the model (Podsakoff et al., 2003).

As shown in the Table 4, the majority of the variance was not accounted for by one general factor and the variance did not exceed a cut-off point of 50% (Eichhorn, 2014; Podsakoff and Organ, 1986). Thus common method bias was not evident in this study.

### 4.2. Measurements of variables

#### 4.2.1. IT investment

The respondents classified their IT investment is infrastructure or not. The questionnaires were adapted from a study (Weill and Aral, 2006) at Massachusetts Institute of Technology (MIT)'s website (<http://web.mit.edu/cisr/MITCISR-ITPortfolio.doc>). The qualitative aspects of the original questionnaire were modified to suit the purpose of this study. The respondents were also asked to specify the nominal amount expended annually for their IT investment.

#### 4.2.2. Moderator-decentralized decision making

This measurement was intended to measure the degree of decentralized decision making in any particular organization. The measurement was adapted from Andersen (2005) which was made on the basis of reported indices measure of hierarchy of authority (Dewar et al., 1980). This scale refers to the measure of decision authority on the part of middle managers on getting approval from management before starting any important activities. Each item was accessed on a Likert scale ranging from 1 to 7 to ensure that any decentralization practices embraced by the company is being captured by this instrument, however big or small the degree of decentralization is. In this scale, the higher the number, the higher the decentralization levels are.

Principal Component Factor Analysis (PCFA) with varimax rotation was carried out for the five items of decentralized decision making measure. The results showed that Bartlett's Test of Sphericity (Bartlett, 1954) was significant ( $p$ -value < 0.01). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.70, which exceeded the recommended value of 0.5 (Kaiser, 1974). There were five questions to assess the decentralized decision making. These five questions were asked using Likert scale of 1 (strongly agree) to 7 (strongly disagree). The scale is reversed in nature because it measures the degree of centralization and decentralization of decision making. The higher the scale, the more decentralized a firm is. The factor analysis on the five items of the dimension produced one dimension for this construct (Unidimensional). A reliability test for this dimension produced a Cronbach alpha of 0.78 which is acceptable (Nunnally, 1978).



#### 4.2.3. Company performance

The instrument to measure a company's performance was adapted from Hoque et al. (2001) and which has also been used by other researchers (Fang and Lin, 2006; Bradford and Roberts, 2001; Grover and Davenport, 2001). Each dimension of the performance indicators comprises of multiple items specified under the four perspectives of BSC. The respondents were asked to indicate, on a five point Likert scale, ranging from one (decrease in performance) to five (increase in performance), the effect of performance across the four BSC dimensions in the last three years (Ruzita et al., 2006).

Principal Component Factor Analysis (PCFA) with varimax rotation was carried out for the 20 items of the company's performance measures. The results showed that Bartlett's Test of Sphericity (Bartlett, 1954) was significant ( $p$ -value < 0.01). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.84, which exceeded the recommended value of 0.5 (Kaiser, 1974). Both of these results support the use of the data for further factor analysis. This was further subjected to varimax rotation and loading equal or > 0.7 for sample size = 60 (Hair et al., 2006). Four distinct dimensions were extracted from the PCFA with eigenvalues exceeding 1.0. After several runs of factor analysis, five items were deleted from further factor analysis, these being employee satisfaction, market share, customer satisfaction, on time delivery and customer response time. These items were deleted because their factor loading was < 0.7, which is required for sample size equal to 60 (Hair et al., 2006). These dimensions were renamed as internal business process measure, customer measure and financial measure and innovation & growth. A reliability check was later performed on the items in the new dimensions, in order to determine the internal consistency of the measuring items. The values of Cronbach Alpha for component financial, internal business process, innovation & growth and customer were 0.93, 0.90, 0.92 and 0.89 respectively.

## 5. Results

### 5.1. Hierarchical regression analysis

Hierarchical regression analysis was conducted, which tested the effect of the relationship between independent variables, dependent variables, control variables and moderator. In this study, size was treated as a control variable. Controlling for size provides a better test for a company's IT Investment and its impact on BSC measures. Regression was conducted for each of the BSC perspectives.

### 5.2. Hierarchical regression

Hierarchical regression analysis was conducted, where it tested the effects of a relationship between the independent variable, the dependent variable and the control variable. Size was treated as a control variable. Regression was conducted for each of the BSC perspectives.

#### 5.2.1. Result on the hypotheses testing: financial performance (hierarchical regression)

As shown in Table 5, when the financial measure serves as a dependent variable, model 1 and model 2 significantly explains 4.1% and 8.2% of the variance in financial perspective [ $F = 3.085; 3.203, p < 0.1$ ]. This indicates that an infrastructure objective provides significant positive impact on financial performance at Beta = [0.204,  $p < 0.1$ ]. The results also indicate that company size is associated significantly with this perspective ( $p < 0.1$ ). This suggests that a company's size will influence the relationships between infrastructure IT investment with a company's financial performance. It also indicates that company size will not influence the outcome from the moderating effects in the relationship. Models 3 and 4, which have included the effects of moderator and

**Table 5**  
Model summary & coefficients 1.

Model	R	R square	R square change	F change	Sig. F change
1	0.203	0.041	0.041	3.085	0.083
2	0.287	0.082	0.041	3.203	0.078
3	0.291	0.084	0.002	0.148	0.702
4	0.337	0.113	0.029	2.252	0.138

Model	IV	Beta	t	Sig.
1	Number of employee	- 0.203	- 1.756	0.083
2	Number of employee	- 0.214	- 1.877	0.065
	Infrastructure	0.204	1.790	0.078
3	Number of employee	- 0.219	- 1.898	0.062
	Infrastructure	0.211	1.817	0.073
	Moderator	- 0.045	- 0.385	0.702
4	Number of employee	- 0.215	- 1.881	0.064
	Infrastructure	0.613	2.102	0.039
	Moderator	0.182	0.957	0.342
	Interaction moderator * infrastructure	- 0.519	- 1.501	0.138

Dependent variable: financial.

**Table 6**  
Hypotheses summary (financial performance).

No	Hypotheses	Result
1	H1a: Company's emphasis on infrastructure IT investment is positively related to the company's financial performance.	Supported
2	H2a: Decentralized decision making moderates the relationship between company's emphasis on the infrastructure IT investment and company's financial performance.	Not supported

interactions, were not significantly related to financial performance. Thus, only hypothesis H1a is supported, hypothesis H2a is not supported. The summary of the hypotheses and results are presented in Table 6.

### 5.2.2. Result on the hypotheses testing: internal business process performance (hierarchical regression)

As shown in the Table 7, when internal business process measures serve as a dependent variable, only Model 2 significantly explains 6.9% of variance in internal business process performance ( $F = 4.808$ ,  $p < 0.05$ ). The results also indicate that infrastructure provides significant positive impact on internal business process performance at Beta = 0.251 ( $p < 0.05$ ). The results also indicate that size is not associated significantly with this perspective. However other models were not significantly related to internal business process performance. Thus, hypothesis H1b is supported whereas H2b is rejected. The summary of the hypotheses and results are presented in Table 8 below.

### 5.2.3. Result on the hypotheses testing: innovation and growth performance (hierarchical regression)

As shown in the Table 9, when Innovation & Growth serve as a dependent variable, all the models were not significant except for model 2 which significantly explains 8.1% of variance in Innovation & Growth performance ( $F = 4.792$ ,  $p < 0.05$ ). The results also indicated that infrastructure provides significant positive impact on Innovation & Growth performance at Beta = 0.249 ( $p < 0.05$ ). The results also indicated that size was not associated significantly with this perspective. However other models were not significantly related to Innovation & Growth performance. Thus, hypothesis H1c is supported whereas H2c is rejected. The summary of the hypotheses, results and discussions are presented in Table 10.

### 5.2.4. Result on the hypotheses testing: customer performance (hierarchical regression)

As shown in the Table 11, when Customer measure served as a dependent variable, models 2 and 4 significantly explains 10.3% and 27.8% of variance in customer perspective ( $F = 6.863$  and  $F = 13.482$ ,  $p < 0.05$ ). The results also indicated that for model 2, infrastructure provides significant positive impact on customer performance at Beta = 0.295 ( $p < 0.05$ ). As for model 4, it showed that moderator was significant at  $p < 0.05$ . However other models were not significantly related to customer performance. Thus, hypotheses H1d and H2d are accepted. The summary of the hypotheses, results and discussion are presented in Table 12 below.

**Table 7**  
Model summary & coefficients.

Model	R	R square	R square change	F change	Sig. F change
1	0.075	0.006	0.006	0.407	0.525
2	0.262	0.069	0.063	4.808	0.032
3	0.276	0.076	0.008	0.585	0.447
4	0.313	0.098	0.021	1.633	0.206

Model	IV	Beta	t	Sig.
1	Number of employees	-0.075	-0.638	0.525
2	Number of employees	-0.089	-0.772	0.443
	Infrastructure	0.251	2.193	0.032
3	Number of employees	-0.078	-0.672	0.504
	Infrastructure	0.237	2.038	0.045
	Moderator	0.090	0.765	0.447
4	Number of employees	-0.075	-0.646	0.520
	Infrastructure	0.583	1.982	0.052
	Moderator	0.285	1.482	0.143
	Interaction moderator * infrastructure	-0.446	-1.278	0.206

Dependent variable: internal business process.

**Table 8**

Hypotheses summary (internal business process perspective).

No	Hypotheses	Result
1	H1b: Company's emphasis on the infrastructure IT investment is positively related to the company's internal business process performance.	Supported
2	H2b: Decentralized decision making moderates the relationship between company's emphasis on infrastructure IT investment and company's internal business process performance.	Not supported

**Table 9**

Model summary &amp; coefficients.

Model	R	R square	R square change	F change	Sig. F change
1	0.138	0.019	0.019	1.401	0.240
2	0.285	0.081	0.062	4.792	0.032
3	0.291	0.084	0.003	0.256	0.615
4	0.291	0.085	0.000	0.004	0.949

Model	IV	Beta	t	Sig.
1	Number of employees	- 0.138	- 1.184	0.240
2	Number of employees	- 0.152	- 1.331	0.188
	Infrastructure	0.249	2.189	0.032
3	Number of employees	- 0.145	- 1.253	0.214
	Infrastructure	0.240	2.070	0.042
	Moderator	0.059	0.506	0.615
4	Number of employees	- 0.145	- 1.245	0.217
	Infrastructure	0.223	0.752	0.455
	Moderator	0.049	0.254	0.801
	Interaction moderator * infrastructure	0.023	0.064	0.949

Dependent variable: learning &amp; growth.

**Table 10**

Hypotheses summary (innovation &amp; growth).

No	Hypotheses	Result
1	H1c: Company's emphasis on the infrastructure IT investment is positively related to the company's innovation and growth performance.	Supported
2	H2c: Decentralized decision making moderates the relationship between company's emphasis on infrastructure IT investment and company's innovation and growth performance.	Not supported

**Table 11**

Model summary &amp; coefficients.

Model	R	R square	R square change	F change	Sig. F change
1	0.128	0.016	0.016	1.199	0.277
2	0.321	0.103	0.087	6.863	0.011
3	0.370	0.137	0.034	2.740	0.102
4	0.527	0.278	0.141	13.482	0.001

Model	IV	Beta	t	Sig.
1	Number of employees	- 0.128	- 1.095	0.277
2	Number of employees	- 0.144	- 1.278	0.205
	Infrastructure	0.295	2.620	0.011
3	Number of employees	- 0.122	- 1.085	0.282
	Infrastructure	0.265	2.357	0.021
	Moderator	0.187	1.655	0.102
4	Number of employees	- 0.113	- 1.095	0.277
	Infrastructure	1.153	4.383	0.000
	Moderator	0.689	4.009	0.000
	Interaction moderator * infrastructure	- 1.147	- 3.672	0.000

Dependent variable: customer perspective.

**Table 12**  
Hypotheses summary (customer perspective).

No	Hypotheses	Result
1	H1d: Company's emphasis on the infrastructure IT investment is positively related to the company's customer performance.	Supported
2	H2d: Decentralized decision making moderates the relationship between company's emphasis on infrastructure IT investment and company's customer performance.	Supported

## 6. Discussion

### 6.1. Relationship between infrastructure IT investment and performance

The hierarchical multiple regression results revealed that infrastructure IT investment was significantly positively related with the financial (H1a) internal business process (H1b), innovation and growth (H1c) and customer performance (H1d). These findings support the findings in previous studies (Weill and Aral, 2003, 2004, 2006; Weill and Johnson, 2005; Weill and Broadbent, 1998) which stated that infrastructure IT investment brought different and diverse benefits to the organization. Benefits of infrastructure investments were business integration, business flexibility, reduced marginal costs and standardization (Weill and Broadbent, 1998). Infrastructure IT investment also serves as a foundation for shared IT services (Weill and Aral, 2004).

With regard to the relationships of infrastructure IT investment to company performance, various authors have suggested how this could be achieved. Reducing cost, which relates to an increase in the financial perspective (Weill and Broadbent, 1998). Increase in internal business process measure could be achieved by facilitating greater business processing and management (Weill and Woodham, 2002). Increase in innovation and growth performance could be achieved when infrastructure IT can enable future IT initiative (Weill and Aral, 2004). Finally an increase for customer performance could be achieved by making infrastructure IT as a source of competitive advantage (Weill et al., 2002). IT infrastructure could serve as a platform for a shared customer database (Weill and Aral, 2004) and to reduce time to market for new business initiatives. All these explanations are provided to explain the significant findings from this study with regard to the relationship between infrastructure IT investment and company performance. Based on the above explanations, infrastructure IT investment will lead to improvements in the all perspectives of BSC as shown by the findings of this study. Infrastructure IT investment will also lead to improvements in the all perspectives of BSC as shown by the findings of this study.

### 6.2. Moderating effect of decentralized decision making

As can be seen in the statistical output (Tables 5, 7, 9 and 11), all the relationships were not significant for model 3, that is where moderator was included to test for the moderating effect. This clearly indicates that decentralized decision making does not have bring any significant moderating effect to the financial, internal business process and customer performance perspectives. Since the moderator has a negligible correlation with the criterion variable, decentralized decision making could not be considered as quasi moderator as, for moderator to be termed as quasi moderator, it must interact with the criterion variable itself (Sharma et al., 1981).

If we were to look further into the statistical output (Tables 5, 7, 9, 11), we can see that all the relationships were not significant for model 4 except for customer (H2d) perspective. For model 4, it showed that the moderator was significant at  $p < 0.05$  and the interaction effect of infrastructure IT with moderator is also significant at  $p < 0.05$ . Since the moderator had a significant influence on the relationship between categories of IT investment with customer performance in model 3 and model 4, upon the introduction of moderator, and also upon the interaction effects of moderator with infrastructure IT, we can deduce that the moderator is a pure moderator. According to, a variable is termed as pure moderator variable when it enters into interaction with predictor variables, while having a negligible correlation with the criterion itself (Sharma et al., 1981; Cohen and Cohen, 1977).

The moderating effects of decentralized decision making on IT investment and customer perspective are that decision makers can utilize decentralized decision making to obtaining data about business activities and act upon that information. This can lead to them being able to make effective responses (Andersen and Segars, 2001), especially responding to customer enquiries, identifying problems and opportunities faster (Andersen and Segars, 2001) and in enhancing overall organizational effectiveness (Batra, 2006). The plausible explanations would be that these benefits from the moderating effects would have an effect on the relationship between infrastructure IT investment and customer perspective and thus produce the significant finding on this relationship. Based on these explanations, this has answered RQ3.

### 6.3. Effect of sample size

Size is based on the number of employees (Lee and Bose, 2002; Libby and Waterhouse, 1996; Mitra and Chaya, 1996; Weill and Aral, 2004; Wu et al., 2006). Size is used as the controlling variable in this study to determine whether it has any significant impact on the relationship between IT investment and company performance, and also on the moderating effects of decentralized decision making. Thus, by taking size as a control variable, the nature of relationship between IT investment and firm performance can be explored. Based on the data in the hierarchical regression analysis (Tables 5, 7, 9 and 11), it can be seen from model 1 that size does not have any significant effects on the relationships except on the relationship between infrastructure IT investment and financial

performance. This means that the size of the company will bring significant effects on the relationship between infrastructure IT investment and financial performance. Based on these data, we can say that the size of the company will not significantly influence the relationships between infrastructure IT investment and other perspectives; namely internal business process, innovation & growth and customer perspectives. This explanation has answered on the RQ2.

#### 6.4. Limitations of the study

This study has several limitations. The first limitation pertains to the sample. The sample is rather limited and samples are only taken from MIDA's list. The sample is also relatively small and confined to E & E manufacturing firms only, thus would provide a potential source of bias to generalizability to manufacturing sectors in general. Secondly the limitation relates to the low response from mail-surveyed questionnaire. A common problem faced is the difficulty to ensure that respondents answer the questionnaire. The low response rate has indicated that they were not too enthusiastic in replying to the mailed questionnaire.

#### 6.5. Conclusion

To conclude, this study has shown the benefits of relating infrastructure IT investments with company's multidimensional performance. This study has demonstrated that infrastructure IT investment can bring different benefits to a company, both tangible and intangible. These benefits can be both financial and non-financial in nature. Decentralized decision making only moderated the customer perspective only, it had negligible effects on other perspectives.

This study has provided additional evidence related to the issue of the infrastructure IT productivity paradox and the moderating role of decentralized decision making to the relationship between infrastructure IT investment and firm's performance within the Malaysian electrical and electronics sector.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.accinf.2017.09.001>.

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