T.C.
MARMARA UNIVERSITY
INSTITUTE FOR GRADUATE STUDIES IN PURE AND APPLIED SCIENCES

RELATIONSHIP BETWEEN IT INVESTMENTS AND PRODUCTIVITY

Sinan Osman TURHAN

(Electronics & Communications Engineer)

THESIS

FOR THE DEGREE OF MASTER OF SCIENCE

IN

ENGINEERING MANAGEMENT PROGRAMME

SUPERVISOR
Asst. Prof. Dr. Serol BULKAN

ISTANBUL 2009

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12.12.2008 **Sinan Osman Turhan**

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ABSTRACT

Relationship between IT Investment and Productivity

One thing in common among all of the companies, in which sector they operate or in what scale they are, is investing in Information Technology (IT). The main objective of this study is to investigate whether there is a return on such investments or not. This return can be tangible, intangible or both. This study is investigating the value of IT for companies.

A literature survey has been conducted about the IT investment evaluations and its relationship with productivity. Different approaches and models were investigated and summarized in the "general background" part. In the light of literature survey, we classify the studies into two main approaches. First approach based on economic value calculation. It states that any kind of IT systems or investments can be modeled mathematically and as a result, quantitative results can be taken from these models. Second approach is the strategic approach. It states that although IT investments can be expressed as mathematical equations in some ways, it is a strategic decision rather than an economic necessity. It states that to benefit from an IT investment, managers should make good insights to their companies and make IT the part of the company culture.

After the theoretical background about the topic has been summarized, we will investigate whether the results are valid for Turkey's market conditions or not. A questionnaire is prepared including the results of the two main approaches. We have sent the questionnaire to the chief information officers (CIO) of first 500 companies declared by İstanbul Chamber of Industry in 2007. In the "Survey Study" section the methodology of the survey study and the structure of the questionnaire are expressed. The findings of the survey study are tabulated in the "Results" part of the study. In this part, we compare the findings of the survey study and the literature survey and state the similarities and differences between them. In the "Discussions and Evaluations" part detailed analyses of the results of the survey study are expressed. Classifying the participating companies into two groups as local companies and global companies, we also investigate the differences in managerial approaches between them.

12.12.2008 **Sinan Osman TURHAN**

ÖZET

Bilişim Teknolojileri Yatırımlarının Verimliliğe Etkisi

Hangi sektörde olursa olsun, büyük, orta ve küçük ölçekli firmaların ortak yanı küçük ya da büyük, basit ya da karmaşık bir Bilişim Teknolojisi (BT) altyapısına sahip olmasıdır. Firmaların BT ürünlerine yaptıkları yatırımların firmalara geri dönüşü oluyor mu sorusu bu tezin ana konusunu oluşturmaktadır. Bu tez BT sistemlerinin firmalar için oluşturduğu değeri ve bu değerin nasıl ölçüldüğünü incelemektedir.

Tez çalışması kapsamında BT yatırımlarının değerlendirilmesi ve verimliliğe olan etkilerini araştıran çalışmalar incelenmiş, değişik yaklaşımlar ve modellemeler taranmış ve sonrasında elde edilen verilerin Türkiye'deki yansımaları araştırılmıştır. Yapılan literatür araştırmasının sonrasında iki temel yaklaşımın öne çıktığı görülmüştür. Bunlardan ilki ekonomik değer analizi ile BT sistemlerini matematiksel modellerle modelleyip kantitatif sonuçlara varılabileceğini savunur (Motohashi, 2003, Aral and Bryjolfsson, 2006 Fisher, 1997). Diğer yaklaşımsa stratejik yaklaşım olarak isimlendirilebilir (Tallon, 2004, Devaraj & Kohli, 2002). Bu yaklaşım BT yatırımının, her ne kadar belli ölçülerde ekonomik olarak ifade edilebilse bile, matematiksel modellerle ifade edilemeyecek getirileri olduğunu savunur. Bu yaklaşım başarılı bir BT yatırımı yapabilmek için yöneticilerin şirketin iş ve süreçleri ile ilgili detaylı analizler yapmalarının, başarılı bir değişim yönetimi sergilemelerinin ve BT sistemlerini şirket kültürünün bir parçası haline getirmelerinin en önemli etkenler olduğunu ileri surer.

Literatür araştırmalarının sonrasında, öne çıkan yaklaşımların Türkiye için ne kadar geçerli olduğu bir anket çalışması ile araştırılmıştır. Anket çalışması İstanbul Sanayi Odasının 2007 yılında yayınladığı en büyük ilk 500 firma listesindeki firmaların BT yöneticilerine gönderildi. "Survey Study" bölümünde, hazırlanan anket ve uygulanan metodolojinin açıklamaları verilmiştir. "Results" bölümünde anket çalışmasının sonuçları incelenmiş ve literatür araştırmasının sonuçları ile karşılaştırılmıştır. "Discussions and Evaluations" bölümünde araştırmaya katılan firmalar yerli ve çok uluslu olarak iki kategoriye ayrılmış ve bu firmaların BT yönetim stratejileri ve öncelikleri karşılaştırılmıştır.

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PART I

INTRODUCTION AND OBJECTIVES

I.1. INTRODUCTION

In today's business environment companies are forced to struggle with the global rivals in their sector. Since the globalization has started, a company is not only in competition with its local competitors or big companies in its local marketplace but also in a more cruel competition with the global firms too. This competition forces companies to work as efficient as they can. Some faces bankruptcy and some survive with the great benefit of eliminating others. As survivors continually improve their competencies, the price to stay in business and take a share in the marketplace will continue to rise.

To stay alive in business and improve market share, companies will have to be focused on their customers. The ones which communicate with its customers more effectively have the chance to make necessary adjustments in its production or service to improve customer satisfaction and loyalty that determines the strength of a firm. On the other hand, surviving a battle does not guarantee market leadership either. The advantage can be gone tomorrow unless companies continually make necessary adjustments in their competencies, stay tuned to their relevancy in the market and adjust as conditions change. An analogy can be made with the wild life and today's wild global competition environment. In wild life survival of species is explained as: "It is not the strongest species that survive, nor the most intelligent, but the ones most responsive to change." This explanation also summarizes the characteristics of survived companies in today's global economic environment.

Since the competitors have nearly the same economic, strategic or managerial equipments, the kind of tool that helps a company to make a difference is explained by former General Manager of IBM Consulting Services North America, Michael Albrecht, Jr. as: "The tool, the technological marvel that will make it possible for us to stay ahead of our competition is

Information Technology (IT). This tool has matured and demonstrating over and over again that it can and will allow companies to compete successfully in a very volatile, intensely competitive forum of collaboration. We are now able to create products and services using the best and most creative minds in our organizations, no matter where in the world they are located, and do it in a cost effective manner using this technology. Companies which have mastered the management of that tool have realized handsome returns on their technology investments. More importantly, we now have a body of knowledge which allows us to suggest companies how best to manage information technology" (Cortada, 1998).

I.2. OBJECTIVES

The definition of productivity can be made as the amount of output produced per unit input. Properly measured output should include not only the total number of goods produced in a factory or lines of code compiled by a software development team but also, and most importantly, the value created for customers. "Fifty years ago, tons of steel or bushels of corn were a reasonable proxy for the value of output but in today's economy, value depends increasingly on product quality, timeliness, customization, convenience, variety and other intangibles" (Brynjolfsson & Lorin, 1998).

There are also some different points that should be taken into account like, quantity and quality of capital equipment used, worker training and education and even amount of organizational capital required such as supplier relationships cultivated and investments in new business. There is an ironic trade off in productivity measurements that is; although academics have more raw data today than ever before, productivity in the information economy has proven harder to measure than it ever was in the industrial economy (Brynjolfsson & Lorin, 1998).

There is another question that should be answered to conduct a valid relationship investigation between IT and productivity: Whether IT investments lower costs or not? Conventional metrics of productivity are composed of counting items; number of employees, pounds of nails, or number of checks processed. As long as computers lower the normalized costs of a unit product these metrics work just fine. However, when managers are asked why do they invest in IT customer service and quality consistently rank above cost savings.

This study investigates the relationship between IT investments and productivity. The biggest question in most of the IT managers and upper level managers is “does IT worth investing?” IT had lived its golden age since year 2000 and at these times the benefit that should be taken from IT investments are not considered and the cost-benefit analyses were not conducted. This study investigates first the historical background of information technology; secondly the approaches to the IT-productivity relationship and as a conclusion surveyed the projection of the findings in Turkey’s business environment.

The importance or the role of IT in business can vary from country to country as well as sector to sector. For example, in western countries infrastructure investments were made far before than Middle Eastern countries. These were made as a necessity for the companies. Strategic advantages or reduction of costs were mostly not taken into account at that phase. After companies stabilized their infrastructure suitable for future investments, they would plan their ERP investments or adoption of other strategic information technology tools. The technological gap between countries may differentiate the priorities of IT managers.

PART II

GENERAL BACKGROUND

Can a typical company truly benefit from a focus on information technology to differentiate itself from competitors and achieve important business objectives? The answer is not found in a simple measure of the dollars invested in IT. The amount a company spends on IT is a poor indicator of IT functionality and business impact. It is easy to spend a considerable amount of money on technology with very little improvement in the functional capability of the business. Another consideration may have been an exclusive focus on firm profitability. Profitability is likely a bad metric for firm health given the wide variability in its measure and the tendency of a firm to minimize profitability during periods of rapid growth due to investments (Iansity & Favaloro, 2005).

Productivity may be considered as a valid indicator for the value of IT or there may not be direct relationship between new technology investment and the productivity or profitability. The customers may be benefiting from that investment and thus, IT may increase the customer satisfaction. in 1999, the University of Notre Dame implemented a high-speed network called “ResNet” to make the campus network accessible throughout its residential buildings. The tangible income from this network is the cost reduction in phone costs but it is negligible when compared to the installation cost. Similarly, the on-line package tracking system adopted by a leading cargo company FedEx and the on-line charge tracking system adopted by the hotel chain Hyatt were established to increase customer satisfaction rather than to increase profitability or productivity (Devaraj & Kohli, 2002).

Since the amount a company spends on IT or profitability is not a good indicator, information technology (IT) business value can be defined in terms of expected Return on Investment (ROI). But ROI is a one-dimensional financial metric which measures financial returns and non-IT factors have to be evaluated via other methods. Yet IT can also create significant strategic value, and it is on such high-stakes strategic value and its associated competitive

edge that the longer-term performance of the firm is likely to depend. This observation leads corporations to ask how can they pursue strategic value, and how can they minimize the risks associated with that pursuit (Tallon, 2004).

After most of the preliminary e-business models faced bankruptcy, corporations' information technology (IT) investments slowed down. However, many studies declare that, over time, companies allocate significant resources to IT. "There is a growing awareness among executives that IT is not only just critical to run their business operations but also capable of creating significant economic and strategic benefits. Recent research by Boston College and the Center for Research on IT and Organizations (CRITO) at the University of California, Irvine (UCI) finds an increasing propensity among corporations to invest in strategic applications, particularly in processes that interface directly with customers" (Tallon, 2004).

Investments on internet use have changed the way of doing business. Internal processes, customer relations and profitability were affected by internet use after year 2000. If average profitability is under pressure in many industries influenced by the Internet, it becomes all the more important for individual companies to set themselves apart from the pack—to be more profitable than the average performer. The only way to do so is by achieving a sustainable competitive advantage—by operating at a lower cost, by commanding a premium price, or by doing both. Cost and price advantages can be achieved in two ways. One is operational effectiveness—doing the same things your competitors do but doing them better. Operational effectiveness advantages can take myriad forms, including better technologies, superior inputs, better trained people, or a more effective management structure. The other way to achieve advantage is strategic positioning—doing things differently from competitors, in a way that delivers a unique type of value to customers. This can mean offering a different set of features, a different array of services, or different logistical arrangements. The Internet affects operational effectiveness and strategic positioning in very different ways. It makes it harder for companies to sustain operational advantages, but it opens new opportunities for achieving or strengthening a distinctive strategic positioning (Tallon, 2004).

On the other hand, business and information systems (IS) executives complained about their inability to accurately determine whether these investments are delivering value as they are supposed to. "Researches again reveal that while 90% of corporations routinely conduct a cost-benefit or ROI analysis before committing a large-scale investment, fewer than 20%

perform a post-implementation check of whether the investment is actually delivering the desired level of value. A closer investigation of this anomaly reveals that with the concern of measuring IT impact on business all IT impacts — tangible and intangible — converted into a quantifiable ROI metric. While ROI remains a useful benchmark, it has to be remembered that IT value not in a one-dimensional sense but as a multidimensional notion composed of multiple IT factors that, independently or in combination, create value for the corporation" (Tallon, 2004). In examining the different faces or dimensions of IT value — avoiding the temptation to consolidate each dimension into an all-inclusive ROI metric — companies has to recognize the potential for corporations to generate new and useful insights into how IT is creating strategic value both at the application level and, more broadly, at the process level. "Bringing this knowledge to bear on a post-implementation audit can help companies to probe the unique performance characteristics of enterprise IT applications, together with the risks associated with delivering that value" (Tallon, 2004).

II.1. Defining IT Value: Linking to Business Objectives

When Kaplan and Norton used a simple analogy to explain evaluating the firm performance using a solitary financial measure such as profitability was no different from a pilot trying to monitor aircraft performance (e.g., speed, direction, height) using a single all encompassing dial they introduced the concept of the Balanced Scorecard as a solution. The issue of evaluating the real value of IT investments is nearly similar to the case of firm performance within the framework of the Balanced Scorecard. "The key issue here is that while some elements of IT value can be monetized and embedded within an ROI calculation, IT value is much broader than this. Unfortunately, the need to monetize all aspects of IT value for capital budgeting purposes has perpetuated an ROI culture where the focus is on making the cut-off rather than understanding the process by which IT creates value. Not surprisingly, therefore, a strict ROI culture can cause IT value to be misunderstood and mislabeled" (Tallon, 2004).

Since we cannot show all benefits of IT investments on financial papers or ROI analysis we have to exhibit basic standards to measure the success. "Just as aircraft performance can be measured against a flight plan and firm performance against a business plan, so IT value can be measured against a set of strategic business objectives. This suggests that the performance of an IT application must be evaluated in light of its strategic goals. For example, a business goal of low-cost leadership provides an important frame of reference for defining IT value in

terms of cost control, productivity, and efficiency. In contrast, a strategic goal of capturing market share through product differentiation or innovation requires IT value to be defined in terms of revenue generation such as increased sales per customer or sales to new customers" (Tallon, 2004). In other words, while the value of a labor automation application can be measured in labor cost savings, the value of a CRM application cannot be judged simply in cost terms, but based on numbers of new accounts, leads, and quotes. This approach to understanding how IT investments link to, and support, business goals is consistent with prior research by Harvard professor Michael Porter who argues that corporations can increase performance through operational excellence (i.e., improving internal operations) or strategic positioning (i.e., growing existing markets or exploiting new market opportunities): "IT value can be defined in terms of how much IT contributes to the realization of these two dimensions of performance with this approach. For example, the IT value created by a CRM application can be measured against operational effectiveness (e.g., number of customers served by each sales rep) and strategic positioning (e.g., incremental sales per sales rep). The biggest concern of IT management is to articulate these high-level goals at an application level, leading to a set of key performance indicators around which IT value can be measured" (Tallon, 2004).

A quick survey of the literature shows that, many studies claim IT investments to be strategic decisions (Tallon, 2004, Devaraj & Kohli, 2002) rather than results of economic analyses. The depiction of operational excellence and strategic positioning which contains business goals facilitates a top-down approach to defining IT value; a complementary bottom-up approach defines the impacts of IT as automation, informational, or transformational. "For example, in the case of process automation, we can define IT value in terms of lower labor costs, reduced error rates or productivity gains — all of which are consistent with a business objective of operational excellence" (Tallon, 2004). The informational effects of IT are related to secondary benefits that come about as a result of capture and interpretation of information. For example, credit card companies might assess decision quality using delinquency rates (number of new accounts that are in default after one year). In this way, the value of a knowledge management application would be the marginal change in this delinquency rate. Finally, a transformational impact speaks to the strategic way in which certain applications can change the nature of competition between firms by building new and often radical business models. As one might expect, these impacts can be highly strategic and sustainable; for example, the disintermediation impacts of e-commerce applications as reflected in subsequent changes in market share would fit into this category. Besides, the well known

examples of disintermediation in Travelocity.com (travel) or Amazon.com (book retailing), Calyx & Corolla (flower selling) experienced a significant increase in its market share when it placed its sales catalog on the Internet. Calyx & Corolla was already disintermediation retail flower stores and distributors by going directly to the grower — pursuing online sales went even further. While this bottom-up approach does not directly consider business objectives, it should again be clear that any identified impacts or IT value should be consistent with the strategy of the company. In previous research, Tallon repeatedly found that corporations with greater alignment between IT and business strategy — at the level of a business process — achieve greater value from IT. As illustrated in Figure II-1, one way to interpret this result is to say that a benchmark for IT value is how well an application supports business strategy either in terms of operational excellence or strategic positioning. The performance of an IT application must be evaluated in light of its strategic process and business goals (Tallon, 2004).

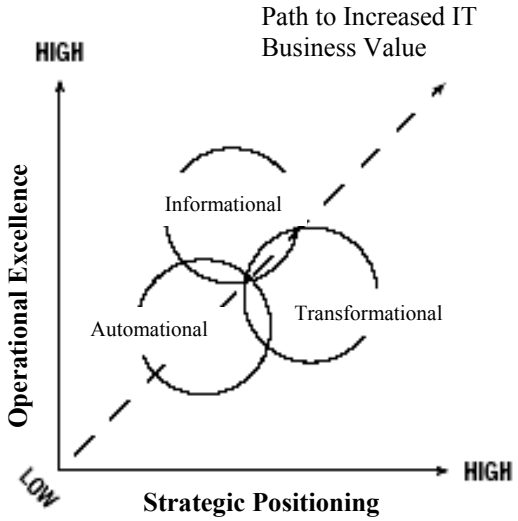


Figure II-1 Linking IT value to business objectives (Tallon, 2004).

While there is a certain level of granularity associated with these three dimensions of IT value, this is very different from the traditional micro-level "speeds and feeds" analysis that IT managers tend to favor. This is not to say that metrics for availability, accessibility, uptime, etc., are not important. Rather, the concept of IT value should be redefined so as to tie the performance of IT investments directly to strategy and business goals, through what can be called as key performance indicators. At a certain level, all applications will exhibit speeds and feeds characteristics. The argument is that in order to truly understand the impact that IT

is having on business performance, IT executives need to step back from the minutiae of IT operations to determine whether IT is truly meeting its business objectives (Tallon, 2004).

A significant benefit to defining IT value in a broader, multidimensional sense is the ability to link these key performance indicators to business risk. A common problem with one-dimensional measures of ROI is their exclusion of risk factors, a particularly vexing problem where an executive is managing a diverse portfolio of IT applications. In a customer service function, for example, two applications could have the same ROI although both are exposed to different levels of business risk. When executives typically think about IT and business risk, it is usually to ask if users will adopt an application in sufficient numbers or if the benefits of an application can be identified and copied by a competitor. Intuitively, most IT executives maintain an ordered set of priorities or key performance indicators for each IT application. Each priority will likely have a different risk profile. Some of the more desirable aspects of IT value might be seen as low risk (i.e., easily available or attainable) but it could just as easily happen that the important aspects of IT value are the most difficult to attain. Consequently, if IT executives evaluate IT value using an ordered set of key performance indicators and find that some initial expectations have not been met, it makes sense to juxtapose the IT value information against the risk factors associated with each indicator in order to better understand why IT value may be deficient (A common problem with one-dimensional measures of ROI is their exclusion of risk factors) (Tallon, 2004).

For example, if the goal of a new CRM application is to increase the number of customer accounts, users could in reality feed the application with highly suspect customers who might be failing on payment. The issue here is not just to identify new customers but to do so in a way that does not expose the corporation to unnecessary risk.

Problems associated with companies having a myopic ROI culture were already mentioned. By adopting a broader definition of IT value, corporations have an opportunity to revise their approach to IT investment evaluation. Specifically, when value is made operational at the level of an IT application in terms of key performance indicators, corporations can refocus their attention away from periodic or point estimates of performance to ongoing or continuous evaluation of performance. When IT projects fail, IT executives are often criticized for not finding and fixing the problem sooner. Irrespective of who might be to blame, compounding the failure is a lack of management insight into how the underlying application is performing

over time. It is our contention that if executives adopt a broader understanding of IT value that is consistent with the use of IT to support business objectives, they will have the means to evaluate on an ongoing basis whether they improving on their ability to achieve those objectives (Tallon, 2004).

Recalling the earlier example of the Balanced Scorecard, it is known that if management waits until the end of a quarter to evaluate financial performance, it could be too late to solve the problem. Instead, a multidimensional measurement tool like the Balanced Scorecard can be used to determine whether it is on target to achieve its business objectives. Similarly, it is possible through the adoption of broader IT value measures to assess whether an application is on target to achieve its goals or whether corrective actions should be taken to correct for any problems. Although some executives may consider continuous monitoring to be questionable, where large scale strategic investments are involved, in fact any additional monitoring costs will likely be less than the marginal IT value that is created for the corporation. Just as with corporations that undertake regular post-implementation reviews of large IT investments, continuous monitoring of IT value allows IT executives to better identify what works and what doesn't, leading to an improved understanding of what practices lead to greater IT value. This means that any steps taken to restore lost IT value are more likely to be successful. The key challenge, however, is for IT management to institutionalize an IT value culture that uses measurement as an ongoing tool (Tallon, 2004).

Regardless of how IT value has been defined, it is imperative that IT executives communicate relevant IT value information to application owners on a timely basis. Previous research reveals that greater cohesion and cooperation between business and IT executives is of paramount importance to realizing greater value from IT. The challenge for IT management is to articulate business and process goals in the context of an enterprise application (Tallon, 2004).

A study by Pisello and Strassmann examines the performance and IT spending of over 10,000 companies worldwide and reveals that there is little correlation between IT spending and superior information productivity, or other key performance indicators of corporate performance such as return on equity, return on assets, or profitability. From a macro-economic viewpoint, those that spent the most on IT did not always see superior results in corporate performance. In fact, over 40% of the companies did not have positive return on

equity at all. Companies that had low IT expenditures per employee were just as likely to achieve positive returns on equity as those with high IT spending per employee (Pisello and Strassmann, 2003). This study reveals that the amount a company spends on IT does not guarantee success.

Dell's IT investment story can be examined as a case study for us. Dell is widely seen as a well-run company, not simply within the PC industry, but across the Fortune 500. Given Dell's high expectations and performance goals, it should come as no surprise that IT investments receive significant ongoing scrutiny. Although Dell consistently applies an ROI metric called "Return on Invested Capital", an examination of how ROIC is used in practice shows that it is built on the dual pillars of operational excellence and strategic positioning. What Dell has realized is that rather than focus on the ROI result (the end); the focus should be on how that result is obtained (the means). In this case, the value created by an IT investment can be subdivided into how that investment allows Dell to be more efficient in the execution of its operations, or how it enables Dell to expand its market reach (Gurley, 1998). This simple but highly effective approach to defining and evaluating IT performance shows a culture that understands the multidimensional nature of IT value and that tries to use IT in increasingly strategic ways.

Besides, to be in alignment, a firm's core business processes must be enabled by integrated IT capabilities. Each iterative expansion or modification of this core business process must be made with an intimate knowledge of how IT can be used to enhance or simplify the process. For example, PrintingForLess.com, a high growth e-commerce printer manufacturer, leveraged its core electronic ticketing system to redesign its customer service and sales operation. The newly designed business process created a new position called the technical sales representative who could manage the sale, conversion, acceptance, modification, and shipping of an electronic order. From this redesign, a new IT system was built to automate the workflow of the technical sales representative. This new system enabled the company to continue to grow deliberately and profitably despite extremely high growth rates. Additionally, the system provided improvements in customer service satisfaction, sales conversions, employee satisfaction, and order process speed (Iansity & Favaloro, 2005).

On the other hand, it is also possible to tie key performance indicators from multiple applications to a specific business process. For example, in the air travel industry, customer

service is typically supported by applications that can manage frequent flyer accounts, communicate last minute schedule changes, or streamline personalization of airfare sales. While these applications have different key performance indicators that will generate IT value in unique ways, it is clear that they share a common set of business objectives around customer intimacy (Tallon, 2004).

II.2 Computer Paradox

What MIT professor Robert Solow claimed in 1987 briefly summarized the challenge "... you can see the computers everywhere but in the productivity statistics" (Vogel, 2003). This phrase caused several discussions among academics and it is briefly referred to as the "computer paradox". It states that the paradox can be seen in some managerial issues like labor displacement, asset displacement and overhead displacement (Vogel, 2003).

Initial investments in IT are concentrated on the mechanization of repetitious tasks of clerical and administrative personnel. We can refer to these initial investments as the "first wave". The biggest concern for the "first wave" is the potential unemployment of such personnel. When the U.S. occupational structure is observed it can be seen that from 1983 to 1999, employment of clerical and administrative personnel is increased from 16.4 million to 18.7 million, or 14.2% but executive, managerial and professional personnel increased by 73.3%. It can be said that, it is true that IT investment or the process of computerization decreases the need for clerical and administrative personnel but, on the other hand, increases the need for managerial and professional personnel in maintenance operations. Since the business became information-based, the compensation for the information workforce's wages continued to increase (Vogel, 2003).

The unemployment scenario is not a disaster as to be afraid of. Old clerical and administrative personnel became professionals and embraced the increased demand for higher technical skills, enabling them to move into higher-paying positions. The increased need for professional personnel compensated the decrease in need for clerical personnel. Besides the new demand for professionals bring high-paid workforce. Computerization decreased the ratio of clerical and administrative support personnel by 20 % since 1983 and the corresponding saving is about $400 billion per year. At that point IT investments seem to be beneficial in the

financial view but if one compares the 1983 with the 2000 occupational data, the managerial and professional jobs rose by 17.3 million (Vogel, 2003).

In the past migration from farms to factories and then from factories to offices brought ultimate labor productivity gains. A similar pattern was expected from computerization too but clearly it did not happen. Today 90 % of workforce do their job with computers but majority of the workforce cannot make this work done in fewer hours. In other terms, the capacity and performance of computers has passed the capacity of humans so although there are more powerful computers in work floor productivity is no longer increasing.

IT is expected to reduce need for assets with favorable effects on corporate return-on-assets like improved capacity utilization, faster inventory turns, and just-in-time supply management. A research by Standart & Poor kept track of the ratio of total assets needed to generate a given unit of revenue (Vogel, 2003). The results are showed in Figure II.2. The study claims that, IT investments could not decrease the percentage of assets needed to generate a given unit of revenue.

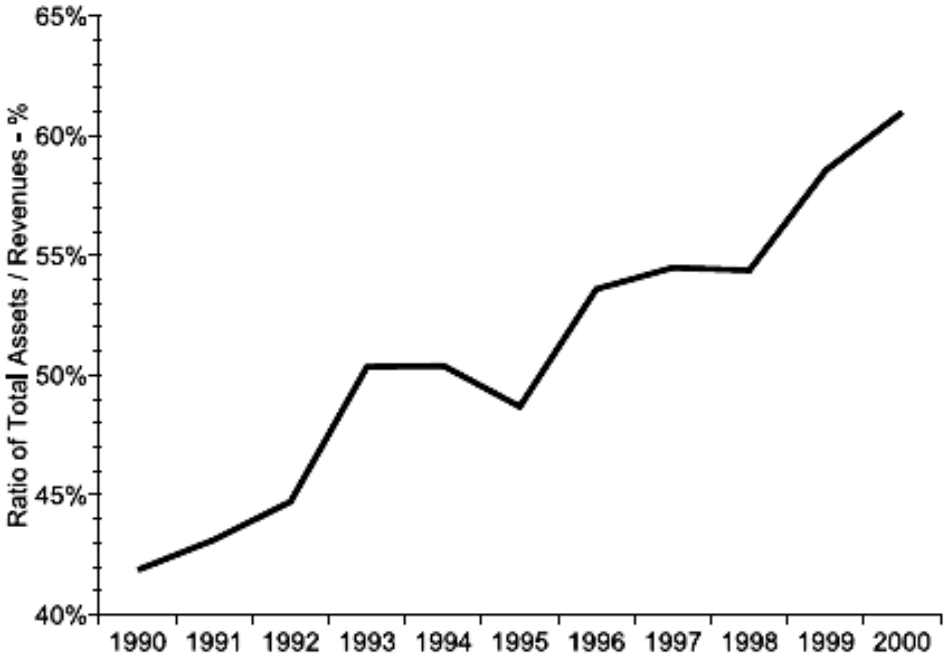


Figure II.2 Ratio of Total Assets to Revenue. (Standard & Poor's Compustat, September 6, 2001, Data for 9,559 U.S. firms) (Vogel, 2003)

Investment in IT claimed to reduce overhead costs with its direct benefits to company like the increase in knowledge, improved links with customers, direct communications among

employees and flattening of hierarchical organization structures. IT enhancements were supposed to reduce the "transaction costs" that are incurred in the process of managing movement of goods or services from sources to customers. According to statistics, as shown in Figure II.3, in contrast to expectations, the median of this ratio rose from 34 % in 1990 to 49 % in 2000 (Standard & Poor's Compustat, September 6, 2001, Results for 6,603 U.S. firms) (Vogel, 2003).

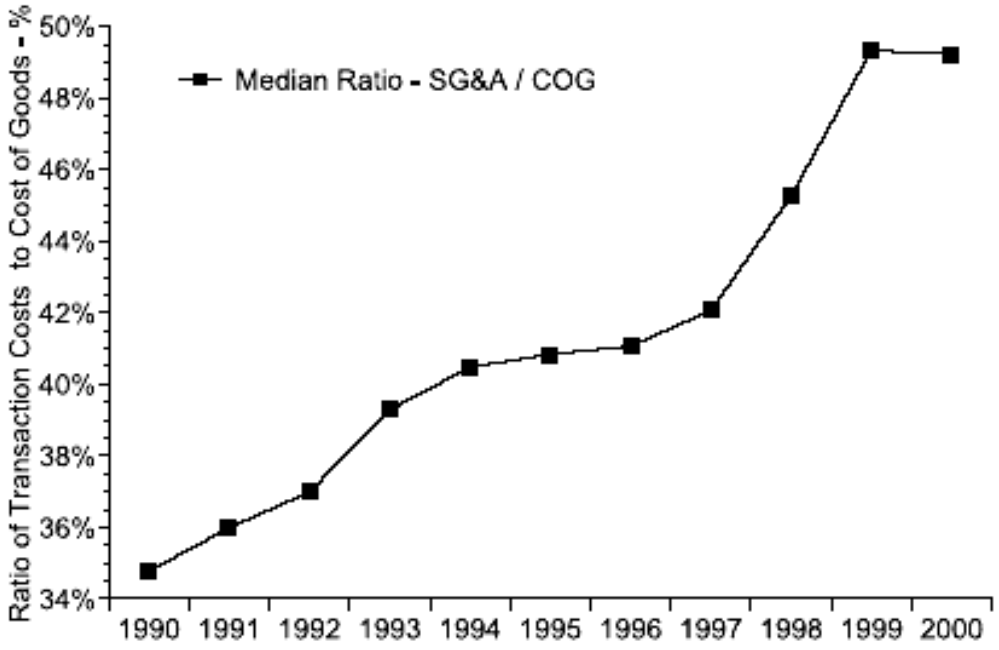


Figure II.3 Ratio of Transaction Costs to Cost of Goods. (Vogel, 2003)

As claimed above, the basic assumptions or forecasts of investing in IT did not come true. Total labor expenses have not decreased, total assets required for production weren't reduced and administrative costs also have not declined. Computer paradox claims that these results show that IT investments have failed to achieve expected results. However, there are also contrary theories defending IT investments as well as some factors contributing to the IT productivity paradox.

The computer paradox simply investigates the statistics collected since the beginning of computerization and relates the results to IT investments. On the other hand, IT investments are extremely subjective to strategies and implementations (Devaraj & Kohli, 2002). ERP implementations in candy maker HERSHEY became a nightmare and $112 million investment caused widespread disarray including shipment delays and incomplete orders. On the contrary, IBM's ERP implementation made great impact in efficiency by reducing its time

to ship a replacement from 22 days to 3 days. These two contradicting examples cannot be generalized individually; neither Hershey's failure means that IT investments are useless nor IBM's success means that it is guaranteed to get benefits by investing in IT.

It has not to be forgotten that during the time interval investigated by Standard and Poor there are also some other micro and macro economic factors affecting the productivity values and corporate success such as competition, capacity utilization, economic cycle etc. and IT has to be considered as one of these factors.

Protech Solutions was a leader in providing IT-based solutions to service and manufacturing firms. A new knowledge management system which provides capture and reuse of the knowledge gathered by 10.000 workers were adopted at Protech. The implementation did not come easy and inexpensive. The CIO and Knowledge Manager had to tell the board how the new investment pays off. In their presentation they showed that the amount of new orders during last quarter, which was the period when the KM system had been implemented, was 35% higher than previous quarter. In addition, there was an 85% increase in revenues during the same quarter compared to that of the previous year and that this might be attributed to the new IT investment. The leap of faith in their arguments is clear. The one question that their analysis and similar analysis cannot answer is "can you attribute the performance improvement or decline to the IT implementation" (Devaraj & Kohli, 2002)? Since it is not quite easy for an analyzer to isolate the effect of IT on firms' performance, the conclusions that result from the statistical data, as seen in computer paradox theory, becomes questionable.

The IT payoff studies have been conducted at different levels: economy, industry and firm level. Each level of studies has different objectives, advantages and disadvantages. In economy-level studies the impact of IT for the whole economy, not separating high-tech and low-tech companies is tracked. These studies ignore the firm's different level-of IT investment and special positions in the market or competitive challenges of their industry. The industry-level studies are useful to estimate the industry trends in conversion of IT into business value but their results are more confusing. While one study shows significant impacts of IT in business value, another can detect that there is no or insignificant advantage in IT investments. Firm-level studies are more detailed analyses, and generally they show a positive relationship between technology and performance. The more detailed the study, the

better the chance to disentangling IT from other factors and accordingly to detect the impact (Devaraj & Kohli, 2002). In conclusion the results of the studies surveyed indicate that the performance of IT in computer paradox theory is blurred.

On the other hand, some academics claim that to make a successful IT implementation and get a fast payoff, an "IT-driven" reengineering of existing process of achieving a task(s) has to be conducted. "One of the arguments put forth, based on this theory, was that investments in IT and reengineering cannot succeed if done in isolation. Since technology and business processes were viewed as complementary factors, they must be changed in coordinated manner to improve performance" (Devaraj & Kohli, 2002).

In conclusion, there are still discussions on the IT investment – Productivity issue. This makes it even harder for senior managers to decide whether or not to invest in new technology for the sake of the company. The basic challenge that makes the analysis more complicated is the difference between the implementation level and observed level (Devaraj & Kohli, 2002). Technology investments are made at process level but the results are evaluated at organizational level. This level difference makes the IT investment - productivity relationship hard to clarify. To get more reliable results, firm-level studies need to be conducted.

II.3. Review of the Studies

According to our literature survey, we have classified the studies into two main approaches. The first approach is based on economic value calculation (Motohashi, 2003; Aral and Bryjolfsson; 2006 Fisher, 1997). It states that any kind of IT systems or investments can be modeled mathematically and as a result, quantitative results can be obtained from these models. Second approach is the strategic approach (Tallon, 2004; Devaraj & Kohli, 2002). It states that although IT investments can be expressed as mathematical equations in some ways, it is a strategic decision rather than an economic necessity. It states that to benefit from an IT investment, managers should make good insights to their companies and make IT a part of the company culture.

A firm level analysis of information network use and productivity in Japan made by Kazayuki Motohashi has developed a mathematical equation about the IT – production relationship.

Motohashi used the firm level data of Japanese manufacturers and distributors provided by Ministry of Economy, Trade and Industry (METI). "Since Motohashi (2001) uses METI's cross section data of Basic Survey of Business Structure and Activity (BSBSA) in 1991, it addresses only relative productivity impact of IT network use by its type of application, but not productivity impact of IT by comparing network users with non users due to the difficulty of controlling for firm level unobserved factors by cross section data". In a previous study published in 2001, Motohashi found that productivity impact of information network use differs depending on application of network. In addition, due to rapid progress of information technology, economic value of information network might be different according to the timing of its introduction (Motohashi, 2003).

In Motohashi's study, the error component model of Cob Douglas production function in Equation II.1 is estimated first, using panel data (Motohashi, 2003).

$$\ln VA_{it} = \alpha \ln L_{it} + \beta \ln K_{it} + \gamma \ln IT_{it} + u_{it}$$
$$u_{it} = \alpha_{it} + e_{it} + \varepsilon_{it}$$

Equation II.1

Where VA, L, K and IT is value added, non-IT labor input, non-IT capital input and IT input. Error terms of Equation II.1 can be decomposed into it a: firm specific unobservable factors for firm's performance, such as managerial capabilities and workers' motivation and e_{it}: exogenous shocks for firm's performance, such as macroeconomic business cycle, and ε_{it}: error terms associated with measurement errors. In addition, if we assume both e_{it} and ε_{it} are independent of right hand side variables, Equation II.1 can be treated as fixed effect model or random effect model, depending on assumption of the distribution of a_i (Motohashi, 2003).

Table II.1 shows estimation results of equation II.1 by using data of years 1991, 1994, 1997 and 2000. This table shows regression coefficients and t-values by pooled regression (TOTAL), cross section regression by data averaged over time (BETWEEN), fixed effect model regression (WITHIN) and random effect model regression (RANDOM). In all models, the coefficients with IT are positive with statistical significance at 1% level. Relatively larger coefficients for between dimensions of firms suggest the existence of unobserved factors of firm level performance, positively correlated with 'IT' variable (Motohashi, 2003). The result of Hausman test shows that there is statistically significant difference between fixed effect

estimator and random effect estimator, which also supports unobserved factors' correlation with independent variables (Motohashi, 2003).

Table II.1 Estimation results of equation II.1 by using data of 1991, 1994, 1997 and 2000 (Motohashi, 2003).

(Manufacturing)

	TOTAL		BETWEEN		WITHIN		RANDOM	
	coef	t-value	coef	t-value	coef	t-value	coef	t-value
EMP	0.704	169.340	0.697	94.860	0.535	54.680	0.715	141.090
CAP	0.224	88.790	0.224	52.730	0.135	28.570	0.206	66.050
IT	0.134	58.680	0.144	32.190	0.102	38.200	0.123	53.920
Hausman test		CHISQ(3)	1258.78	P-value	[.0000]			

(Wholesale and Retial)

	TOTAL		BETWEEN		WITHIN		RANDOM	
	coef	t-value	coef	t-value	coef	t-value	coef	t-value
EMP	0.597	125.030	0.550	65.110	0.530	52.850	0.636	107.480
CAP	0.081	33.140	0.078	18.970	0.081	17.150	0.088	27.970
IT	0.288	90.860	0.349	57.830	0.137	36.320	0.201	61.730
Hausman test		CHISQ(3)	1448.1	P-value	[.0000]			

This firm-level analysis has confirmed the macro level observation of IT's contribution to economic growth. "The analysis showed that IT stock contributes to value added growth significantly, and use of information network shows positive impacts on Total-Factor Productivity (TFP) growth, which further pushes up firm's output. It should be noted that IT's impacts on firm's output and productivity becomes greater in recent years. Commercial use of Internet started in the mid 90's. In addition, according to the information on revisions of semiconductor roadmap, acceleration of semiconductor's technological progress is observed in 1995. In addition to these findings of IT's progress, its wider diffusion may contribute to more efficient use of IT" (Motohashi, 2003).

Since the IT's effect on firm's productivity is questioned, discussions are made on that relationship but there is no valid result. We can say that, different from other investments, IT investments have specific challenges which make its success dependable on firm specific factors. Accordingly, we saw that, there is no general theory or mathematical model that can be applicable to any country, sector, industry or company. Besides studies made with the use of industry – aggregated data give insecure results because the effect of IT cannot be

separated from other factors with that method. To get reliable data detailed firm-level studies have to be conducted and decisions have to be made after examining similar firms' analysis.

Most of the studies, which are seeking a valid answer to the relationship between information technology investments and productivity, are mostly getting fuzzy or questionable results. There is a principle for natural sciences stated by Herbert Simon; "In the physical sciences, when errors of measurement and other noise are found to be of the same order of magnitude as the phenomena under study, the response is not to try to squeeze more information out of the data by statistical means; it is instead to find techniques for observing the phenomena at a higher level of resolution. The corresponding strategy for [social science] is obvious: to secure new kinds of data at the micro level" (Aral, Bryjolfsson and Alstyne, 2006). In light of this principle a more detailed task level analyses were conducted to inspect IT Worker productivity.

There are some surveys that can be classified as hybrid. These surveys do not ignore non-technical factors affecting the IT value calculation and also include social effects. The IT and IT worker productivity analysis can be given as an example of such surveys. The aims of these studies are to get a different look at the IT value assessment problem. The researches opened basically two new frontiers: (1) detailed task-level evidence of information worker output and (2) objective measures of information flows through social networks. Today's IT value evaluation tools include more complex econometric methods but the effect of IT on social networks and work styles are not taken into account (Aral, Bryjolfsson and Alstyne, 2006). This approach provides a higher resolution microscope with which to study organizational phenomena, revealing finer grained relationships than would be possible with any amount of firm, industry, or country-level data.

There are three contributions that result from these researches. First, it is generally shown that information work can be measured. These studies analyze behaviors and information flows and identify a context with objective performance metrics. Precise estimates of the productivity of information workers are produced (Aral, Bryjolfsson and Alstyne, 2006).

Second, it is revealed that individual differences in IT use behaviors correspond with differences in performance. Workers using more asynchronous email and database tools finish more projects simultaneously. Traditional synchronous communication modes like telephone

calls decrease multitasking and accordingly decrease performance. The work speed appears to be not correlated with productivity. Multitasking is seen as the driver of productivity instead of work speed. Workers, who multitasked heavily benefit from common knowledge base and able to complete more projects per unit time. This implies that targeted training about using information technology tools could improve speed and thus firm performance (Aral, Bryjolfsson and Alstyne, 2006).

Finally, it is revealed a very interesting result when social network analysis applied to the email data. It is found that position and flow are critically important. A concept called "betweenness centrality" indicates that, the probability that an individual will fall in the shortest path between any two other individuals linked by e-mail communication, and the "constraint" of the network, which measures the degree to which an individual's contacts, are connected to each other (a proxy for the redundancy of contacts). It is a strategic position and it represents a broker role which connects one portion of the social network to another portion. Betweenness centrality shows a positive association with ability to multitask. A position with a high betweenness centrality has great influence over what flows and what does not. Among information workers, it pays to be a communications middleman. Peripheral employees, outside the communication flow, work on fewer projects over time. The total volume of communication is also statistically significant as is the measure of constraint, demonstrating that constrained networks and redundant contacts correspond to less multitasking. An implication of these results for managers is that untangling social networks through strategic job rotation could lead to more efficient multitasking. Strikingly, it is also found that richer information flows alone do not necessarily increase the speed with which individuals complete their projects. Central information brokers boost their productivity by multitasking more effectively rather than by working faster (Aral, Bryjolfsson and Alstyne, 2006).

As a conclusion, it is found after surveying similar studies that there is a substantial relation among information, technology and the output. Information technology affects the revenue generated in a company positively but it is not just having IT, but how workers use it that predicts differences in performance. This portends a substantial improvement in our understanding of the relationship between information, technology, and value creation, and reveals important managerial implications related to organizational structure, team

assignment, job rotation, IT use and training, and the management of organizational communication.

According to the arguments above, we can easily say that information technology use increases the information worker performance and accordingly both the individual worker revenue and total revenue generated in a firm increases. It also shapes the work style and causes different ways of making jobs done within the firm. The relationship between IT and productivity is analyzed with firm-level and task-level studies in a very detailed manner. Let us now widen our focus and study the relationship between enterprise wide information technology systems and productivity by investigating how enterprise information systems like ERP, MRP and CRM affects the company's' performance and stimulate a return on investment (Aral, Bryjolfsson & Wu, 2006).

Enterprise systems integration stems from the managerial need to monitor all the activities from raw material purchase to finished product delivery in the company. The first implementations are called MRP (Material Requirement Planning) which covers the whole production activities. The success in MRP systems forced companies to integrate their financial tools to the enterprise system and see all financial and production activities in a unified manner. ERP (Enterprise Resource Planning) systems which cover all of the activities within a company are evolved to meet this demand. ERP systems are still popular in today's business environments. Successful implementations of ERP opened the door to develop enterprise systems focused on customer relations and supply chain systems called CRM (Customer Relations Management) and SCM (Supply Chain Management) consecutively. During our literature survey the relationship between ERP systems and productivity is investigated in detail but as well as the relationship between ERP systems and CRM and SCM and also CRM and SCM systems and productivity. (Aral, Bryjolfsson & Wu, 2006).

SCM systems not only support operational performance in terms of internal efficiencies and cost reduction (Cachon & Fisher, 2000), they enable firms to serve their customers in a timely and comprehensive manner. When supply chain experiences glitches, firms experience reductions in their asset utilization, operational performance, and profitability (Hendricks & Singhal, 2005). Effective SCM can improve productivity and performance through two main complementary mechanisms established in the literature: market mediation and materials management (Fisher, 1997).

Market mediation involves matching supply to demand. So effective market mediation requires accurate, timely information about the dynamics of supply and demand and incorporates IT-enabled processes, including collaborative planning and forecasting replenishment (CPFR), advanced supply chain planning, and logistics and distribution management. Information sharing and collaborative forecasting can mitigate the impact of demand variability on operations and reduce the upstream escalation of order variance known as the bullwhip effect (Lee, 1997). Improvements to demand forecasts enable firms to increase sales and order fulfillment rates and reduce inventory costs.

Materials management involves optimizing the movement of raw materials, work-in-process and finished goods inventories through the supply chain. Efficiencies in the materials management process minimize the costs of production, transportation, and inventory storage. Information sharing, CPFR, and supply chain optimization, can improve order quantity decisions, lower the time and costs of order processing, increase order frequencies, reduce lead times and batch sizes, reduce inventory levels, and increase order fulfillment (Cachon & Fisher, 2000). These operational improvements can reduce costs and lost sales, improve customer satisfaction and retention, and increase the performance of each individual firm in the supply chain.

Since small shops and boutique style businesses were replaced with big corporations and multinational companies, the gap between customers and the companies were extended. In today's business, understanding the customer valuations, consumption behaviors and relationships became the number one priority for all businesses to gain more competitive advantage. Customer Relationship Management (CRM) systems are designed to fulfill this need. "By enabling (1) effective sales force automation; (2) centralized customer data warehousing and data mining; and (3) decision support designed to inform marketing resource allocation decisions, promotion policies, and marketing campaigns to maximize customer satisfaction and retention, CRM can reduce costs by streamlining repetitive transactions and maximize data integrity by creating a central, firm-wide repository of customer information. Sales automation and centralized data enable data mining to identify dynamic changes in demand, cross-selling opportunities, and improvements in after-sales support to customers" (Cohen, 2006).

There are also implications about IT adoption in processes beyond the firm boundary. "The boundary of the firm has long been a theoretical demarcation across which investment incentives, coordination costs, and the distribution of information are theorized to change dramatically. These differences have economic implications for the structure of contracts, organizational decisions (such as making or buying intermediate inputs), and the existence of firms" (Holmstrom & Roberts, 1998). Several theoretical arguments predict differential returns to IT within and across firm boundaries. There may be greater opportunities to reduce coordination costs between firms than within firms because of the additional transaction costs associated with economic activities outside the firm (Aral, Bryjolfsson & Wu, 2006). In addition, because market procurement is more coordination intensive than internal production, the efficiency gains from automating or digitizing external transactions are potentially greater than those of IT-enabled process improvements within the firm. Finally, greater agency costs and potential opportunism, which could be addressed by improved monitoring and transparency provided by IT, may exist across firm boundaries (Jensen & Meckling, 1976). Working across firm boundaries requires greater management coordination and entails greater risks than working inside the firm. Firms which can overcome such barriers with the use of IT should earn greater returns, on average (Aral, Bryjolfsson & Wu, 2006).

Whether IT causes productivity and performance increases is one of the most critical questions in IT research. Only a definitive answer to this question can resolve the debate about whether IT really "pays off" or if performance increases correlated with IT investments are simply a by-product of other drivers of success. Studies of IT value have used successively more sophisticated econometric methods to disentangle causality in the IT–performance relationship with mixed results. Generally speaking, good instrumental variables are hard to find; most are too weak to provide explanatory power or not exogenous enough to address reverse causality (Aral, Bryjolfsson & Wu, 2006).

By analyzing a remarkable data set that separates purchasing decisions from IT implementation and use, some researchers approach the causality question from a different angle. Their strategy highlights a new tool to tease apart casualty in the IT literature. When these studies were surveyed, it is found that the use of this tool in the context of enterprise systems led to results which (1) clarify the causal relationships between IT and performance; (2) provide up-to-date estimates of the impact of enterprise systems; and (3) provide new evidence of the differential returns to internal and external IT adoption. Furthermore, several

new issues in the estimation of returns to systems of process-enabling IT were identified (Aral, Bryjolfsson & Wu, 2006).

Most importantly, the results revealed a new perspective with which to view causality in IT value research. It is found that, ERP causes performance increases rather than performance inspiring ERP purchases. Successful ERP adoptions encourage adoption of extended enterprise systems, which in turn improve productivity and operational performance. The results of the studies support the view that a "virtuous cycle" exists in the relationship between IT investment and performance, such that initial investments drive performance gains, which encourage further investments, over the course of several years (Aral, Bryjolfsson & Wu, 2006).

PART III

THESIS STUDIES

The aim of this study is to seek an answer for the IT valuation problem. During our literature survey, we encountered different approaches to the problem. Each of these studies had different theories and each used different data sets. Mainly, we can classify these approaches into two categories; strategic approach (Tallon, 2004, Devaraj & Kohli, 2002) and EVA (Economic Value Add) approach (Motohashi, 2003, Aral and Bryjolfsson, 2006, Fisher, 1997). Briefly, strategic approach emphasizes the intangible returns of the information technology investments and EVA approach claims that information technology investments, like any other types of investments, can be represented by means of mathematical models and their value can be evaluated and represented with Cob Douglas estimation models (Motohashi, 2003, Aral and Bryjolfsson, 2006, Fisher, 1997). There are also some studies which state that IT does no effect on productivity. They claim that IT systems are commodities that add little value to a firm or a ubiquitous utility, like electricity, and has no strategic advantage to a company that employ it. These considerations were gathered around the "computer paradox" theory which was formulated by MIT Professor Robert Sollow (Pisello and Strassmann, 2003). These theories were very premature studies and the datasets used in these studies were questionable in many ways. The early pronouncements of the computer paradox were subsequently refuted by analysis on better data that demonstrated IT investment actually increased productivity at the economy, industry and firm level (Pisello and Strassmann, 2003).

III.1 Hypothesis

In light of the above information we found some common methods or approaches to the information technology investments in literature and wanted to investigate the approaches in Turkey. Before investigating the understanding of IT value in local market we formulated our hypotheses. Our first hypothesis stands on the phase difference on technological innovations

and their use between Turkey and developed countries. Since research and development on information technology is made, mostly, in USA there is an inevitable difference in state of the art technology usage between USA and other countries. We assume that the IT needs and priorities of chief information officers (CIOs) in Turkey may differ with their colleagues in developed countries. This differentiation will be seen in the factors triggering the investment decision. Our first hypothesis states that, in Turkey infrastructural needs are more dominant than intangible benefits of IT.

Our literature survey revealed that IT managers conduct some analyses to value their IT implementations before and after the investment. Benchmarking, cost-benefit and ROI analysis are the most popular methods used by IT managers. We also aimed to investigate the popularity of the use of such methods in Turkey. Our second hypothesis is that, investment analysis tools are not used commonly in Turkey. This hypothesis stems from the first hypothesis. Since the need for new technology investment in Turkey is infrastructural the decision makers would not need to use these tools.

Our last hypothesis is about the relationship between IT and productivity. Our hypothesis indicates that, IT investments have positive effect on productivity in Turkey. This assumption is based on the nature of IT. Although there are some differences between IT investments, the common property of all IT investments is its effect in productivity. Our literature survey revealed that there is no evidence indicating a negative correlation. The only theory indicating a zero correlation is "computer paradox" and it is refuted by later studies (Pisello and Strassmann, 2003). We are expecting that, this characteristic would be the same for Turkey even though the needs and approaches to the new technology are different from our literature survey.

III.2 Methodology

Since it is a necessity to install an IT system for all of the companies to run their business, all of the companies operating in Turkey constitute the "population" for this research. At this point we narrowed this target population down to get valid results for the survey because companies approach IT in different manners. While some companies allocate a department for

information technology, some treats such investments as an operational cost and some companies are too small sized to talk about an IT management.

We narrowed the target population and limited it to mid level and enterprise level companies in Turkey. It is almost impossible to talk about IT policies, strategic value of IT or any kind of metric calculation in small sized companies. In small sized companies, IT is evaluated as a commodity. Thus, we excluded the small sized companies from the target group.

The classifications about company sizes change from country to country. In USA companies with employees up to 100 were referred as "small sized", those with employees less than 500 were referred as "medium sized" and those above 500 were categorized as "enterprise level". In this study, by taking the structural characteristics of local companies into account, companies with employees up to 50 are categorized as "small sized" and excluded from the target group. Companies which have employees between 50 and 250 were classified as medium sized and those with more than 250 employees were categorized as "enterprise level companies". This classification is also EU's standardization about categorization of companies based on company size (ec.europa.eu, 2009).

The target population became Turkey's mid-level and enterprise-level companies after this limitation but it was still impossible to reach every one of these companies. At this point we had to take a sample from among them. This sample selection had to be made in a manner that the survey results can be generalized to the target population. We decided to take the first 500 companies as our sample population. Istanbul Chamber of Industry, publishes the biggest 500 companies of Turkey every year and, for our survey study, we took that list published in 2007 as our sample population. This list provides a homogenous sample population for the survey study. This homogeneity had crucial importance for the accuracy of the survey study because if the sample population were homogenous the generalization of the findings would have minimum error.

A questionnaire was prepared in order to both summarize the results of the study and shed some light to the approaches in Turkey. The questionnaire had both closed ended questions for categorization of the key concepts and open ended questions to understand the strategic approaches, Turkey's special needs and conditions and some other factors that may not be predicted before the survey study.

The template of the questionnaire and the results are given in Appendix I and Appendix II. In the first question, the participants are asked to make a general comment about the most important factor that triggers IT investment decision in their organization. This question investigates the answer to the question, are the reasons for IT investments in Turkey similar to the findings of our literature survey. The answers to this question will also clarify whether our first hypothesis is true or false.

The next four questions investigate the pre-implementation characteristics of managers. Participants are asked to answer questions regarding IT investments they made within a year, instead of their general opinions. We aimed to narrow the projection of the tendencies of last 12 months to get consistent answers because IT approaches change every year due to technological innovations. These four questions supposed to reveal whether a common pre-implementation plan or strategy is used by IT managers or if they rely on their personal experiences or vision. The benchmarking method was mentioned as one of the most common decision making method in the literature survey. The questionnaire is also investigating whether the use of benchmarking is as common, in Turkey, as the developed countries.

The next three questions investigate the post-implementation manners of IT managers. The questionnaire aims to reveal whether IT investments are audited or questioned on a cost-benefit or strategic approach. The link between IT and productivity is also questioned. In addition, the common belief that "IT investment decreases costs" is also questioned.

The last four question is about the decision making process. This process covers both the IT manager and top level management approaches. There may be different manners between the IT managers and upper level management about IT investments. The questionnaire also investigates these differences and aims to reveal the factors that top management focuses on. The prioritization of the factors may vary from sector to sector or even company to company.

Each participant's answers and comments are compared with each other and a final conclusion is made according to the findings. These results are compared to the findings mentioned on the previous sections of this study and finally a projection of the approaches to the IT valuation problem can be made more clearly. A comparison matrix is made according to the results of the questionnaire to see the big picture and come to a conclusion. Pre-

implementation and post-implementation characteristics were analyzed based on the type of the implementation. Different IT implementations may have different goals and different analyses should be made for every one of them. Some investments may return as a cost reduction for the company and some may be made just because of a legal requirement. Types of investments may also determine whether a cost-benefit analysis should be made or not. All of these questions and arguments are answered and studied in detail in the last parts of the study.

PART IV

RESULTS

Target population and sample population were selected with the methodology explained in the previous section. The survey study was seeking similarities and differences between local CIOs and their western colleagues. We have gathered the results and formed a results matrix with MS Excel program. We have made the statistical analyses by configuring different formulas of Excel. The questionnaire can be found in appendix – 1 and the results matrix can be found in Appendix – 2. According to sample selection criteria described in the previous section the top 500 companies, which were announced by İstanbul Chamber of Industry in 2007, was selected for the survey. Every company was reached via phone. E-mail addresses of every CIO in the sample group's list were collected. The questionnaire was sent via e-mail. We sent our questionnaire to sample population one by one instead of mass mailing. Every respondent received a mail sent to his name. The mail briefly summarizes the study and its goals and the questionnaire attached. This mail was sent to the top 500 companies and 69 had responded giving a 13.8 % return rate. 61 % of the participants are in manufacturing business, 39 % are in service business. In this section, findings of the survey study will be summarized.

We have calculated the confidence level and confidence interval figures for our survey study. Confidence level shows the rate of accuracy for the survey study. A 95 % confidence level means the results of the survey study will be 95 % accurate when they are generalized to the population of 500 companies. Confidence interval indicates the error rate of the study. A 10 % confidence interval means the result true for 70 % is in fact between 60 % and 80 %. The formulation of the confidence level and confidence interval for θ for any number α between 0 and 1 is an interval ($u(X)$,$v(X)$) is given in Equation IV.1 (Freund, 1962).

$$\Pr_{X;\theta,\varphi}(u(X) < \theta < v(X)) = 1 - \alpha \text{ for all } (\theta,\varphi)$$ Equation IV.1

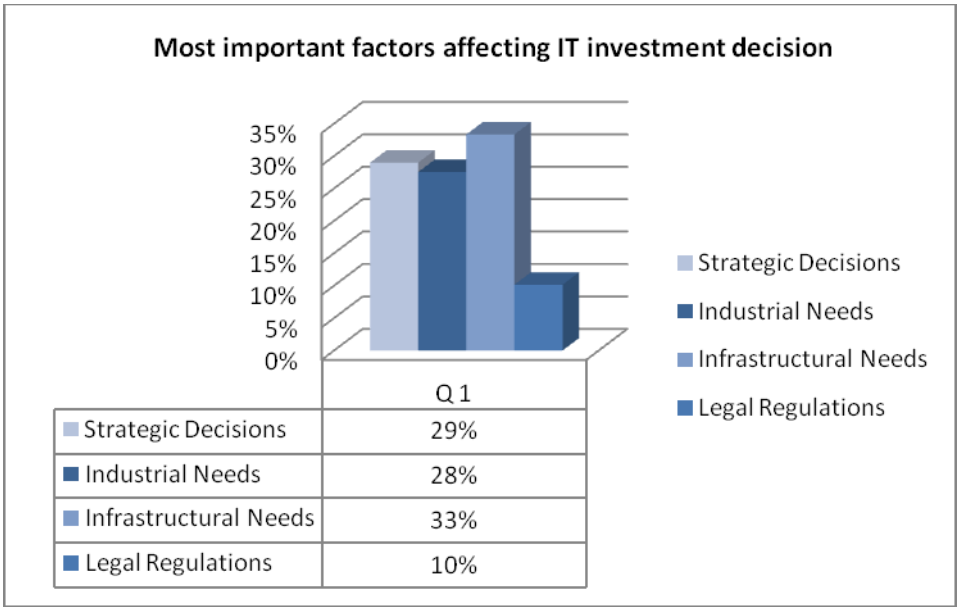
In Equation IV.1, u(X) and v(X) are observable random variables, i.e. one need not know the value of the unobservable quantities θ, φ in order to know the values of u(X) and v(X) (Freund, 1962). We have calculated the confidence level of our survey study for 95 % confidence interval as 11 %. This means, we are 95 % sure that the true value of 60 % in the results of our survey study will be between 49 % and 71 % when it is generalized to 500 companies. The summary of the results matrix can be seen in the Table IV.1.

Table IV.1 The summary of the results matrix

Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12
Industrial Needs	Yes	Yes	To minimize the costs	Yes	Yes	Yes	Yes	Strategic	Return on investment	Yes	Yes
20%	48%	30%	10%	36%	16%	33%	19%	26%	7%	49%	42%
Legal Regulations	No	No	To improve productivity	No	No	No	No	Necessity	Minimizing the costs	No	No
1%	4%	43%	10%	9%	36%	1%	20%	6%	7%	4,5%	2%
Infrastructural Needs			To meet the infrastructural needs			Not analyzed	Not analyzed	Both	Strategic advantages	Not evaluated	
20%			9%			19%	14%	23%	26%	4,5%	
Strategic Decisions			To add value to the business						Legal Regulations		
30%			17%						1%		
			To provide business continuity								
			9%								
			To improve Data Security								
			3%								

We have first investigated the factors that affect the IT investment decisions in companies. According to the results of the survey, 33 % declared that the major factor which triggers IT investment decision in their organization is infrastructural needs. They implement new IT systems to fulfill the basic needs and obligations in their industry and remain competitive in the market or renew their old infrastructure because of inadequacy. Industrial needs and strategic decisions are the secondary motives, with equal weights of 29 %, for information system adoptions. Legal regulations seemed to be the least important factor affecting IT investment decision for the companies studied, with a greater importance for companies in telecom, finance and banking sector. The results are shown in Figure IV.1. This finding supports our first hypothesis by showing that companies in Turkey mostly make their IT investments to improve their infrastructure to support their core businesses.

Figure IV.1. Most important factors affecting IT investment decision.



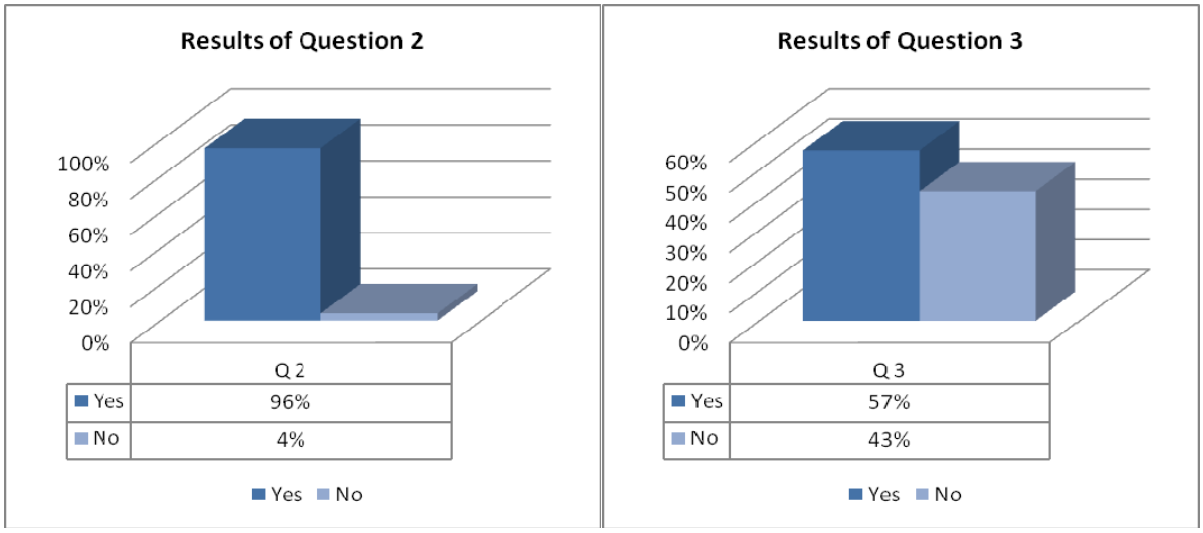
	Q 1
Strategic Decisions	29%
Industrial Needs	28%
Infrastructural Needs	33%
Legal Regulations	10%

We also asked the participants whether they have planned, implemented or adopted any kind of information systems in the last 12 months. According to Moore's Law, computer power doubles every 2 years. This capacity improvement, no doubt, affects decisions of CIOs. With an aim to catch the latest trends in information technology, 96 % of the participants declared that they made at least one IT investment decision in the last 12 months.

Additionally, we have investigated whether IT managers use any kind of benchmarking methods before adopting an IT system. We received interesting replies to that question. According to our survey results, we can say that benchmarking method is not as common as we have found during our literature survey. We have found that; 57 % of the participants employ benchmarking before deciding on an investment in their organization and 43 % does not think that benchmarking is necessary. Question 2 investigates whether an IT investment is made within last 12 months and question 3 investigates benchmarking usage. The results of question 2 and 3 are shown in Figure IV.2. This finding validates our second hypothesis that claims IT analysis tools would not be used commonly. IT managers told that the nature of the investment affects the need for benchmarking. If the CIO has doubts in his/her mind about the characteristics of the IT system that will be adopted, he makes a research about similar investments and talk to his/her colleagues. On the other hand, if the CIO is confident about the investment, the investment request came from internal needs or a unique reason triggered the investment benchmarking would be ignored freely. In companies which has specific rules and procedures IT managers have to make benchmarking even if they don't think it is

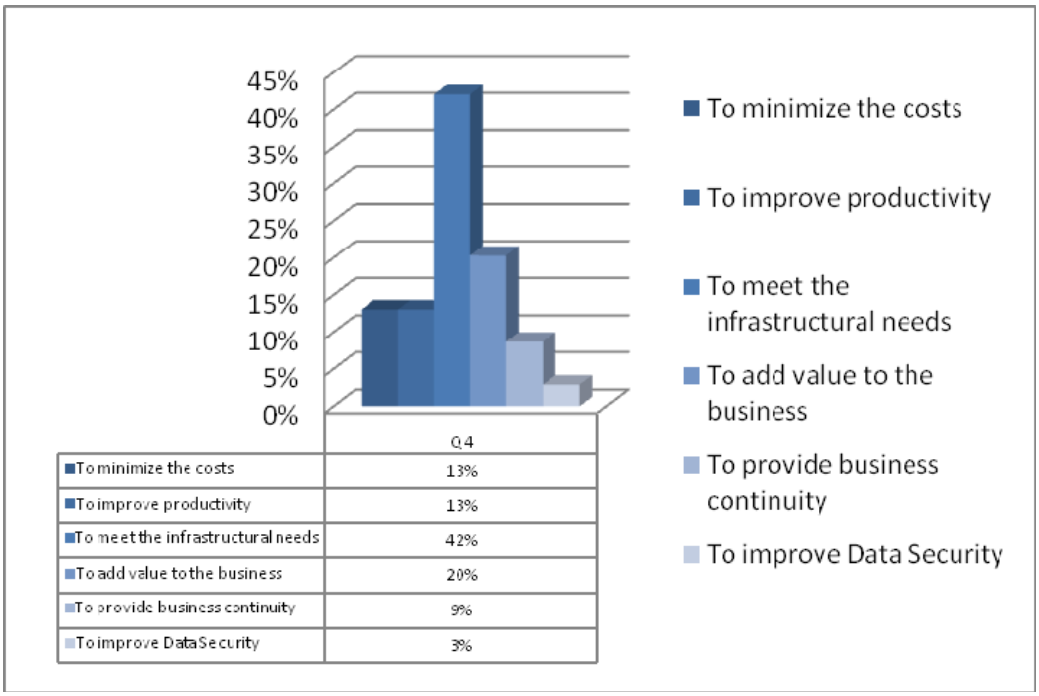
necessary. IT standards like ITIL and SOX forces managers to employ methodologies like benchmarking, ROI and cost-benefit analyses.

Figure IV.2. The results of questions 2 and 3. Question 2 investigates whether an IT investment is made within last 12 months and question 3 investigates benchmarking usage



The goal of the IT investment is another argument for the study. To understand the importance or value of an IT investment, the aim of the project should be clear. When the purpose of their investment was asked to CIOs; 40 % of the participants told that they made the investment to meet the infrastructural needs, 20 % of the participants told that their aim was to add value to the company. Only 11 % of the participants made their investment to lower the costs and the other 12 % made their investments to increase productivity. The results are shown in Figure IV.3. This result can be interpreted in two ways. Turkey's IT infrastructure, like other developing countries, is not adequate yet to fulfill industrial needs. Companies still need additional equipments, data lines or extra capacity for their data sizes. According to the literature survey, western countries made very less infrastructure investment. The value added system adoption is more common than other factors. In Turkey's market conditions great majority of the IT investments are made as infrastructure investments and value added system adoption takes the second raw. The other factor that causes this characteristic in local companies is the characteristic of emerging markets. The Turkey's market has a tendency to grow and local companies reflect this characteristic. We saw that majority of infrastructural investments were made to expand IT infrastructure to new branch offices or new premises. This finding overlaps with our explanation.

Figure IV.3. The results of question 4. Question 4 investigates the goal of new technology investments.



	Q4
To minimize the costs	13%
To improve productivity	13%
To meet the infrastructural needs	42%
To add value to the business	20%
To provide business continuity	9%
To improve DataSecurity	3%

The questionnaire also revealed that % 81 percent of the participants conduct a cost-benefit analysis before the installation phase. During the interviews we saw that there is no pre determined method, standard procedure or a mathematical model to do this analysis. CIOs develop their own methods for this need. Most of the times the intangible returns of information technology systems were taken into account in their analyses. They conduct simple cost-benefit analyses instead of detailed calculations. They compare similar investments and decide whether the investment makes the company's life easier or not. The investment decision is made by the CIO and CIO makes that decision depending on his/her experiences and vision.

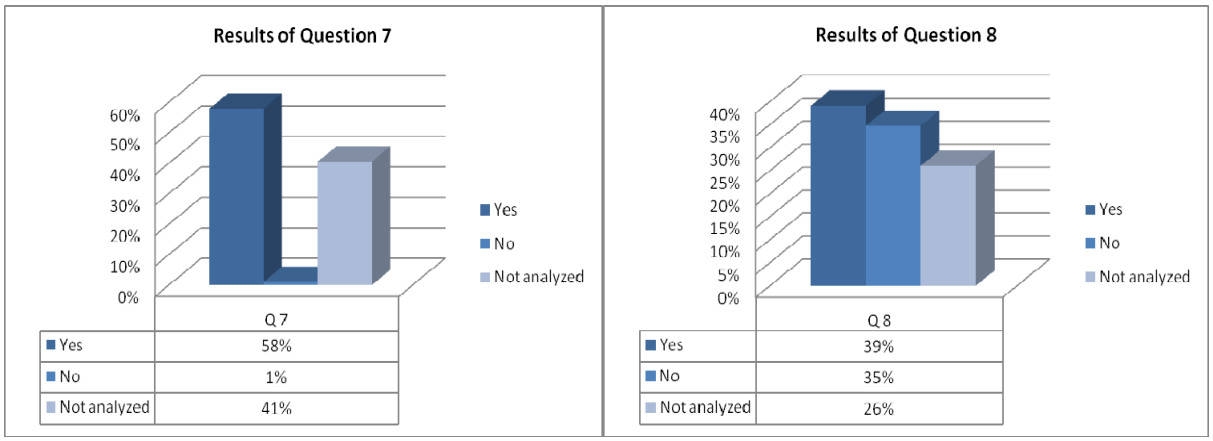
On the other hand, surprisingly, only 29 % of the participants make return on investment (ROI) analyses. Most of the executives, who made cost-benefit analyses before the implementation, did not investigate the results. Most of them claimed that they made the investment in order to get the intangible advantages or that the adopted IT system has such a vital and strategic value that ROI analyses is not needed. Participants, who made ERP implementations, told that it is too early to see the returns and added, to understand the returns they should wait for the necessary modifications to be made to the system and the learning period for the end users. This result also fits with the literature survey findings. For ERP,

MRP or CRM systems, the real returns can be seen after the "go-live phase". The "purchase phase" has no or insignificant effect to the total output of the company. The ones, who claimed that they had made ROI analyses after the implementation, did not use a mathematical model or a predefined method. They just compared the costs before and after the implementation which is questionable in most ways.

When it comes to productivity, participants fell into two again. 56 % claimed that their investment improved productivity and 41 % told that they didn't analyze the relationship. We note that, nobody told about a negative correlation. Only 1 % claimed that there is no correlation between IT and productivity. 63 % of the participants, who claimed that they improve the productivity in their environment, was triggered by industrial needs and strategic decisions. Besides, 10 % of them aimed to improve productivity before planning the investment. The results are shown in Figure IV.4. This shows that productivity is a byproduct of all IT investments. Perfectly tailored ERP systems, improved capacity and communication channels and information technology usage result in an improvement in productivity. This finding enhances the productivity relationship arguments. The study showed that in Turkey's market conditions IT investments are made with aims other than productivity. Infrastructure needs and strategic advantages are primary goals. During the interview, the CIOs who did not analyze productivity gain, told that they did not found it necessary to measure the effect of IT on productivity because the positive correlation between them is in IT systems' nature. This finding is in parallel with our third hypothesis.

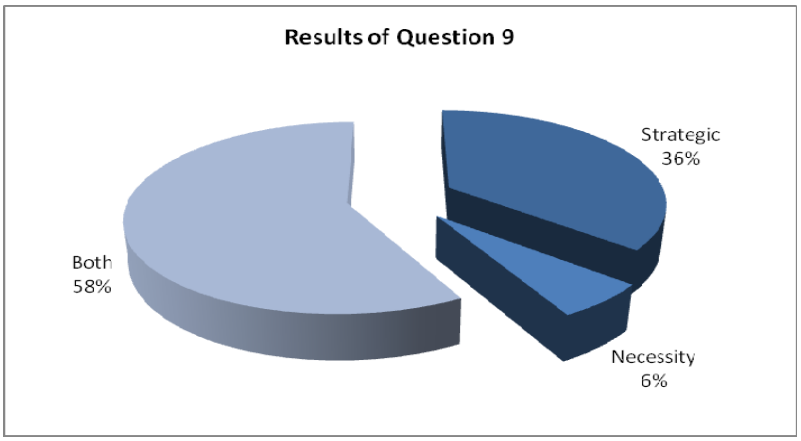
It is a common belief that new technology investment reduces the costs of the company. In contrast of this statement we don't see a very high percentage in our survey results. While 38 % of the participants told that their investment decreased their costs, 35 % of them told just the opposite. The results are shown in Figure IV.4. Participants claimed that they did not plan to decrease their cost. They wanted to get strategic and infrastructural benefits instead of cost minimization. On the other hand, we saw that the companies whose goal was to minimize their costs have reached their objectives. Besides, 87 % of the participants described their objective to be factors other than cost minimization. This finding shows that IT investments have long term and mostly intangible returns and these decisions are made basically to gain such benefits regardless of the effect on total costs of a company.

Figure IV.4. The results of questions 7 and 8. Question 7 investigates IT's effect on productivity and question 8 investigates IT's effect on cost reduction.



We also asked to the participants to provide information about the nature of the decisions made on new technology investments. This question investigates the basic motivation which leads top level managers to approve the investment decision. 36 % of the participants claimed that IT adoption was seen as a strategic decision and 58 % of them claimed that both strategic and economic factors are affecting the decision. Only 6 % of the participants claimed that IT decisions are made with only economic necessities. The results are shown in Figure IV.5.

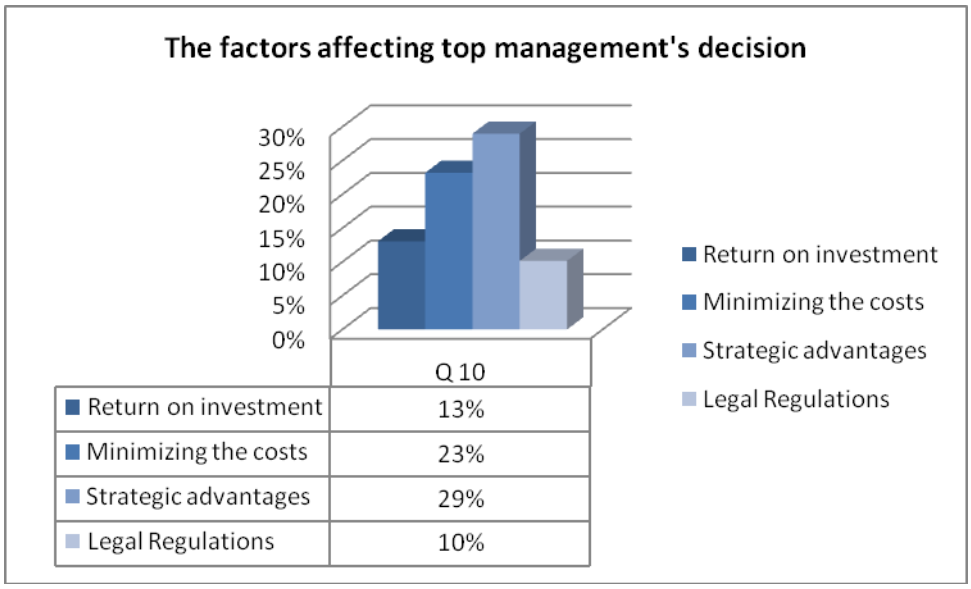
Figure IV.5. The results of question 9. Question 9 investigates the nature of IT investments.



We also investigated the top management's vision about information technology systems. We asked the participants the most important factor that affects the board's decision. 29 % of them told that the board makes the investment decision based on the possible strategic advantages of new technology, 23 % of them told that cost minimization is the most important factor and 13 % of them told that ROI is the biggest concern for top management. Only 10 % claimed that legal regulations affect IT investment decision. This finding shows that top management is aware of the importance of IT in Turkey. Most of the CEOs are confident

about IT's power to leverage their business performance, improve competitiveness and improve productivity. They do not see their IT departments as a cost center. The results are shown in Figure IV.6.

Figure IV.6. The results of question 10. Question 10 investigates the factors affecting top management's decision.



	Q 10
Return on investment	13%
Minimizing the costs	23%
Strategic advantages	29%
Legal Regulations	10%

The last finding of the survey shows that 90 % of the investments have reached their goals. Most of the participants did not make any ROI analyses or any calculations related to objectives of the investment but CIOs claimed that they have reached their goals depending on their experiences and vision. 90 % of the participants told that successful implementations triggers new IT investments and that finding are in parallel with the findings of the literature survey.

PART V

DISCUSSIONS AND EVALUATIONS

Literature survey clarified some answers to the IT valuation problem and our survey study showed that Turkey's specific conditions bring different approaches to the same problem with global alternatives. Turkey is classified as a "developing country" for many years and our economy is referred as one of the emerging economies of the world. This characteristic brings rapid economic growth and consecutively, continuous investments in every industry. Thus, investments were made to fulfill the needs of the industry or to provide infrastructure needs for new investments of the companies. On the other hand, our IT infrastructure is not mature and new services and technologies are announced continuously. Thus, companies have to adjust themselves to the changing IT environments.

The main characteristic of emerging economies is the penetration of global firms to the local market. In the top 500 companies list, there are both global companies and local companies. IT managers from both types of companies have responded to the survey. There are different managerial approaches between them. IT managers of global companies are controlled periodically by head office for compliance to their companies' pre-defined set of rules. As a result, although the IT staff and CIOs of such companies are local, they reflect the strategies and approaches of the head office. We saw some differences between globally managed and locally managed companies in our survey results. When we looked at the survey results of globally managed companies, we saw that 20 % of them claimed that infrastructural needs are the most important factor triggering their IT investment decision. 38 % of them points out to strategic advantages as the major reason for their information technology investment. 55 % of them make benchmarking before the investment and this ratio is in line with that of general. 72 % of them make cost-benefit analyses and 55 % of them makes ROI analyses after the

investment. 38 % of them made an investment for infrastructural purposes in the last 12 months and 41 % of them claimed that the implementation reduced their costs.

When we look at locally managed companies, we saw that ratios are not similar to the globally managed companies. 42 % of the CIOs in local companies mentioned that infrastructural needs are the major factors, which triggers the investment decision. 31 % points out to industrial needs as the most important motive behind IT investments. Only 21 % of them take the intangible returns on information technology usage into account before deciding on an IT investment while the ratio for strategic decision making is 38 % in globally managed companies. This reflects the fact that the infrastructure of local companies have not matured yet. There is still a need for infrastructure investments and basic requirements of the industry have not been fulfilled yet. CIOs are still investing with an aim to reach an adequate information technology infrastructure and at that point it is too early to speak about the strategic value of IT.

We saw interesting ratios for cost-benefit analyses and ROI analyses in locally managed companies. 87 % of them makes cost-benefit analyses and 84 % of them do not pursue the ROI values after the investment. These ratios became meaningful when you look at the factors affecting the board's approval for IT investments. 47 % of the locally managed companies' CEOs ask for returns on investments and cost minimization from CIOs to approve their projects. Thus, in high proportions, CIOs conduct cost-benefit analyses to prepare reports to the board members for approval. On the other hand, when we look at the aim of the investment we see that 42 % of the answers point out to infrastructural needs. Other participants point out to intangible returns. Other factors listed are business continuity and improve productivity which are intangible benefits with nearly equal ratios. Thus CIOs do not pursue the ROI numbers because they convince their superiors with intangible benefits after the installation.

When asked, who made their IT investments to meet infrastructural needs, whether their investment affected the productivity of the company or not, 68 % of the CIOs confirmed that their investment made the organization more productive than before. During the interviews executives told that the infrastructure investments are necessities for companies to run their core businesses. Companies cannot operate without the IT infrastructure so these investments

were done regardless of their effect on productivity but IT executives claim that productivity is a byproduct of IT.

Besides, 71 % of CIOs, whose aim is to add value to the company, declared that they have analyzed the relationship between the firm's productivity and the new technology investment. This finding shows that the aim of the investment shapes the post-installation behaviors of the CIOs. If it is an infrastructure investment ROI calculations are ignored commonly but if it is a strategic investment ROI calculations are made with a high percentage.

We also found a relationship between the causes of IT investments and submissions of the board. When we classified our survey results we saw that, boards of the companies, who made IT investments to fulfill industrial needs, made the investment decision based on the strategic advantages and returns of investment. 84 % of the CIOs of such companies mentioned that their board asks for the strategic returns of their investment plans for the approval. When we look at infrastructural needs, the boards' decisions are based on cost minimization at the rate of 68 %. This reflects that, in Turkey, top managements of the companies want to adjust their IT environment with an aim to increase the efficiency of their business environment. They expect strategic returns and improvement in productivity for such investments. Besides, when it comes to infrastructure enhancements or renovations, cost savings become the number one priority for CEOs.

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Appendix – 1 Questionnaire

Marmara Üniversitesi Fen Bilimleri Enstitüsü Mühendislik Yönetimi Ana Bilim Dalı BT Yatırımlarının Değerlendirilmesi Tezi Anket Çalışması

Hazırlayan: Sinan Osman Turhan (Elektronik ve Haberleşme Mühendisi)

1- Bulunduğunuz organizasyonda yeni IT yatırımını tetikleyen en önemli faktör nedir?

( ) Sektörel ihtiyaçlar

( ) Yasal zorunluluklar

( ) Altyapı İhtiyaçları

( ) Stratejik Kararlar

( ) Diğer .....

2- Son 1 yıl içerisinde herhangi bir IT yatırımı planladınız ve/veya uyguladınız mı?

( ) Hayır

( ) Evet (Kısaca özetleyiniz.....)

3- Planlama safhasında herhangi bir kıyaslama yöntemi kullanıldı ya da benzer firmaların benzer yatırımlarını inceleyip karşılaştırıldı mı?

( ) Hayır

( ) Evet (Kısaca özetleyiniz.....)

4- Planladığınız/uyguladığınız IT yatırımının amacı neydi? (Kısaca özetleyiniz)

5- Uygulama aşamasına geçmeden önce fayda-maliyet analizi yapıldı mı?

( ) Hayır

( ) Evet (Kısaca özetleyiniz.....)

6- Proje sonunda ROI analizi yapıldı mı?

( ) Hayır

( ) Evet (Kısaca özetleyiniz.....)

7- Yapığınız IT yatırımı verimliliği etkiledi mi? Kişisel fikrinizi ya da yapıldıysa verimlilik analizinin sonucunu kısaca özetleyiniz.

( ) Hayır

( ) Evet (Kısaca özetleyiniz.....)

( ) Analiz Edilmedi

8- Yaptığınız IT yatırımı toplam giderleri azalttı mı? Kişisel fikrinizi ya da yapıldıysa ROI analizinin sonucunu kısaca özetleyiniz.

( ) Hayır

( ) Evet (Kısaca özetleyiniz.....)

( ) Analiz Edilmedi

9- Çalıştığınız şirkette/organizasyonda IT yatırımları için verilen kararlar stratejik kararlar mıdır yoksa ekonomik ya da yasal zorunlulukların sonucu mudur? Lütfen karar verme süreci ile ilgili olarak fikrinizi belirtiniz.

( ) Stratejik bir karardır.

( ) Ekonomik ve yasal zorunlulukların bir sonucudur.

( ) Sadece stratejik ya da zorunluluk olarak ayrım yapılamaz. Her iki faktör de etkilidir.

10- Çalıştığınız şirkette/organizasyonda IT yatırımları için üst düzey yönetimin onayını etkileyen faktörler nelerdir?

( ) Yatırımın geri dönüşü

( ) Maliyetlerin azaltılması

( ) Stratejik faydalar

( ) Yasal zorunluluklar

( ) Diğer (Kısaca özetleyiniz……..)

11- Yaptığınız IT yatırımı hedefine ulaştı mı?

12- Çalıştığınız şirkette/organizasyonda başarılı IT projeleri sonrasında yeni IT projelerini tetikliyor mu?

Attachment – 2 Resuts of Questionnaires

Company Name	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12
Company #1	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Not analyzed	Yes	Both	Minimizing the costs	Yes	Yes
Company #2	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Not analyzed	Not analyzed	Strategic	Minimizing the costs	No	Yes
Company #3	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Not analyzed	Yes	Both	Minimizing the costs	Yes	Yes
Company #4	Infrastructural Needs	Yes	No	To meet the infrastructural needs	Yes	No	Not analyzed	No	Necessity	Minimizing the costs	Yes	Yes
Company #5	Infrastructural Needs	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Yes	Both	Minimizing the costs	Yes	Yes
Company #6	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Yes	Yes	Both	Minimizing the costs	Yes	Yes
Company #7	Infrastructural Needs	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Yes	Both	Minimizing the costs	Yes	No
Company #8	Infrastructural Needs	Yes	No	To minimize the costs	Yes	No	Yes	No	Both	Minimizing the costs	Yes	Yes
Company #9	Infrastructural Needs	Yes	Yes	To provide business continuity	Yes	No	Not analyzed	Yes	Both	Minimizing the costs	Yes	Yes
Company #10	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	Yes	Yes	Yes	Both	Multiple factors	Yes	Yes
Company #11	Infrastructural Needs	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Yes	Both	Multiple factors	Yes	Yes
Company #12	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	Yes	Yes	Yes	Both	Multiple factors	Yes	Yes
Company #13	Infrastructural Needs	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Not analyzed	Both	Multiple factors	Yes	Yes
Company #14	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Not analyzed	Not analyzed	Strategic	Multiple factors	Yes	Yes
Company #15	Infrastructural Needs	Yes	No	To minimize the costs	Yes	No	Not analyzed	Not analyzed	Both	Multiple factors	Yes	Yes
Company #16	Infrastructural Needs	Yes	Yes	To add value to the business	Yes	No	Not analyzed	Yes	Strategic	Return on investment	Not evaluated	Yes
Company #17	Infrastructural Needs	Yes	Yes	To improve productivity	Yes	No	Not analyzed	Yes	Both	Return on investment	Not evaluated	Yes
Company #18	Infrastructural Needs	No	No	To improve productivity	Yes	Yes	Yes	No	Both	Return on investment	No	No
Company #19	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Yes	No	Both	Return on investment	Yes	Yes
Company #20	Infrastructural Needs	Yes	Yes	To add value to the business	Yes	No	Not analyzed	No	Both	Strategic advantages	Yes	Yes
Company #21	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	No	No	Yes	Not analyzed	Both	Strategic advantages	Yes	Yes
Company #22	Infrastructural Needs	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Not analyzed	Both	Strategic advantages	Yes	Yes
Company #23	Legal Regulations	Yes	Yes	To improve Data Security	No	No	Yes	Not analyzed	Both	Legal Regulations	Yes	Yes
Company #24	Legal Regulations	Yes	No	To meet the infrastructural needs	Yes	Yes	Not analyzed	No	Strategic	Legal Regulations	Yes	Yes
Company #25	Legal Regulations	Yes	No	To meet the infrastructural needs	Yes	Yes	Not analyzed	No	Strategic	Legal Regulations	Yes	Yes
Company #26	Legal Regulations	Yes	No	To meet the infrastructural needs	Yes	Yes	Not analyzed	No	Strategic	Legal Regulations	Yes	Yes

Company #27	Legal Regulations	Yes	Yes	To meet the infrastructural needs	Yes	Yes	Not analyzed	Yes	Strategic	Legal Regulations	Not evaluated	Yes
Company #28	Legal Regulations	Yes	No	To meet the infrastructural needs	No	No	No	No	Both	Legal Regulations	Yes	Yes
Company #29	Legal Regulations	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Not analyzed	Both	Legal Regulations	Yes	Yes
Company #30	Industrial Needs	Yes	No	To improve productivity	Yes	No	Not analyzed	No	Strategic	Minimizing the costs	Yes	Yes
Company #31	Industrial Needs	Yes	No	To meet the infrastructural needs	Yes	No	Yes	Yes	Both	Minimizing the costs	Yes	Yes
Company #32	Industrial Needs	Yes	Yes	To minimize the costs	Yes	Yes	Yes	Yes	Both	Minimizing the costs	Yes	Yes
Company #33	Industrial Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Not analyzed	No	Both	Multiple factors	Yes	Yes
Company #34	Industrial Needs	Yes	Yes	To meet the infrastructural needs	Yes	Yes	Yes	Not analyzed	Both	Multiple factors	Yes	Yes
Company #35	Industrial Needs	Yes	Yes	To add value to the business	Yes	Yes	Yes	Yes	Necessity	Return on investment	Yes	Yes
Company #36	Industrial Needs	Yes	No	To add value to the business	No	No	Not analyzed	No	Strategic	Return on investment	Yes	Yes
Company #37	Industrial Needs	Yes	Yes	To meet the infrastructural needs	Yes	No	Yes	Yes	Strategic	Return on investment	Yes	Yes
Company #38	Industrial Needs	Yes	Yes	To minimize the costs	Yes	Yes	Not analyzed	Not analyzed	Both	Return on investment	Yes	Yes
Company #39	Industrial Needs	Yes	Yes	To minimize the costs	Yes	No	Yes	Yes	Strategic	Return on investment	Yes	Yes
Company #40	Industrial Needs	Yes	No	To add value to the business	Yes	Yes	Yes	No	Strategic	Strategic advantages	Yes	Yes
Company #41	Industrial Needs	Yes	No	To add value to the business	Yes	Yes	Yes	No	Strategic	Strategic advantages	Yes	Yes
Company #42	Industrial Needs	Yes	No	To add value to the business	Yes	Yes	Yes	No	Strategic	Strategic advantages	Yes	Yes
Company #43	Industrial Needs	Yes	Yes	To improve productivity	Yes	Yes	Yes	Yes	Both	Strategic advantages	Yes	Yes
Company #44	Industrial Needs	Yes	Yes	To improve productivity	Yes	No	Not analyzed	No	Strategic	Strategic advantages	Yes	Yes
Company #45	Industrial Needs	Yes	No	To meet the infrastructural needs	Yes	No	Not analyzed	Yes	Both	Strategic advantages	Yes	Yes
Company #46	Industrial Needs	Yes	No	To minimize the costs	Yes	Yes	Yes	Yes	Both	Strategic advantages	Yes	No
Company #47	Industrial Needs	Yes	Yes	To provide business continuity	Yes	No	Not analyzed	No	Necessity	Strategic advantages	Yes	Yes
Company #48	Industrial Needs	Yes	Yes	To provide business continuity	Yes	No	Not analyzed	No	Necessity	Strategic advantages	Yes	Yes
Company #49	Strategic Decisions	No	No	To add value to the business	No	No	Yes	Not analyzed	Strategic	Strategic advantages	Yes	Yes
Company #50	Strategic Decisions	Yes	Yes	To add value to the business	Yes	No	Yes	Not analyzed	Both	Strategic advantages	Yes	Yes
Company #51	Strategic Decisions	Yes	No	To add value to the business	Yes	No	Yes	No	Strategic	Strategic advantages	Yes	Yes
Company #52	Strategic Decisions	No	No	To add value to the business	No	No	Yes	Not analyzed	Strategic	Strategic advantages	Yes	Yes
Company #53	Strategic Decisions	Yes	Yes	To add value to the business	Yes	No	Yes	Not analyzed	Strategic	Multiple factors	Yes	Yes

Company #54	Strategic Decisions	Yes	Yes	To add value to the business	Yes	Yes	Yes	Yes	Both	Multiple factors	Yes	No
Company #55	Strategic Decisions	Yes	Yes	To add value to the business	No	No	Not analyzed	Not analyzed	Both	Minimizing the costs	No	No
Company #56	Strategic Decisions	Yes	Yes	To improve Data Security	Yes	Yes	Yes	Yes	Both	Multiple factors	Yes	Yes
Company #57	Strategic Decisions	Yes	Yes	To improve productivity	Yes	No	Yes	No	Both	Strategic advantages	Yes	Yes
Company #58	Strategic Decisions	Yes	No	To improve productivity	No	No	Not analyzed	Not analyzed	Both	Multiple factors	Yes	Yes
Company #59	Strategic Decisions	Yes	No	To improve productivity	Yes	No	Yes	No	Strategic	Multiple factors	Yes	Yes
Company #60	Strategic Decisions	Yes	No	To improve productivity	No	No	Not analyzed	Not analyzed	Both	Strategic advantages	Yes	Yes
Company #61	Strategic Decisions	Yes	No	To meet the infrastructural needs	No	No	Yes	No	Strategic	Strategic advantages	Yes	No
Company #62	Strategic Decisions	Yes	No	To minimize the costs	No	No	Not analyzed	Yes	Strategic	Minimizing the costs	Yes	No
Company #63	Strategic Decisions	Yes	Yes	To minimize the costs	No	No	Yes	Yes	Strategic	Minimizing the costs	Yes	Yes
Company #64	Strategic Decisions	Yes	Yes	To minimize the costs	No	No	Yes	Yes	Strategic	Minimizing the costs	Yes	Yes
Company #65	Strategic Decisions	Yes	Yes	To provide business continuity	Yes	Yes	Not analyzed	Yes	Strategic	Strategic advantages	Yes	Yes
Company #66	Strategic Decisions	Yes	Yes	To provide business continuity	Yes	No	Not analyzed	No	Both	Multiple factors	Yes	Yes
Company #67	Strategic Decisions	Yes	Yes	To meet the infrastructural needs	Yes	No	Yes	Not analyzed	Both	Multiple factors	Yes	No
Company #68	Infrastructural Needs	Yes	Yes	To meet the infrastructural needs	Yes	Yes	Yes	Yes	Both	Multiple factors	Yes	Yes
Company #69	Strategic Decisions	Yes	Yes	To provide business continuity	Yes	No	Yes	No	Both	Multiple factors	Yes	Yes

MARMARA UNIVERSITY

THE INSTITUTE FOR

GRADUATE STUDIES IN PURE AND APPLIED SCIENCES

ACCEPTANCE AND APPROVAL DOCUMENT

The jury established by the Executive Board of the *INSTITUTE FOR GRADUATE STUDIES IN PURE AND APPLIED SCIENCES* on 22.12.2008 (Resolution no: 2008/31-30) has accepted Mr. Sinan Osman Turhan's thesis titled "**Relationship Between IT Investments and Productivity**" as Master of Science thesis in Engineering Management.

Advisor : (Yrd. Doc. Dr., Serol Bulkan)(Marmara Üniversitesi) ..... serol bulkan

1. Member of the jury: (Prof. Dr., Demet Bayraktar)(İTÜ) .....

2. Member of the jury: (Doc. Dr., Bekir Kemal Ataman)(Marmara Üniversitesi) ..... B. K. Ataman

Date : 06.02.2009...

APPROVAL

Mr. Sinan Osman Turhan has satisfactorily completed the requirements for the degree of Master of Science in Engineering Management at Marmara University. The Executive Commitee approves that he be granted the degree of Master of Science on 01.06.2009 (Resolution no: 2009/13-02)

DIRECTOR OF THE INSTITUTE

Prof. Dr. Sevil ÜNAL
Müdür