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Information Technology's Influence on Productivity

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Information Technology's Influence on Productivity

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Abstract

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Previous research has had mixed results correlating information technology investments to increases in productivity. This research surveyed the perceptions of information technology managers to determine the impact that information technology, decentralized decision making, and improved business processes have on productivity. It concluded that information technology's influence on productivity is to magnify the effect of decentralized decision making and improved business processes.

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Introduction

In today's business world, people are encouraged to do more with less. Companies are challenged to lower prices while improving quality. This has fueled competition and increased value for consumers. If one supplier is not able to provide the acceptable value and price, another supplier is eager to step in. In order to compete, companies have to become more efficient. This is most notably seen when examining information technology budgets. In an *infoworld* article, more than half of senior information technology managers polled said they have an adequate budget to get the job done, but an increasing number of managers felt that top executives do not understand the value of information technology (Fox, 2006). Thus, employees are expected to get more done in a shorter amount of time in order to help their companies compete.

The importance of productivity becomes clear when it is related to our standard of living. A country's standard of living is a reflection of consumers' ability to consume more while spending less. The level of productivity is one way to determine the standard of living for a country. Increasing productivity 1 percent each year will double the standard of living for a country every 70 years. Productivity increases of 3 percent each year will double the standard of living every 25 years. During the 1970's, 1980's, and early 1990's, the productivity growth in the United States economy was barely 1 percent each year. Many economists thought the growth would remain constant, but since 1995 annual productivity growth has averaged more than 3 percent (Brynjolfsson & Brown, 2005).

In order to compete, some organizations have turned to information technology to help provide more valuable goods and services at a lower price. This should ultimately

help the company become more profitable. Brynjolfsson and Brown (2005) determined that information technology holds the potential for productivity growth but it may require changes in business practices. Similarly, revolutions in business practices were necessary to take advantage of previous technology advances.

Information technology has also enabled some companies to change how they structure their organization. Teams of people with various information technology and business skills work together to achieve business objectives. These companies use information technology to shift responsibilities to lower level workers and decentralize decision making. According to a senior executive in a 2002 Chabrow article, significant improvements in information technology allow an organization to maintain independent departments while leveraging the power of a large corporation.

The lofty expectations of information technology investments have not always been met. This has prompted a lot of research on the effect of information technology on productivity (Brynjolfsson & Brown, 2005; Brynjolfsson & Hitt, 1998; Hitt & Brynjolfsson, 1995; Kudyba, 2004; Melville, Kraemer, & Gurbaxani, 2004). Early attempts to tie investments in information technology to increased productivity had mixed results. These researchers found that investments in information technology had little to no effect on productivity (Brynjolfsson, 1993; Dedrick, Gurbaxani, & Kraemer, 2003; Mahmood & Mann, 2005; Solow, 1987). However, the measurement of productivity has improved as more research has been done. Additionally, researchers have learned that effects of information technology take time to appear (Brynjolfsson, 1993; Dedrick et al., 2003; Mahmood & Mann, 2005).

Statement of Purpose

A significant amount of research has attempted to determine if information technology is a good investment for an organization. Because these investments can be substantial, companies want to ensure that their investment will yield the results they expect. This study is intended to determine how companies can make the most of an information technology investment. The following research describes how information technology can be used to decentralize decision making, improve business processes and ultimately improve productivity.

Operationally Defined Variables

When researching expansive topics like information technology, productivity, and decentralized decision making, it is helpful to establish a common understanding of terminology. Brynjolfsson (2003), Hitt and Brynjolfsson (1995), and Dedrick et al. (2003) narrowly define information technology as computer hardware expenditures. Hitt and Brynjolfsson, (1995) expand this definition by noting that ideally information technology should include all components that are considered information technology such as software expenses, support costs, training, and implementation costs in addition to actual hardware costs. However, detailed data on total information technology expenditures is often not available.

Previous research defines productivity as the amount of output produced for a given amount of input (Brynjolfsson, 2003; Hitt & Brynjolfsson, 1995; Dedrick et al., 2003). When measuring changes in productivity, researchers can hold either the input or output static. An increase in productivity can occur when output increases without an

increase in inputs, or when output remains constant while the amount of inputs is decreased.

Business processes are the day to day operations of an organization. They can be seen through the sales requests, work approvals, and financial reports that must be completed as work flows through the organization. These processes can be ingrained into the culture of the company, and have a significant impact on how the organization does business. While changes to business processes can be difficult to implement, they may be necessary in order to take advantage of the information technology available to the organization.

Operationally defined, decentralized decision making reorganizes the information flow of an organization down to lower level workers and empowers them to make more decisions. Because workers are more self-directed, managers are able to supervise more individuals and increase their span of control. With more employees working and fewer people managing, the organization will increase the productivity per person (Brynjolfsson & Brown, 2005).

Information technology can be viewed as a tool available to an organization. Similar to traditional tools that you would find in a hardwood store, each tool has a specific purpose, and is designed to be used in a certain way. The key to getting the greatest impact from a tool is to use it correctly. While it is possible to use a screwdriver to pound a nail, it is more productive to use the screwdriver to tighten a screw and a hammer to pound a nail. Much like a screwdriver, information technology is a tool that, when used appropriately, can improve business processes and decentralized decision making. When organizations use information technology to improve business processes

and decentralize decision making, they will see greater increases in organizational productivity.

Variable Definitions

Information Technology	Computer hardware, software, support, training, and implementation costs.
Organizational Productivity	The amount of output produced for a given amount of input.
Business Processes	The day to day operations of an organization.
Decentralized Decision Making	Reorganize the information flow of an organization down to lower level workers and empower them to make more decisions.

Table 1. Variable Definitions

Literature Review

Research has shown that investments in information technology alone have a limited effect on productivity. Mahmood and Mann (2005) found that increases in performance and productivity are not solely reliant upon information technology investments. Strategic decision making by management is needed to determine a direction before deciding the specific information technology investment necessary to achieve the goals and objectives. When an investment in information technology occurs in unison with changes in work processes, the effect on productivity will be significantly greater than an investment in information technology alone. Keller (2004) determined that productivity gains do not come from an information technology group but rather from the business unit that must determine how to best utilize information technology resources already in place.

Does information technology increase a firm's productivity? Brynjolfsson (2003) found a statistically significant correlation between information technology capital per worker and the company's overall productivity. The most effective organizations invested more in information technology and experienced higher performance and productivity measures. Growing investment in information technology has been the most important reason for recent productivity growth (Mahmood & Mann, 2005). Brynjolfsson and Hitt (1998) found that companies generally had a positive return on information technology investment, but there was a significant variance across organizations.

Those variances have led some researchers to question the value of information technology related to productivity. Some even concluded that information technology has a negative impact on productivity. According to Dedrick et al. (2003), "Studies have failed to identify a relationship between IT [information technology] investment and firm profitability (p11)." When studying previous research and literature, there is inconclusive evidence whether information technology has had a positive impact on organizational performance and productivity (Mahmood & Mann, 2005). The term 'productivity paradox' describes information technology's inability to increase productivity.

Stephen Roach (1994) was one of the first to use the term productivity paradox. He described the paradox as a situation where America's service sector owns about 85 percent of the country's information technology and is experiencing disappointing productivity growth. In the 1980's the service sector spent about $860 billion in information technology but continued to have disappointing productivity growth. The

productivity paradox signaled that something was wrong as the United States entered the information age. When a factory buys equipment that makes workers more efficient, individual workers produce more and unit labor costs go down. When a service company buys information technology it tends to employ the same number of workers with the same labor costs. "Sheltered from competition by regulation and the lack of foreign players, service companies were becoming more complacent about matters of cost control and were loading up on both workers and machines (p55)" (Roach, 1994).

As far back as 1987, there were critics of how technology was being utilized. Solow (1987) felt that a technology revolution has been accompanied by a slow down of productivity growth. His often referenced quote was "You can see the computer age everywhere but in the productivity statistics. (p1)" Solow also did not see information technology being used to increase productivity. Many companies were making large investments in information technology, but they were not receiving the benefits that were expected. More research was necessary to determine the reason for this.

The productivity paradox prompted more investigative research. Brynjolfsson and Hitt (1998) determined that "IT [information technology] has a positive and significant impact on firm output, contradicting claims of a productivity paradox." (p52) The change in research findings can be explained through Mahmood and Mann's (2005) findings that research measurement can have a significant influence on information technology's measured impact on firm output. They also discovered that multiyear research is necessary because information technology investments typically take several years to produce any sort of measurable performance improvements.

Research to find a cause and effect relationship between information technology investment and worker output is ongoing and the results have shown information technology's impact on productivity. According to Brynjolfsson (2003), and Dedrick et al. (2003), information technology has been increasing productivity and annual output per worker for more than three decades. Kudyba (2004) concluded that greater information technology skills increased firm output. Enhanced information technology skills among employees resulted in higher productivity, organizational performance, and firm output (Hitt & Brynjolfsson, 1995; Kudyba, 2004). Brynjolfsson and Brown (2005) also found that information technology intensive companies tend to be more productive.

Productivity comes from working smarter, which normally requires new production technologies and techniques. Productivity gains from information technology can be realized in three ways: decrease information technology costs and business benefits remain the same; increase business benefits and information technology costs remain the same; or decrease information technology costs and business benefits increase (Brynjolfsson, 2003; Brynjolfsson & Hitt, 1998; Keller, 2004). Mahmood and Mann (2005) concluded that companies which invest more in information technology appear to achieve a higher level of performance and productivity.

According to Melville et al., (2004), information technology is valuable. The potential benefits range from flexibility and quality improvements to cost reduction and productivity enhancement. Using information technology efficiently and effectively has an impact on a company's return on sales and market share. Companies with high information technology efficiency ratings have reported higher return on sales than companies with low efficiency ratings. Companies with high information technology

effectiveness ratings also increased their market share more than companies with low effectiveness ratings. Low information technology effectiveness resulted in lost market share. (Hosseini, 2005) A study by Mahmood and Mann (2005) concluded that computer capital and information technology labor spending contribute to firm's return on investment. They also indicated that effective corporations are spending more on information technology and have better information technology infrastructures.

These information technology infrastructures establish a medium where information can be better distributed. Both managers and employees are able to be more productive in an environment that promotes open information access. A well established infrastructure also helps create an environment that promotes decentralized decision making (Brynjolfsson & Brown, 2005).

Decentralized Decision Making

Melville et al., (2004) found that information technology investment in combination with decentralized decision making can improve productivity. Organizations that combined information technology investment with decentralized work practices were about 5 percent more productive than firms that do neither. But, firms were found to be worse off if they invested in information technology without new work systems (Brynjolfsson & Hitt, 1998). Decision making is decentralized when non-management workers are empowered to make decisions. Information technology users were also more likely to decentralize decision making by empowering workers with information (Brynjolfsson, 2003).

Information technology investments enable traditional and hierarchical management structures to change to a more open and collaborative structure. A

centralized management center empowers people on site to make decisions and take advantage of matrix organizations in order to get the right person doing the right thing. Time and distance barriers can also be overcome through modern communication technologies. People will be encouraged to utilize the internet as a communication tool due to its low cost and convenience. Physical distance is no longer a determinant in the cost of communicating (Charoenngam, Ogunlana, Fu-Ning, 2004).

Brynjolfsson and Hitt (1998) found that "The greatest benefits of computers appear to be realized when computer investment is coupled with other complementary investments; new strategies, new business processes and new organizations all appear to be important in realizing the maximum benefit of IT [information technology]. (p50 – 51)" These investments do not occur in a vacuum, whether an information technology investment improves productivity depends mostly on complementary organizational investments that companies make in addition to their information technology investment (Brynjolfsson & Brown, 2005). Brynjolfsson (2003) found that the greatest information technology benefits are realized when an information technology investment is coupled with a specific set of complementary business investments. Companies that use information technology intensively work differently from their competitors. For example, the productivity gap between Wal-Mart and Kmart cannot be overcome by Kmart installing a new information technology system. It is the way that Wal-Mart utilizes its technology to manage its inventory that enables Wal-Mart to be more productive. Information technology can increase productivity when combined with complementary investments in work practices, human capital, and organizational restructuring.

Managers searching for increased profitability should look beyond productivity. They should focus on how information technology can address other strategic levers such as product position, quality, or customer service. While information technology can potentially lower the cost of providing these services, attaining a competitive advantage may involve using information technology to radically change the way products or services are produced and delivered so that they cannot be duplicated by competitors (Hitt & Brynjolfsson, 1995).

Integrating information technology into existing business processes

When a firm makes a large investment in information technology, it must evaluate its business processes (Zhou & Chen, 2003). Whether the technology is adapted to the business processes or visa versa depends on the particular situation. However, both should be analyzed. Researchers also found that organizations benefit when information technology is combined with other investments and integrated into existing business processes. For example, Brynjolfsson and Hitt (1998) found that information technology is more beneficial when it is coupled with other complementary investments. Kudyba's (2004) research indicated that in order for a company to achieve the desired results of an information technology investment, the technologies must be integrated into existing business processes.

In order to take advantage of new technologies, firms must ensure that employees are properly trained. Skilled employees are a source of sustained competitive advantage (Kudyba, 2004). Brynjolfsson (2003) found that companies achieved high levels of productivity and more employee and customer satisfaction when they successfully combine automation of numerous routine tasks, highly skilled labor, decentralized

decision making, improved information flow (vertically and laterally), strong performance-based incentives, and an emphasis on training and recruiting. Information technology investments will either directly or indirectly contribute to each of these attributes.

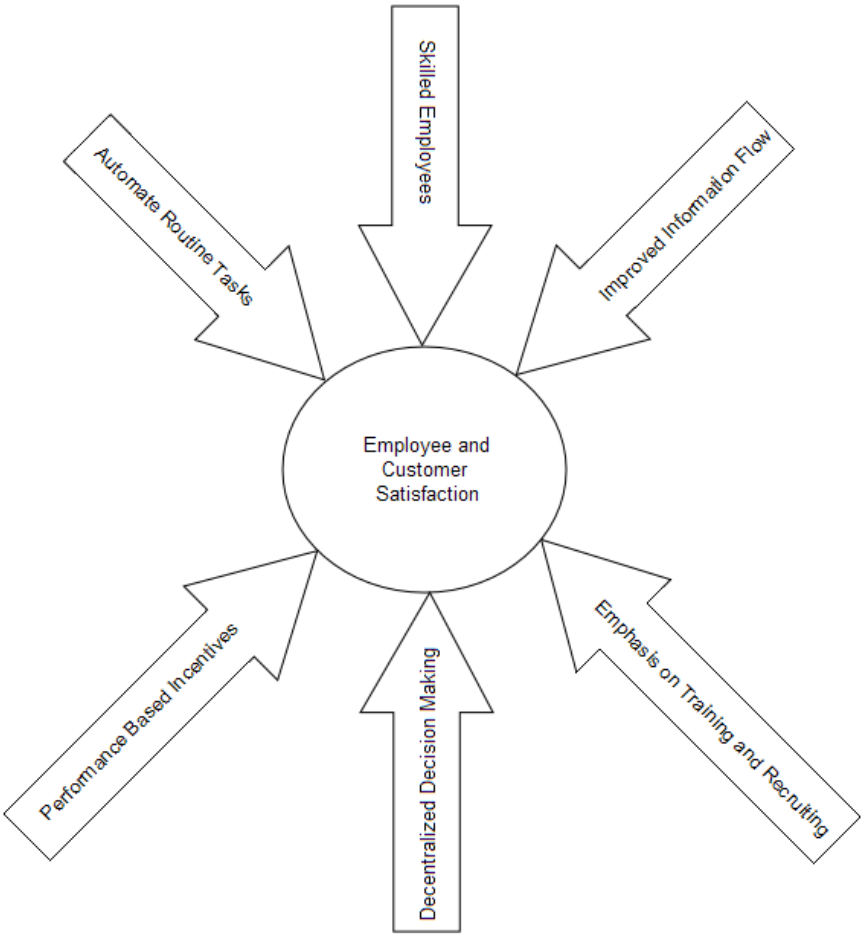

Figure 1. Factors that Contribute to Employee and Customer Satisfaction

According to research, when a firm's investment produces a new information system, it is important to redesign business processes around it. This is especially important when the business environment changes (Zhou & Chen, 2003). In order to maximize the large investment of a new information system, a firm should make sure that

its business processes utilize the advantages that the new system provides. This also includes making sure that the advantages are well communicated to employees, and employees are adequately trained.

Information technology alone will not necessarily improve organizational performance. Organizational performance improvements need to be done through improved business processes which embody an organization's day-to-day activities. Improved processes and organizational performance is a result of the right information technology applied within the right business process (Melville et al., 2004). The productivity increase does not come directly from a new investment; rather the increase comes from the business unit. For this reason, the direction for an information technology investment must come from the business unit. The information technology investment is intended to allow the business unit be more efficient or take advantage of new opportunities (Keller, 2004).

A critical question facing managers and decision makers is how to best utilize existing information technology investments. Two companies with identical information technology investments may have very different productivity levels depending on how they choose to utilize the technology (Brynjolfsson, 2003). These differences allow organizations to try to use information technology to separate themselves from competitors and create a competitive advantage. Melville et al. (2004) found that the competitive advantage resulting from technical and human resource synergies is likely short lived. Sustained competitive advantage is achieved through a complex mechanism that is difficult to imitate. Information technology investments can enable a competitive advantage when the firm utilizes information technology to do something that other firms

are not doing. Once other firms begin utilizing information technology in a similar manner, the firm will no longer have a competitive advantage (Brynjolfsson, 2003).

When an organization needs to modify its business processes, the integration of technology systems becomes very important. A large information technology investment takes time to implement; normally the two information systems must work alongside and sometimes the existing technologies are never discontinued. New technology solutions must integrate with existing technologies in order for the organization to realize expected productivity increases (McNamara & Watson, 2005).

Research indicates that maximizing an organization's information technology investment sometimes applies to its existing information technologies. However, utilizing existing information technologies to implement a new business process is as productive as creating a new technology system (McNamara & Watson, 2005).

A firm's performance is determined by more than productivity. Company executives often use measures such as profitability, market share, margins and product quality in order to measure the productivity of an organization (Dedrick et al., 2003). It is possible that firms can achieve increased productivity from effective management, but fail to realize higher profitability. This is because productivity, consumer value, and business profitability are related, but ultimately separate variables. Information technology has been found to increase productivity and create value for customers, but these benefits have not resulted in higher than normal profitability (Hitt & Brynjolfsson, 1995).

One possible way to increase profitability would be to focus less on achieving productivity gains and concentrate more on pairing the benefits of information

technology with available market opportunities. Increased efficiency can raise firm competition by lowering the barriers to entry and eliminating market inefficiencies. This increased competition can reduce the prices paid for firm output. Lower prices paid for output will directly reduce profitability, possibly more than any cost savings achieved through information technology (Hitt & Brynjolfsson, 1995).

Measurement

In order for researchers to determine the importance of productivity, it is necessary to find a method to measure productivity. Brynjolffson and Hitt (1998) emphasized the importance of productivity by indicating that "productivity growth determines our living standards and the wealth of nations (p49)." However, they also discussed the difficulty to measure such an abstract concept. "Productivity is a simple concept. It is the amount of output produced per unit of input. While easy to define, it is notoriously difficult to measure, especially in the modern economy (p49)."

Several researchers have determined that it takes many years for an information technology investment to increase productivity. Mahmood and Mann (1998) concluded that there may be lags of two to three years before the impact of an information technology investment on organizational performance and productivity is realized. Dedrick et al. (2003) found an even longer time separation. Their research indicated that over time firms have learned to apply information technology productively. Payoffs to information technology are maximized after a lag of four to seven years. Studies that utilize multiyear data will likely provide a more accurate perspective of the information technology investment and organizational performance relationship (Mahmood & Mann, 2005).

Tallon and Kraemer (2006) provide another perspective on how to accurately measure information technology's impact on productivity. They propose a method of perceptual measures. Perceptual measures would add a new dimension to determining information technology impact. Typically, research is focused on economic, financial or accounting measures; "perceptual measures, if structured around information technology impacts at the process-level, can yield richer insights than objective criteria alone (p1019)". These perceptual measures would develop a process-oriented thermometer of information technology's business value based on executives' perception of the information technology impact.

Literature Review Conclusion

An information technology investment itself does not increase productivity; rather it is a key part of enabling change within the organization (Brynjolfsson & Hitt, 1998; Dedrick et al., 2003). The investment assists changes to how the firm does business as well as organizational restructuring to support those changes (Melville et al., 2004).

There is a wide range in performance among companies regarding information technology investments. Some differences are due to firm idiosyncrasies. However, there is strong evidence that management practices such as decentralized decision making, job training, and business process restructuring have a major impact on the success of information technology investments (Dedrick et al., 2003).

The organizational changes are not necessarily restricted to within the information technology departments. Instead, Brynjolfsson "Found that IT [information technology] is embedded in a cluster of related innovations, notably organizational changes outside the IT department" (Brynjolfsson, 2003). An information technology investment can

increase productivity, but only if the investment is included in a plan that integrates organizational changes and improved business processes.

Information technology is a tool that can increase productivity and improve an organization's performance. Like any tool, it is most effective when used properly. This literature review has determined that information technology is best utilized to assist in organizational and process changes. Firms that use information technology to decentralize decision making and to improve their business processes are more likely to perceive their investment as successful.

Problem Statement

To what extent does information technology ease decentralized decision making and improved business processes in order to increase the productivity of an organization?

Hypotheses

1. As an organization better utilizes information technology to decentralize decision making, perceived productivity will increase.
2. As an organization better integrates information technology into its business processes, perceived productivity will increase.
3. Organizations that invest in information technology without related business process improvements will not perceive expected productivity improvements.

Theoretical Framework

Decentralized Decision Making: When organizations have a decentralized structure, managers are able to supervise more individuals and increase their span of

control because workers are more self-directed. With more employees working and fewer people managing, the organization will increase the productivity per person. In order for decision makers to be able to make well informed decisions, information needs to be easily available and in a usable format. Information technology is a key part of distributing the necessary information for well informed decisions.

This research will attempt to measure information technology's impact on how decentralized decision making increases perceived organizational productivity. It is reasonable to believe that decentralized decision making increases a firm's productivity. However, does the level that information technology is utilized impact the significance which decentralized decision making increases productivity.

Improved Business Processes: Organizations should continually be evaluating how they do business, and an information technology investment is a good opportunity to look at a firm's business processes to make sure that they are consistent with the direction of the organization. The information technology and the business processes must work collaboratively in order for both to be maximized. When an organization's investment in information technology includes well defined processes and properly structured workgroups it will lead to increased productivity by the workgroups.

An improvement in business processes should obviously improve organizational productivity. This research will attempt to determine what impact information technology has on improving business processes. Do firms that use information technology to create new sales markets or make other changes in how it conducts business have a higher level of perceived productivity?

Organizational Productivity: The dependent variable is the productivity of an organizational unit, which is the variable of primary interest. The productivity of an organizational unit is operationally defined as the amount of output produced for a given amount of input. A highly productive staff will accomplish more objectives while still enabling workers to maintain a healthy work-life balance. Organizations that increase productivity by simply forcing employees to work longer hours and reducing staff will not have long term productivity increases. Rather, firms that utilize decentralized decision making and improved business processes are more likely to achieve the productivity increases that they expect.

Organizational productivity is a difficult concept to measure. Tallon and Kraemer (2006) used perceived measures to determine organizational productivity. They found that firm executives could accurately perceive information technology's impact on organizational performance. When a firm invests in information technology such as a customer relationship management system, it expects to reduce customer turnover, and identify unique customer needs. Most likely the perceived improvements will be reflected in financial reports, but managers prefer to focus on metrics that make the most sense. This research will use perceived measures to determine what effect decentralized decision making, and integrated business processes have on organizational productivity.

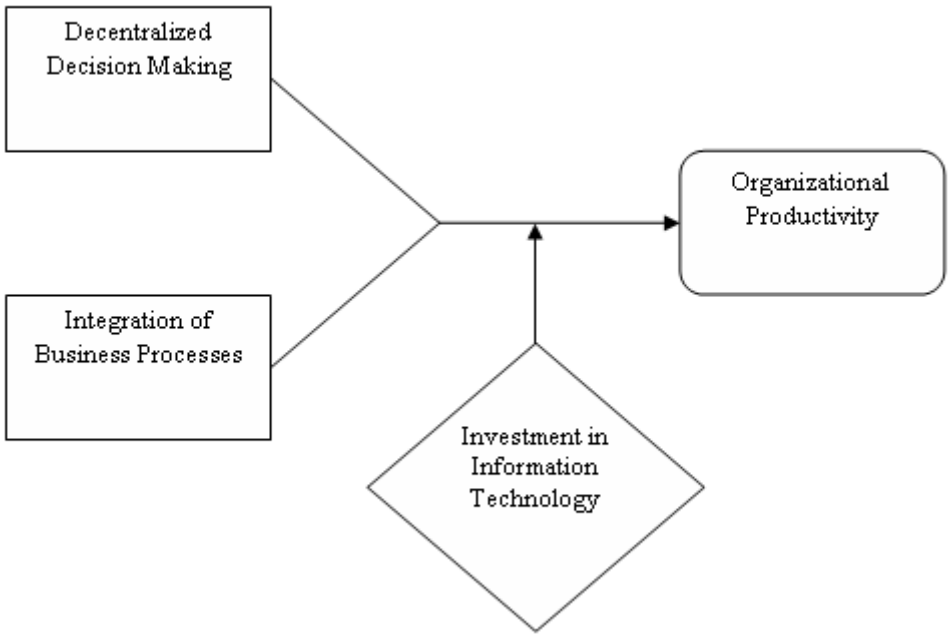

Figure 2. Theoretical Framework

Research Methodology

This research will be conducted through surveys sent to a sample of metro Omaha and eastern Nebraska organizations. By using this method, a statistically significant number of organizations will be examined. The population group of eastern Nebraska organizations has been chosen to manage the amount of data collected. This geographic region is also more familiar with the University of Nebraska at Omaha which should increase the number of survey responses. A smaller population will also ensure that a representative sample is selected to survey.

The questionnaire is a seven point Likert scale that will examine how strongly subjects agree or disagree with statements. The Likert scale will enable the use of an interval scale which increases that amount of statistical analysis that can be done. The

survey will be given to a selection of employees who are in a position to evaluate the use of information technology within an organization. This group includes chief executives, information technology managers, line managers, and information technologists.

Zoomerang, an online survey tool, has been chosen as the method of electronically distributing the survey. An emailed cover letter will be sent to all participants along with a brief explanation of the research and a link to the survey. The researcher is able to download the results of the survey, but cannot tell the identity of individual participants. This ensures that all participants' survey answers will remain confidential.

Regression analysis is used to determine if there is a relationship between survey results related to each independent variable and the dependent variable. The F-test will show the overall significance of the model. When the alpha is greater than the significant F, the null hypothesis is rejected and the overall model is significant. The F value will show the explained variations and how likely the model is the result of a random outcome. The Adjusted R Square determines the variance that is explained by the regression model; the more variance that can be explained by the regression model, the more dependable the model.

The coefficient of each independent variable is the regression coefficient. This is the slope in a $Y = a + bX + e$ equation. The regression coefficient measures how much of an impact the independent variable has on the dependent variable. The impact of the moderating variable will split the survey results based on the investment in information technology questions. The average survey result for the questions related to investment in information technology will be used to divide the results into two groups,

above and below average investment in information technology. The regression coefficient of surveys with above average investment in information technology will be compared to the regression coefficient of surveys with below average investment in information technology.

The 38 question survey is used to test the five items listed in Table 2.

		Questionnaire	
Variable Name	**# of Items**	**Section**	**Item #s**
Investment in Information Technology	8	A	1 – 8
Improved Business Processes	8	B	9 – 16
Decentralized Decision Making	8	C	17 – 24
Organizational Productivity	8	D	25 – 32
Demographics	6		1 – 6

Table 2. Variables Measured in Survey

Previous research was used to compose many of the survey questions. Table 3 summarizes the source for 18 of the 32 survey questions.

Source	**Questions**
Allen, R, S., Helms, M, M., 2006	A5, B11, B12,
Jedd, M., 2007	B14
Martin, R., 2007	A8, D32
Mitchell, V, L., Zmud, R, W., 2006	B13
Tallon, P, P., Kraemer, K, L., 2006	B9, B10, C19, C20, C21, C22, D27, D28, D29, D30, D31,

Table 3. Survey Sources

Results

The survey was sent to 90 information technology managers and officers in the Omaha, Nebraska metro area. The number of surveys completed was 58 or 64 percent. Figure 3 summarizes the demographic breakdown of the survey respondents. There is a representation of many different ages, education levels, and amount of time a respondent has spent with their current employer.

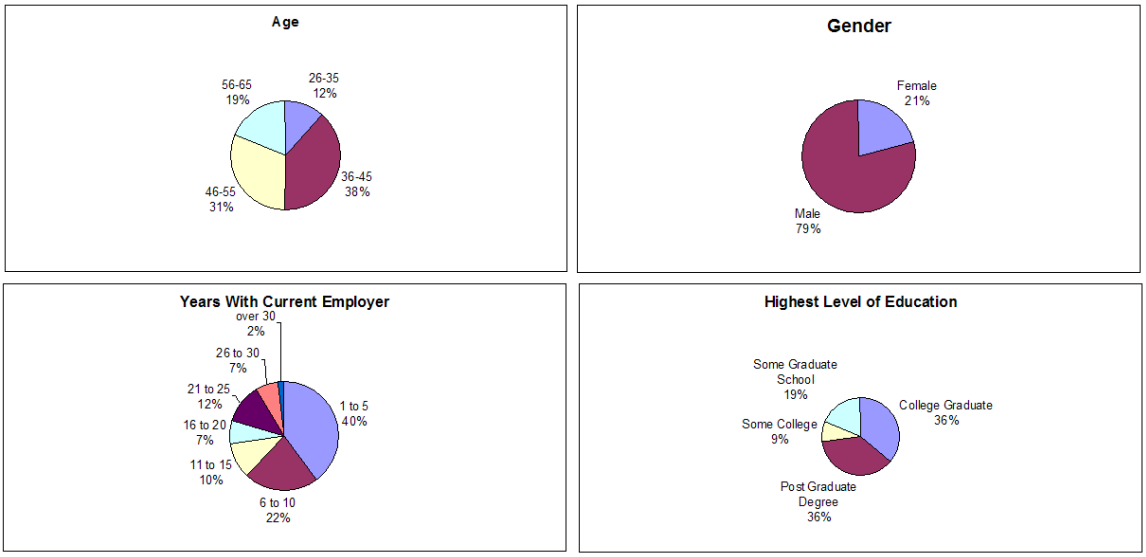

Figure 3. Demographic Breakdown

Fifty-nine Omaha Nebraska metro area organizations were invited to participate in the research. The survey results from Zoomerang do not reveal the identity of the individuals taking the survey; therefore it is impossible to tell exactly what organizations chose to complete a survey and which declined. The size of the organizations that were sent requests to participate varied from very large with more than 2,500 employees to medium sized businesses with between 20 and 50 employees. The organization pool was chosen from the Omaha Chamber of Commerce. The initial subset of organizations

chosen to survey was medium and large financial service companies, but in order to gather a significant survey pool, the audience was expanded to include a wide variety of industries.

The section of questions that measured each variable contained eight items. The survey answers for each respondent were averaged for each section to calculate a single value per respondent per variable. Regression analysis of the averaged results would be used to determine the correlation of these variables. Cronbach's alpha was used to test the reliability of the survey questions. Each set of questions had a Cronbach's alpha greater than 0.90 which shows that the survey was reliable. The results of the Cronbach's alpha test can be found in Table 4.

Variable	Cronbach's Alpha
Investment in Information Technology	0.90
Improved Business Processes	0.91
Decentralized Decision Making	0.91
Organizational Productivity	0.95

Table 4. Cronbach's Alpha

Hypothesis #1: As an organization better utilizes information technology to decentralize decision making, perceived productivity will increase.

The results of the survey in this study show that there is a positive relationship between decentralized decision making and productivity. The regression analysis in Table 5 shows that decentralized decision making has a positive 0.63 regression coefficient. This means that as decentralized decision making increases, productivity will increase as well. This study supports the idea that information technology is a moderating variable. This becomes evident when comparing the regression coefficient of decentralized decision making in Table 6 and Table 7. The regression coefficient for

decentralized decision making is higher for surveys where investment in information technology is above average. This offers support for hypothesis #1.

Regression Analysis for all Survey Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.87963
R Square	0.77375
Adjusted R Square	0.76552
Standard Error	0.59750
Observations	58

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	2	67.1489	33.5745	94.0455	1.78374E-18
Residual	55	19.6351	0.3570		
Total	57	86.7840			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.1388	0.4718	-2.4137	0.0191	-2.0844	-0.1933
Decentralized Decision Making	0.6284	0.1356	4.6353	0.0000	0.3567	0.9001
Improved Business Processes	0.5285	0.1260	4.1957	0.0001	0.2761	0.7810

Table 5. Regression analysis for all survey results

Hypothesis #2: As an organization better integrates information technology into its business processes, perceived productivity will increase.

According to the survey results in this research, there is a positive relationship between improved business processes and productivity. The regression analysis in Table 5 shows that improved business processes has a positive 0.53 regression coefficient. This means that as improved business processes increase, productivity will also increase. Information technology's effect as a moderating variable is less evident in hypothesis #2. When comparing the regression analysis in Table 6 and Table 7, the P-value for improved business processes in Table 6 is greater than .05. The improved business

processes coefficient is not significant because its P-value is greater than alpha (.050). The improved business processes in Table 7 is significant because its P-value is less than alpha. This offers support for hypothesis #2. The survey results show that improved business processes do have an impact on productivity. The compilation of surveys collected from the group with a higher than average investment in information technology has a significant coefficient for improved business processes. The collection of surveys gathered from the group with a lower than average investment in information technology does not have a significant coefficient for improved business processes.

Investment in Information Technology Below Average

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7679
R Square	0.5897
Adjusted R Square	0.5540
Standard Error	0.7322
Observations	26

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	17.7202	8.8601	16.5269	3.56E-05
Residual	23	12.3304	0.5361		
Total	25	30.0506			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.3764	0.8179	-0.4602	0.6497	-2.0685	1.3157
Decentralized Decision Making	0.5159	0.2270	2.2723	0.0327	0.0462	0.9856
Improved Business Processes	0.4535	0.2202	2.0593	0.0510	-0.0021	0.9091

Table 6. Regression analysis for surveys where investment in IT is below average

Investment in Information Technology Above Average

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7850
R Square	0.6163
Adjusted R Square	0.5898
Standard Error	0.4407
Observations	32

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	9.0448	4.5224	23.2882	9.29E-07
Residual	29	5.6316	0.1942		
Total	31	14.6764			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.3334	0.9421	-0.3539	0.7260	-2.2601	1.5934
Decentralized Decision Making	0.6610	0.1529	4.3233	0.0002	0.3483	0.9736
Improved Business Processes	0.3783	0.1623	2.3310	0.0269	0.0464	0.7103

Table 7. Regression analysis for surveys where investment in IT is above average

Hypothesis #3: Organizations that invest in information technology without related business process improvements will not perceive expected productivity improvements.

In order to test hypothesis #3, the regression coefficient for improved business processes should be greater when there is a higher investment in information technology. The average survey result for questions related to investment in information technology was 5.3. Fifty-five percent of the surveys were considered to have an average or above investment in information technology leaving 45 percent of the surveys to have a below average investment in information technology. Hypothesis #3 cannot be supported. The regression coefficient was not significant for improved business processes where

investment in information technology was below average and therefore cannot be compared.

Discussion

The results of this research can be utilized by organizations to increase productivity. The data gathered in this study suggests that organizations should increase productivity by using information technology to decentralize decision making and improve business processes. This is also supported by previous studies conducted by Melville et al., (2004) and Kudyba (2004) and makes a strong case that improving business processes and decentralizing decision making are two initiatives that can be successfully accomplished by an information technology investment.

Decentralized decision making was shown to improve productivity. Survey participants that strongly agreed with questions related to information technology had a stronger correlation between decentralized decision making and productivity than participants that did not strongly agree. This supports the idea that information technology is a differentiation factor for the amount of perceived productivity increase an organization will experience when it decentralizes decision making. Organizations that plan to implement a decentralized decision making strategy with a goal of increasing productivity should utilize information technology to support that strategy. For example, decentralized decision making can cause changes in workflow; and information technology can help make the changes easier and more productive.

Business process improvements also improved productivity. However, this research could not separate productivity improvements based on investment in information technology. One reason for this could be how the survey measured

perceived investment in information technology. An organization's perceived investment in information technology was measured by the extent that the organization embraced information technology. A possible alternative would have been to ask the specific dollar amount invested in information technology, or the percentage of the total budget that information technology makes up. The reason for using perceived investment was that the information was more readily available. An organization's capital investment in information technology could be interpreted as confidential information. Some organizations might have declined to participate in this study if they were required to disclose the size of their information technology investments.

Even though information technology was not shown to be a differentiation factor for improved business processes, there was a positive correlation between the combination of information technology with improved business processes and productivity. Organizations should strongly consider utilizing information technology in order to improve business processes. As new ways of doing business become available, using the appropriate technology to implement new processes will aid the adoption of new processes, and make them more efficient.

The challenges faced by this research, as well as much of the previously studied research, are how to measure productivity and determine the cause of the change in productivity. This research measured each variable through survey questions that would differentiate organizations based on that variable. For example, survey respondents who strongly agreed with questions that measured productivity were more likely working for organizations that were highly productive.

After performing this research study, it has become clear that it is important to consider the choice of the information technology investment and how the investment will be implemented. While information technology can be used to address the unique business challenges of individual firms, the solutions will differ among companies. Organizations should look to industry best practices, other competitors within the industry, and the expertise of their employees to help determine the extent that information technology should be utilized to improve business processes and decentralize decision making.

Leaders within an organization are expected to solve problems and provide a strategic direction. Information technology should be viewed as a means to solve organizational problems rather than being the solution to the problem. By itself, a new or improved information technology system will not increase sales or reduce costs. But, retained customers or a more productive workforce will.

Research Opportunities for Improvement

This research concentrated on two independent variables, improved business processes and decentralized decision making. It has one moderating variable, investment in information technology. Other independent variables could be studied to determine the effect on productivity, the dependent variable. Previous research was used to determine what independent variables to study, but a challenge facing decision makers is the wide range of variables that impact productivity. The variables that were studied in this research can be controlled by an organization. Other variables, such as government regulations, are more difficult for a firm to control.

The number of variables that impact productivity is further complicated by the difficulty to define productivity. Depending on how productivity is measured, the variables that impact productivity will change. An individual's relationship to an organization will have an impact on how they view productivity. A share-holder, CFO, and front line employee will each have different views on how to measure productivity.

The survey measured each variable based on the perception of the participants. The survey instrument asked questions that would determine the respondent's perception of a variable based on the extent they agreed with a statement. Using a respondent's perception can introduce errors based on interpretation of the survey question. Additional research could use accounting information to determine an organization's investment in information technology. This type of research approach could better categorize organizations based on their information technology investment.

Another opportunity to improve this research would be to expand the audience of the survey. The eastern Nebraska and metro Omaha area was well represented in this research. However, other areas within the United States or the world could be included. Investment in information technology, improved business processes, decentralized decision making, and productivity are variables that are applicable across all types of organizations in all locations. The differences will be how these variables are measured and analyzed. This research was challenged to determine a way to measure concepts such as productivity. Further research will have an opportunity to enhance how productivity and the independent variables that impact productivity are measured.

Conclusion

This research supports the notion that decentralizing decision making and improving business processes will increase productivity. Information technology was shown to be a moderating variable for decentralized decision making and improved business processes, but research could not conclude that organizations with a higher than average investment in information technology did a better job of improving business processes.

When an organization attempts to increase employee productivity, many tools are available. Decentralized decision making and improved business processes are two effective ways to increase productivity. Information technology's influence on productivity is to magnify the effect of decentralized decision making and improved business processes. This is important when evaluating a particular information technology investment. The framework of that investment should include tools that will actually increase productivity. In the case of this research, those tools were decentralized decision making and improved business processes.

Increasing global competition is forcing companies to be more effective with the resources they have available. In the illusive search for productivity increases, information technology should not be viewed as the focal point. It should be viewed as a tool which organizations utilize to improve the way that they do business and decentralize decisions.

Information Technology Survey

Using the scales below, please indicate your response to each of the items that follow, by circling the number that best describes your feeling.

Section A		1=Strongly Disagree			4=Neutral			7=Strongly Agree
1	My company is a quick adopter of new information technology.	1	2	3	4	5	6	7
2	My company routinely looks for new ways to use technology.	1	2	3	4	5	6	7
3	My current tasks have benefited from improved information technology.	1	2	3	4	5	6	7
4	My company uses information technology to identify market trends through powerful analytical tools.	1	2	3	4	5	6	7
5	My company routinely pursues cost reductions through information technology.	1	2	3	4	5	6	7
6	My company provides training for its employees on new information technology.	1	2	3	4	5	6	7
7	My company provides the information technology tools necessary for its employees to be successful.	1	2	3	4	5	6	7
8	My company's information technology strategy aligns with its business strategy.	1	2	3	4	5	6	7

Section B		1=Strongly Disagree			4=Neutral			7=Strongly Agree
9	My company uses information technology to facilitate the automation of core business processes.	1	2	3	4	5	6	7
10	My company uses information technology to facilitate new processes that constitute a better way of doing business.	1	2	3	4	5	6	7
11	My company uses information technology to facilitate operational efficiency.	1	2	3	4	5	6	7
12	My company uses information technology to control the quality of products/services.	1	2	3	4	5	6	7
13	Business processes are redesigned in order to create a competitive advantage in my company.	1	2	3	4	5	6	7
14	My company recognizes that continuous process improvement is valuable to its employees.	1	2	3	4	5	6	7
15	My company is working towards establishing a service-oriented architecture.	1	2	3	4	5	6	7
16	My company has modeled its business processes.	1	2	3	4	5	6	7

Section C		1=Strongly Disagree			4=Neutral			7=Strongly Agree
17	I have the authority to make the necessary decisions in order to take advantage of business opportunities.	1	2	3	4	5	6	7
18	Communication across levels is common in my company.	1	2	3	4	5	6	7
19	Information technology improves the process and content of decision making in my company.	1	2	3	4	5	6	7
20	Information technology improves internal communication within my company.	1	2	3	4	5	6	7
21	Information technology provides better coordination among functional areas in my company.	1	2	3	4	5	6	7
22	Information technology improves coordination among geographically separate units of my company.	1	2	3	4	5	6	7
23	My company has increased its management's span of control through information technology.	1	2	3	4	5	6	7
24	Employees at my company are empowered by the use of information technology.	1	2	3	4	5	6	7

Section D		1=Strongly Disagree			4=Neutral			7=Strongly Agree
25	My company is more efficient than the majority of its competition.	1	2	3	4	5	6	7
26	My company is more effective than the majority of its competition.	1	2	3	4	5	6	7
27	My company uses information technology to improve the productivity of labor through automation.	1	2	3	4	5	6	7
28	My company uses information technology to improve the levels of production.	1	2	3	4	5	6	7
29	Information technology assists my company in serving new market segments.	1	2	3	4	5	6	7
30	Information technology increases my company's ability to anticipate customer needs.	1	2	3	4	5	6	7
31	My company uses information technology to facilitate a higher level of responsiveness to customer needs.	1	2	3	4	5	6	7
32	My company is effective at using information technology for business innovation.	1	2	3	4	5	6	7

Demographic Questions			
1	What is your age?	19 and under 20 to 29 30 to 39 40 to 49 50 to 59 60 to 69 70 and over	
2	What is your gender?	male	female
3	How many years have you worked for you current employer?	free form text	
4	How many years have you worked in information technology?	free form text	
5	Please indicate the highest level of Education you have attained:	Some High School High School Graduate Some College College Graduate Some Graduate School Post Graduate Degree No Formal Education or Schooling	
6	Please indicate your employment status:	Exempt (salaried)	Non-Exempt (non-salaried)

Survey Cover Letter

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Dear Participant:

I am a graduate student at the University of Nebraska at Omaha and I am conducting a study for my masters in Management Information Systems. This study will attempt to determine how companies can best improve productivity from their Information Technology investment. Your participation will take less than thirty minutes.

Please be assured that your confidentiality is extremely important. I plan to analyze the results gathered from this survey, but your identity will not be revealed within my findings. You are free to withdraw your consent to participate and may discontinue your participation in the study at any time without consequence. Questions or concerns about research participants' rights may be directed to the University of Nebraska Medical Center's Institutional Review Board, 402-559-6463.

The study will help provide recommendations on how companies can improve productivity from their Information Technology investment. If you wish to receive a copy of the results of the study, or have questions about the study, please contact me at jason_smith@cox.net or by phone at (402) 916-9285.

In order to launch the survey, please click on the link below. If the link does not launch, please copy the link in paste it into Internet Explorer.
http://www.zoomerang.com/survey.zgi?p=WEB2274J98XX6F

Thank you in advance for participating in this study.

Sincerely,
Jason Smith

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