بسم الله الرحمن الرحيم

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College of Graduate Studies and Research

Impact of the Use of Information Technology in Decision-making in Construction Industry in Sudan

أثر إستخدام تقنية المعلومات في صنع القرار في صناعة البناء في السودان

(Thesis Submitted in Partial Fulfillment of Requirement for Degree of Master of Science in Construction Management)

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(وَيَسْأَلُونَكَ عَنِ الرُّوحِ قُلِ الرُّوحُ مِنْ أَمْرِ رَبِّي وَمَا أُوتِيتُم مِّن الْعِلْمِ إِلاَّ قَلِيلاً)

الإسراء (85)

Dedication

To my mother

To my father

To my sister and my brothers

To my teachers

To my friends

To each of the characters helped me and taught me and took my hands

To each of the request High for these country

All of them I dedicate this unpretending effort

Researcher

Thanks

Thank God Almighty, before and after

To the Center of the Engineering Studies, "CETS"

Center for Studies professors who taught me a lot in construction management in this period that I spent with them

Thanks to the administrators, Dr. Nader, who did not spare the opinion and advice?

Same thank my family precious bond that was me in my educational

And my deep appreciation to the family Center of the Engineering &Technical Studies in general for their support and encouragement

All of them great thanks

Researcher

الملخص

يسعى هذا البحث الى التعرف على مدى تاثير استخدام تكنولوجيا المعلومات في الحصول على توفير المعلومات اللازمة لمتخذي القرار في صناعة التشييد في السودان و الدور الذي تلعبه تكنولوجيا المعلومات في إتخاذ القرار .

وايضاً لتوضيح مفهوم تكنولوجيا المعلومات وتأثيرها في إتخاذ القرارات الادارية اللازمة والصائبة وتقييم أداء الأفراد في شركات التشييد، وايضا معرفة مدي استخدام شركات التشييد لتكنولوجيا المعلومات الحديثة في الحصول على المعلومات وكذلك التعرف على العوامل المؤثرة في استخدام تكنولوجيا المعلومات .

تم سرد البيانات وتحليلها وتفسيرها إستنادا إلى الإطار النظري كمرجع. وتم عمل إختبار للفرضيات للتأكد من مدى التوافق بين وجهة نظر الباحث والمبحوثين حول الفرضيات.

بعد مناقشة النتائج وتحليلها وتفسيرها توصل الباحث الي عدة نتائج أهمها توفير الزمن و سرعة اتخاذ القرار والأداء عند استخدام تكنولوجيا المعلومات وكانت المقدرة المالية والإدارة العليا للشركات تمثل العائق الأكبر لأستخدامها وكذلك عدم التدريب الكافي لموظفيها، ومن خلال هذة النتائج توصل الباحث الي توصيات عامة يمكن أن تساعد علي إتخاذ القرار في صناعة التشييد.

Abstract

This research seeks to identify the extent of the impact of the use of information technology to provide information to the decision-makers in the construction industry in Sudan and the role played by information technology in decision-making.

And also to clarify the concept of information technology and its impact on making necessary administrative decisions and audio and evaluate the performance of individuals in construction companies, also know how to use construction companies to make a modern information technology in information as well as identify the factors affecting the use of information technology.

Data and testimonials and interpretation were listed on the theoretical framework as a reference.A testing was formed to be confirmed to ensure the extent to which the researcher view and respondents were conducted on the hypotheses.

After discussing and transparency to the hybridization, the researcher reached several results of the most important to results, the implementation of decision and performance of the use information technology. The financial estimate and the senior management of companies represented the greatest obstacle to use as well as not of enough training for their employers, and during these results Research researchers have been general recommendations that could help to make decision in the construction industry.

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CHAPTER ONE

1-1 **INTRODUCTION :**

Information systems are key factors in the success or failure of any facility, and this importance stems from the fact that information is used as a tool for coordination and support of the management process and decision-making, and as a communication tool within the establishment and with the surrounding environment, the information is also contributed in technology. The IT systems support the strategic planning processes in the management for decision makers.

The expansion of Buildings and the geographical spread and their diversification of productions, beside of their marketing operations, and the need of accurate managing of human resources and finance, these items above should lead to develop a perfect IT system to insure the flow of information of various units of company and also the use IT to the development of performance management in particular.

The optimal use of information technology in construction companies making it a successful company in the construction industry

1-2Research problem :-

This problem could be articulated through these sub-questions:-

- What is the role played by the information system in decision making?
- What are the characteristics or features that must be provided in the information so as to make a sound and rational decisions?

- Does the presence of information system in the construction company make it easier to access information for decision-makers and responsive to their needs?

- Does the presence of information system within a construction company sufficient to make effect to it?

1-3 Hypotheses: -

To answer these questions we have formulated the following hypotheses: -

1- Construction companies lack proper IT capabilities.
2- Construction companies do not consider information as a strategic resource.
3- Construction companies do not use IT for decision support.
4- Construction companies do not use IT for performance & evaluation.
5- Construction companies do not keep up with the changes and they are not aware of the importance of information systems.
6- Construction companies personnel are not well trained for utilizing of information systems.

1-4The importance of this research: -

-To explore the Analysis of information system, and how the resolution take and drafted to their becomes a topic in the field of information system and decision-making.

- To put and developed plan, that would allow the continue for this research in the future.

- Developments in some organizations translate the importance of information and thus stress the necessity of analysis and delivery to the user a way that was able to understand.

- The importance of research stems from two factors:

1. The increasing importance of information technology in decision-making in the construction industry.

2. The absence of previous studies on the subject of research.

1-5 Aims of the research:-

This study aims to identify the extent of the impact and needed the use of information technology for decision-makers in the construction industry. The research aims to achieve the following:

-Explain the concept of information and information system.

- Explain the importance of information in decision the necessary decisions and the right and assess performance of people.

- Explain the relationship of development technological with information system and decision-making.

- To explore the extent of the use in the construction companies of modern information technology.

- To explore the extent of the use in the construction companies and the transfer of modern information technology to provide the information for decision-making.

- To identify the effective factors for the extent of using the information technology.

1-6Research Methodology:-

Use analytical approach in this study to being one of the most appropriate methods to study the phenomena in questions, sources from books and specialized scientific journals, also by the design and preparation of a questionnaire to achieve the research goals and hypotheses.

CHAPTER TOW

SECTION 1
CONSTRUCTION INDUSTRY

2-1-1 Introduction

The construction industry in Sudan is very large and employs more than 2 million people in a wide range of jobs, from engineering and technical staff to skill detrudes people and operatives. It is important for new or potential entrants to the industry to understand about the sector so that they can make informed career choice, also it's provide an understanding for designers and constructors, as well as for those interested in the discipline of construction, the construction industry characteristics, professional practice, terminology, and conventions.[www.sudengineers.com]

In the fields of architecture and civil engineering, construction is a process that consists of the building or assembling of infrastructure. Far from being a single activity, large scale construction is a feat of human multitasking. Normally, the job is managed by a project manager, and supervised by a construction manager, design engineer, construction engineer or project architect.

For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider the environmental impact of the job, the successful scheduling, budgeting, construction site safety, availability of building materials, logistics, inconvenience to the public caused by construction delays, and bidding.

There are many millions of documents (such as drawings, specifications, bills of quantities, correspondence, schedules, programmers) currently exchanged on paper between practitioners in the construction industry. It is commonplace that each of these documents are subsequently re-keyed, photocopied and filed, as they pass between different locations and computer applications. (Hore and West, 2005a).

At present the extent of use of Information Communication Technology (ICT) construction industry is relatively unsophisticated, mainly dependent on telephone, facsimile machines and networked personal computers. At the simplest level, the electronic transmission of business documents offers savings in paper and postage. By going a step further, businesses can make strides in communicating with their partners, at relatively low cost, through direct links between their computers.

Competition from international firms as a result of increased globalization has prompted a renewed focus on improving general performances within the construction industry, both in Ireland and in the United Kingdom (CICA, 1993; CICA, 1996; Building Centre Trust, 1999). Grant (1998) reflected on what was occurring in other industries, with a focus on faster time to market, better quality and service and better control of risk and costs. The difference is that such changes have taken longer to affect the construction industry (Sun and Aouad, 2000).

Market forces have put increased pressure on both construction industry practitioners and academia to try and identify the factors that stand in the way of achieving this performance improvement. A key question that is often asked is why, when other industries have successfully made use of ICT, construction has been so slow to do the same. (Latham 1994; Egan 1998; Capron, 2000; Sun and Aoudad 2000).

2-1-2 The nature of the construction industry

The construction industry is heterogeneous in the nature of its organizations. In order to procure a construction project, a variety of organizations are temporarily combined to create a 'temporary multi organization' (TMO) to discuss and exchange information. When construction problems arise, relevant organizations have to work together to determine appropriate concessions and compromises before solutions can be obtained. The construction industry is centered on projects in which organizations come to work together within the duration of the projects. Each project is unique in the sense that there are 'properties' of construction problems that are inseparable from the project.

In solving construction problems, a great deal of solvers' efforts is placed on the understanding of the problems in order to recognize the similarities of the problems at hand with previous solved problems. The similarities will enable solvers to recall their experiential knowledge, as there is no sufficient formal and procedural knowledge to solve construction problems. Construction problem solvers have to rely on their experiential knowledge.

2-1-3 Working Conditions

Most employees in the construction industry work full time, and many work over 40 hours a week. In 2008, about 18 percent of construction workers worked 45 hours or more a week. Construction workers may sometimes work evenings, weekends, and holidays to finish a job or take care of an emergency. Rain, snow, or wind may halt construction work. Workers in this industry usually do not get paid if they can't work due to inclement weather. [Data from the U.S. Bureau of Labor]

http://www.bls.gov/ooh/About/Career-Guide-to-Industries.htm#conditions]

2-1-4 Work environment

Workers in this industry need physical stamina because the work frequently requires prolonged standing, bending, stooping, and working in cramped quarters. They also may be required to lift and carry heavy objects. Exposure to the weather is common because much of the work is done outside or in partially enclosed structures. Construction workers often work with potentially dangerous tools and equipment amidst a clutter of building materials; some work on temporary scaffolding or at great heights. Consequently, they are more prone to injuries than workers in other jobs. Data from the U.S. Bureau of Labor Statistics show that many construction trades workers experienced a work-related injury and illness

rate that was higher than the national average. In response, employers increasingly emphasize safe working conditions and habits that reduce the risk of injuries. To avoid injury, employees wear safety clothing, such as gloves, hardhats, and devices to protect their eyes, mouth, or hearing, as needed.

SECTION 2
Information Technology

2-2-1 Introduction of Information Technology

What is Information Technology?

Information Technology is a term that includes any technologies that enable or enhance the electronic exchange of information. This is not confined to computer related activities, but encompasses the mobile phone and fax machine. By this measure, IT uptake in the construction industry is much wider than might be imagined. Modern IT is increasingly about efficient communication and effective information exchange, rather than simply the automation of manual tasks. In a project based industry such as construction, which is dependent upon huge amounts of information generated and used by numerous project participants, this technology provides excellent potential to capitalize on the value of connectivity and the power of networking. (IT WG, 2002)

In the past, the cost of entry to an IT enabled future has been thought to be too high for the majority of small players. As the cost of hardware and software has decreased, making its use more affordable, the benefits of using IT have increased.. In addition, the benefits of connectivity are inversely proportional to the costs of entry. However, the cost of not being IT enabled is fast becoming too high. As technology becomes cheaper, the potential for network growth is exponential. The value of effectively integrating with the networked community is now potentially beyond measure. (IT WG, 2002)

2-2-2Culture or Technology

The Task Force of technology determined that the adoption of IT by organizations at all levels within the industry is and will increasingly be influenced by the result of two distinct and separate forces, one technological (pushing) in nature, the other cultural (pulling). (Kanter,1999)

The fig “1pag….” coming later, illustrates some of the key advances and changes in both technology and culture through recent decades. Major developments of these two forces have been contextualized, related to the use of different and emerging procurement/delivery methods and the developing technologies.

In the 1960's, computerization (i.e. mainframes) was in its infancy, with telex and the facsimile being developed. Technology continued to advance through initial automation and commercially available desktop technologies, through to information technology incorporating laptops, palm PCs, emergence of the Internet, virtual projects and infra-red remote information access via mobile phones. At the same time, the industry has undergone change from a fragmented and adversarial industry, to single sourcing, more collaboration and now towards relationship management and strategic aliening.

2-2-3 Business and information management:

The construction process is information intensive with a large volume of information generated and consumed by all participants involved. Electronic Document Management (EDM) of software can create an environment within which disparate forms of information can be linked together, in the context of a project or organization, to achieve easy access and control.

Businesses of all types have to review their processes in the light of new technology and to maintain their competitiveness, and construction is no exception. Greater integration business departments is leading to the use Enterprise Resource Planning (ERP) of software to link the various facets of an organization, such as, purchasing, accounts, planning, estimating, plant, salaries, human resources, contracts, marketing etc.. One such example is the product supplied by the Construction Industry Software Solutions (COINS)

Knowledge Management (KM) is any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organizations (Scarborough et al, 1999). The process of capturing, consolidating, disseminating and reusing knowledge within an organization is the way it gains competitive advantage and builds an innovative and successful organization (Kanter,1999). Information Communication Technology (ICT) can be used to capture and distribute information and knowledge throughout an organization in a structured manner. Construction projects always involve the collaboration of a multi-disciplinary project team located in different parts of a country. Some may be resident on site, others located in an office. The advent of the Internet has greatly enhanced the operational scope of collaboration tools. There is now a wide-range of ready-made tools aimed at supporting projects where participants are potentially widespread. Examples

include, Build online, 4Projects, BIW Technologies, Sarcophagus, Business Collaborator . established technology tools used in everyday business processes, including fax machines, fax/modem cards, Internet fax and e-mail.

Notwithstanding the software selected by the main contractor, behind the scenes of today's construction purchasing departments, there is a consortium of individual suppliers that use different software applications, characterized by poorly synchronized electronic information handling(IT WG, 2002). Electronic Data Interchange (EDI) has become the preferred way of compressing and transmitting data between a buying firm and its suppliers in many sectors .There are however, many limitations in the use of EDI such as cost, the width of connectivity with a business supply-chain, by use of Value-Added Networks (VANs) and dedicated EDI servers. In the early twenty-first century, one dilemma for those with well-developed EDI systems is whether or not they should migrate to a Web-based system. The growing use of extensible Mark-Up Language (XML) technologies will enable automated electronic communication between the buyer and supplier in transmitting order, receipts and payments. XML received WWW recognition in February 1998 (Lenders et al, 2001). Other technologies that will play a key role in the reengineered process includes Enterprise Resource Planning (ERP) software such as that provided by SAP and Oracle; Auto-ID Technologies such as bar-coding; On-line supplier catalogue capability and Pen computers or Personal Digitizer Assistants (PDAs).

2-2-4 Computer Aided Design and Visualization：

Computer Aided Design (CAD) software is widely used by design professionals, with AutoCAD having the largest share of the CAD market (Howard, 1998). Other popular CAD packages include Micro station, Archie CAD, Mini CAD, Fast CAD, etc. These CAD programs have replaced the traditional drawing board in the production of design information. 2D CAD systems have dramatically improved the drawing process. 3D modeling can enable designers to investigate the buildings internal spatial system and its relationship with the surrounding environment. Visualization and animation systems, like 3D Studio, Graph soft, Refit and Archie CAD, can produce photo-realistic, static and moving images so that clients can view the final appearance of the building at the design stage. Virtual Reality (VR) technically now allows the user to integrate with the design model and experience the building in simulated reality situations. Building Information Modeling (BIM) is an innovative new approach to building, design, construction and management. BIM keeps critical design information in digital forms making it easier to update and share design information. It also creates real time, consistent relationships between digital design data with the use of

innovative parametric modeling technology techniques. Autodesk Architectural Desktop and Autodesk Building Systems are examples of software currently available.

2-2-5 Computer Aided Estimating

Controlling costs is one of the most important requirements during a construction project. To achieve this, contractors and subcontractors must first produce an accurate cost estimate to establish the tender price. Today, there are sophisticated computer software packages such as Esti-mate, Manifest, which allow project managers to assist in the production of project estimates and keep track of project spending.

Many of these programmers can assist in the quantity take-off in the production of bills of quantities. Examples of such software includes, Build soft, Master bill, CATOPro. Modern cost estimation programs can be integrated with CAD programs and linked data for labor, materials and plant. The advantage is that cost data does not need to be re-entered thus improving the speed of estimating and avoiding errors.

2-2-6 Planning, scheduling and site management

It is a common misconception that computers are of little help on a building site. In fact computer systems can assist site personnel to plan, co-ordinate and generally to become more efficient in the administration of the project. Apart from the widespread use of planning packages such as, Power Project and Microsoft Project, there are solutions from Primavera, COINS and the growing interest in web-based collaboration tools. (IT WG, 2002)

An additional area that is rapidly expanding is in the use of mobile technology. Mobile technologies enable physical separate hardware devices to connect and share data. Developments in this technology have led to the amalgamation of mobile computing devices and mobile communications protocols, with Personal Digitized Assistants (PDAs) now available with integrated mobile connectivity or via a separate mobile phone, through either a wired or wireless connection such as Bluetooth. This provides the mobile user with the ability to upload and download data from anywhere that a mobile signal is provided. An example of a recent initiative in the UK focusing on mobile computing is construction is the ‘Construction Opportunities for Mobile IT’ (COMIT).

2-2-7 Technological Push

Technology is rapidly advancing, often far ahead of widespread construction industry uptake. Early adopters of new and integrated technologies can reap benefits for their own business and processes, and often influence their project partners to use the technologies. Some industry players, in particular SMEs, have indicated that their priority lies in the introduction of IT at a more basic level.

Some technologies and advancements pushing the construction industry include:

Scheduling, inventory control, project management, advanced 2D, 3D and 4D CAD**;**
Sophisticated object based modeling (incorporating 3D CAD and other applications), allowing attributes to be added by all parties and the capability of maximizing value with concurrent production of project information databases;
Interoperability or seamless information exchange via integrated technologies and based on object modeling, allowing all participants in the process to access and value add to the project information in a form suitable for their needs;
4D project design, constructability and operations incorporating space and time into virtual modeling techniques;
Development and incorporation of internationally accepted integrated standards into applications, such as interoperability enabling IFCs and aecXML, the web language suitable for the built environment;
Web-based technologies enabling virtual projects, on-line project management, collaborative business tools, e-commerce transactions and the possibilities of real time interaction throughout the life of the project, from geographically dispersed project participants;
Virtual environments where project partners access, develop and use information and project data in real time with universal access;
Wireless technologies, including WAP, that enable the transfer of information to remote sites without the requirement for, or restrictions of, hard infrastructure such as cabling or wires; and
Portal web sites, offering streamlined access to materials, plant and professional services, and application service providers (ASP) providing cost effective software applications are starting to appear in the Australian market.

2-2-8 Cultural Pull

There is a trend emerging within both the project and industry cultures of moving from fragmentation to active collaboration with project partners and recently to the incorporation of relationship management and ongoing alliances. This cultural pull on the uptake of IT is evidenced by more collaborative working practices, the utilization of shared objectives and partnerships, especially with clients, and an alignment of IT usage with business objectives.

These changes in project and industry culture require changes in the business processes and relationships, as well as maturing of the clients and other stakeholders. The benefits of business process re-engineering (BPR) to incorporate maximum networking connectivity have been recognized by commercial vendors (i.e. book selling and computer sales) and in industries sharing similarities with the construction industry (i.e. automotive and aerospace). The construction industry is also realizing the benefits of BPR, enabled by IT solutions (refer attached Leighton case study). The wide spread incorporation of better, more effective

communication and information exchange, supported appropriately by IT, is starting to be demanded across the industry.

Central to the analysis of the issue of industry culture is the recognition that:

there has been a change in perception of the client/contractor relationship from the adversarial towards becoming partners in the procurement process (Egan, 1998); and

That real benefits will flow from IT enabled BPR, not simply from the automation of manual tasks.

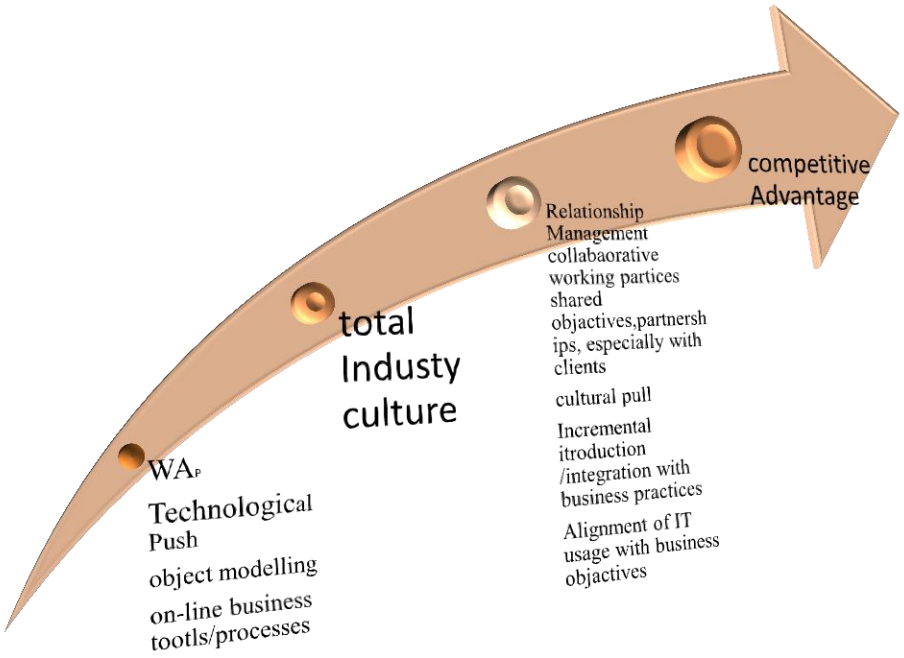
The procurement process in its widest sense is a strategy to satisfy client's development and/or operational needs with respect to the provision of constructed facilities for a discrete life cycle. This places the client at the heart of both the procurement process and BPR (Lenard and Mohsini, 1998). The industry is moving towards more projects partnering, both with the client and other project participants. Relationship management is becoming a goal for more progressive organizations with a focus on collaboration, value (not price) and strategic allowancing.

Enlightened and maturing clients, stakeholders and industry players alike recognize the high cost of producing the information content of their projects. It is reasonable for them to maximize the derived benefit and consequent increased margins that could follow from efficient use and re-use of this information. Possible benefits include:

reduced time, costs and re-work for economic, process and facilities management functions, accrued by the re-use of information generated as part of the briefing, design, construction and operation processes, ultimately resulting from the use of object oriented project databases and virtual environments;

reduced costs with increased productivity (and increased profitability) across the entire supply chain by the use of on-line communication, most likely facilitated by web-based collaborative tools, wireless technologies and real time interaction; and

Subsequent re-structuring of value chain relationships and processes, from both within the organization and across the industry.



[Fig 1]
Culture and Relationships

2-2-9 Resistance to Change

The modern industry can be very adaptive, innovative and responsive to changing conditions at the project level, as long as the solutions are found to ensure that project's success. When faced with problems to overcome, project participants can be ingenious and collaborative when the conditions are right and specifically for that project. The industry as a whole seems to keep beating itself with a stick in relation to its ability to change and adapt. However, due to the competitive nature and low margins of the industry, there is still a tendency to stick with the tried and tested, and resist experimentation, unless there is confidence of timely return on investment. The Task Force speculated that a difference in culture might be detected at the micro and macro levels of the industry.

Equally, the client's role in the culture of the industry and project is changing. Evidence was found to suggest that:
progressive site managers were willing to take on new technologies where specific benefits could be identified for their projects;
head office personnel could be reluctant to support these moves as they inevitably empowered the site level, whilst (perceptions are of) relinquishing a measure of direct control (Cook, 2000);

older managers at all levels were reluctant to engage with new technologies with which they were totally alien. Younger managers had been schooled in their use from an early age and would tend to be comfortable with both new and emerging technologies;
clients have two requirements, their "needs" (hard issues, the five requirements for a building: time, initial cost, quality, size and life cycle costs) and "wants" (soft issues of value, trust and security) (Marsh, 1999).These requirements are being more appropriately addressed with the changes to more collaborative working arrangements and procurement methods; and
The intelligent client, recognizing the possibility of establishing less litigious procurement procedures may increasingly select one service provider on the basis of appropriateness to their particular situation. At the core of this selection will be the buying power, capability of industry in the supply market and the outcome required. This will necessarily involve the creation and fostering of long-term relationships (after Cox and Townsend, 1998).
In 1987, Australian construction companies they first recognized the advantages of computers for presentations of designs to clients, consequently leasing two personal computers. Progressively over the next few years IT became central to the business practices of the firm, with all design work done on computers. Through an incremental process of project-by-project adoption, all architects were given a computer and learned to design using CAD software. By 1992, drawing boards were no longer used, and no draftsmen remained in the firm.

2-2-10 The adoption of IT led to many benefits:

- greater speed,
- flexibility and accuracy in design,
- greater integration of processes across the business,
- efficient contract administration and project management,
- high client satisfaction,
- an industry reputation for IT leadership in architecture,
- lower costs,
- competitive edge,
- Opportunities, especially in urban design and local government planning.

Leading the gradual transformation, partner John Flower developed three basic rules for successful management of IT in the practice.
IT had to be mastered by the professional architects, starting with him. Designing projects from the start in 3D on PCs became standard practice, which forced rapid learning.

- IT had to be integrated into the business, which meant not employing IT specialists or CAD operators. This required a strong commitment to individual and organizational learning in the practice, to ensure that the professionals continued to advance their IT skills.
- IT investment was limited to readily available hardware and software because it was relatively easy to use and required no specialist IT capability.
- The competitive benefits were not obtained directly from the power of the IT systems, rather from the intelligent learning and application of these tools to the task and business process. Essentially this integration meant that Flower & Sami's re-engineered its business processes to obtain maximum benefits from the technology.
- The project model was absolutely central to everything that the office undertook. Developing and maintaining a 3D model of each design could generate relevant drawings and documentation from the model at different stages without further work. Designs were easily amended, with instantaneous updating of elements of the model. Positions for pre-determined elevations, sections and assembly details were programmed onto the model and linked to output files on a separate server. These in turn were connected to DTP machines to produce the documentation for public consumption. The model could also be linked to multimedia packages for the communication of designs to customers. John Flower pointed out that in order to change the appearance of any output alterations were only necessary to the model itself. This ensured that the model was always current, obviating any discrepancies between amended drawings. However he warned that this change required a rethink of work practices. The temptation to alter the final drawing rather than the underlying model was hard to overcome, he said.
- For the future John Flower recognized that the greatest industry-wide benefits would accrue when all of the project participants worked directly from the modeling output of practices like his. He cited advantages including,

- Builders working directly from a copy of the 3D model, allowing them to generate working drawings to their best advantage
- Reduction in number of RFIs since builders could view the virtual project as often and in as many ways as was necessary to achieve understanding
- Greater opportunities for builders to identify innovative cost-cutting solutions without compromising overall project performance
- Use of 3D model to resolve work-scheduling issues i.e. correct sequencing of critical activities in complex situations.

- Automated billing of quantities, utilizing inherent object attributes as the trigger to the process
- Engineers given 3D model to "fit" structural and service elements to it. They would access the 3D model of the project on the firm's server, undertaking their specialist component of the design work on-line, while having read-only access to the rest of the model.
- Communications with suppliers and consultants would become increasingly electronic, with emailed CAD drawings and documents being the norm, bringing attendant cost savings.
- Transparency inherent in the process would require high levels of honesty, trust and confidence: "You can't hide scams!

2-2-11 IT as a project management tool

Success or failure of a project depends upon the ability of key personnel to have sufficient data and processed information's for decision making.

To obtain correct and right time information, company has to develop business processes and methodology for PM. Project management methodology summarize all policies procedures, forms and checklists. It is a base for information system (IS) analysis and design applied by information technology.

Standard project management information system (PMIS) is usually divided in following subsystems:

- Project scheduling: definition of project activities, their relationships, estimation of activities duration, and definition of milestones.
- Resource management: analysis and definition of needed project resources, including cost breakdown and financial analysis.
- Project documentation subsystem: meeting minutes, status reports, submittals, and transmittals, definition of documents, users and user's communication relationships, document coding and tracking. Project description, team members, contracts, annexes, work and material orders, suppliers.
- Product documentation, design drawings, specifications, technical descriptions and guidelines, technical standards, quality standards and procedures.
- Project finance: planned vs. actual costs, financing.
- Project control and monitoring: critical path analysis, early warning indicators, optimization of resources, problem solving

2-2-12 previous studies:

Information technology (IT) has been advocated as the key enabler of process re-engineering in the construction industry. Process re-engineering represents a philosophy of change which embraces a fundamental paradigm of rethinking and redesign of processes, including lean construction. Its potential application to the

construction industry is gradually being recognized. The management of processes invariably requires information, and therefore the capacity for IT to enable process re-engineering in the construction industry needs to be investigated. However, it is suggested that before the potential benefits of IT and process reengineering can be realized, current work practices need to be explored.

A recent survey of 47 contracting companies' current and future applications of IT and the benefits and problems associated with its implementation are described. The results obtained suggest that advanced applications of IT such as simulation, expert systems, and supplier direct-link ordering were limited in their appeal to Australian contractors. This paper concludes that contractors do not foresee IT as having a significant impact on their current work practices, although it is suggested that contractors are possibly not aware of its potential application. The implementation of IT as the key enabler of process re-engineering is discussed. **[**The application of information technology by Australian contractors: toward process re-engineering .by Ms; Peter E.D. Love, Carol Mac Sporran and Selwyn N. Tucker]

1- Current and future investment in information technology

Many contractors found it extremely difficult to give accurate data about their hardware and software applications. Research and development in IT were limited to a few organizations, primarily with a turnover of over $A400 million. Despite the research and development in IT, only one organization had a specialist IT department.

Few respondents answering questions pertaining to the organization's current investment in IT had accurate figures, yet each respondent could give a reasonable estimate of the percentage of IT investment between 1992 and 1995. Generally, the investment in IT for each of the following categories was less than 0.6% of total turnover: research and development, training and education, hardware and operating systems. Contractors with a turnover of over $A150 million invested a much greater percentage of their turnover in IT than the smaller contracting organizations. Many respondents found it difficult to predict their future investment in the selected IT categories, and it was suggested by one respondent that they would be reducing their expenditure on IT hardware and operating systems because the prices for computer hardware and software were expected to substantially decrease over the next few years.

2- The use of hardware:-

Each contractor identified the forms of IT hardware used at both organizational and project levels. Among the most popular forms of IT hardware were mobile telephones, PCs and laptop computers. At the organizational level (Fig 1), 98% of the contractors sampled stated that they used PCs as their major IT hardware platform and 77% stated that their PCs were linked via a network system.

Generally, it was found that those contractors who did not have a network system in place had an annual turnover of less than $A10 million. It was found that one contractor had an annual turnover of more than $A20 million and still used manual systems at the organizational level, although consideration was being given to implementing computing equipment and a network system within the next year. The use of CD-ROM and document scanning were found to be very limited.

At the project level, there were substantial differences in IT hardware usage from the organizational level (Fig. 2). It was found that 96% used mobile telephones, 55% used PCs, and 28% had networks in place on a specific project. Mobile phones were found to be contractors' primary IT hardware on-site, with most contractors stating that mobile phones7 had improved their communication and decision-making processes. Several contractors indicated that networks were only used on site when the project was large enough to support a network infrastructure. Most contractors had a desire to upgrade their existing hardware and increase their hardware portfolio in the future, but the financial outlay was perceived to be a setback.

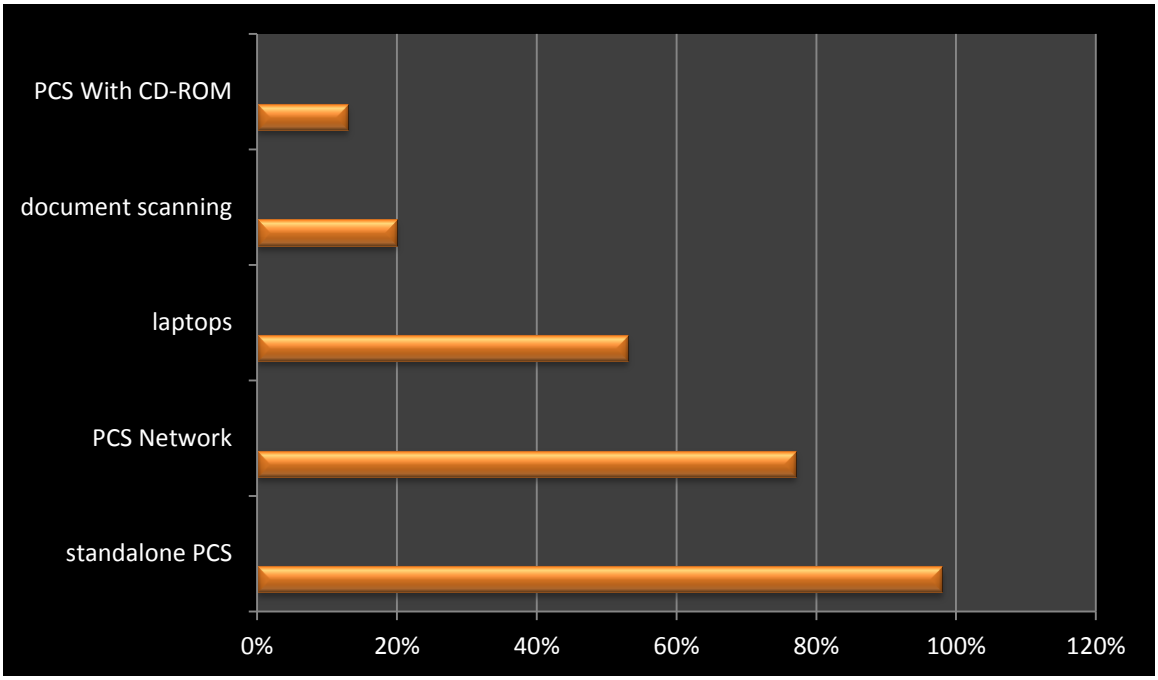


Figure 1: IT hardware – organizational level

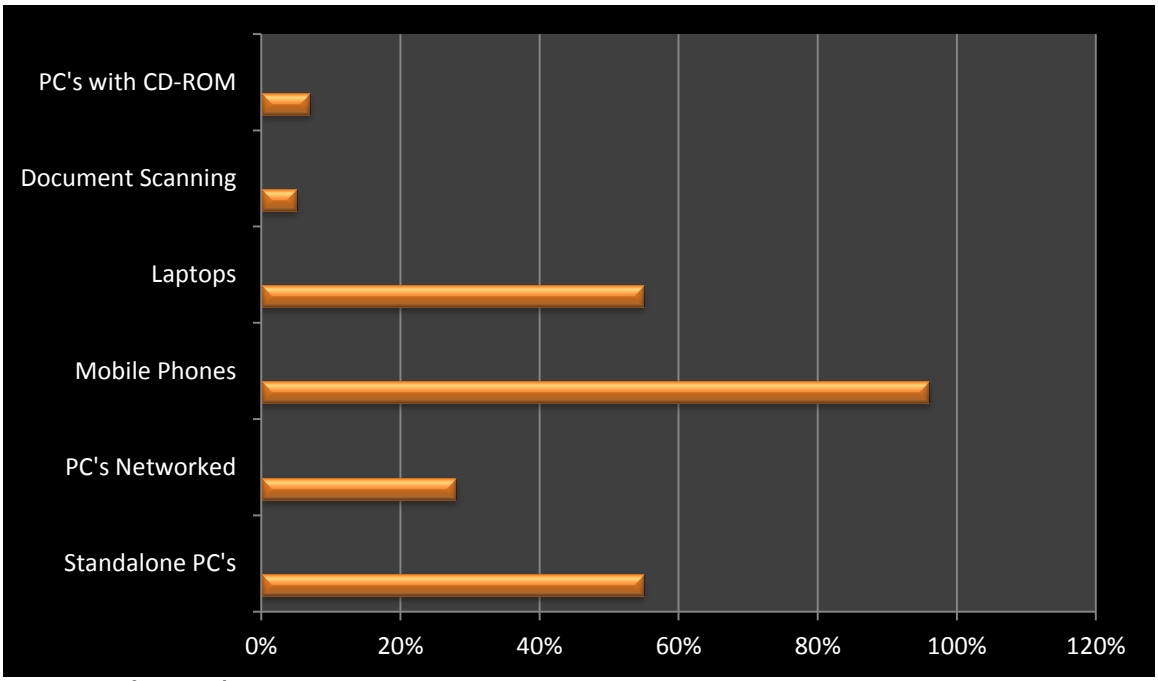


Figure 2: IT hardware – project level

3- The use of software

The survey revealed that a majority of contractors used mainstream general office application software for word processing, spreadsheets and desktop publishing. A variety of specialist application industry software was used for document control, cost control and reporting, cost planning, estimating, and cash flow forecasting, the most popular being identified in Table 1. Advanced software applications such as those based on knowledge-based expert systems and simulation were rarely used. (CAD) software (AutoCAD) was found to be used by 15% of contractors. These were primarily the larger contractors with turnovers8 in excess of $A400 million. The lack of advanced IT applications appears to be alarming, especially as the role of the contractor is changing with the increase in the incidence of design and construct projects. At a project level, the use of software packages was limited to office administration, cost control and reporting, and document control.

Table 1: Most popular software packages

Function	Software package
Office administration	Microsoft Office Professional
Estimating and cost planning	Build soft
Cost control and reporting	Jobpac/Client/Cheops
Cash flow forecasting	Fin cash/Excel
Planning and scheduling	Microsoft/Project/Primavera/Micro
Document control	Jobpac/Client
Computer-aided design	AutoCAD

Typically, software was upgraded when a modified version of the package became available.
Many organizations were reluctant to introduce more advanced software applications, primarily because of the anticipated additional training required and therefore the loss of productivity.

Electronic communication and information transfer
The extent of electronic communication and information transfer was considerably limited to the organizational level for each contractor sampled (Fig. 3). The telephone and fax were undoubtedly the most popular forms of information interchange used by contractors at both levels. While phone conferencing (55%), and fax modems (43%) were frequently used, video conferencing was used by only 15% of contractors and e-mail by 26% of contractors. Primarily these electronic links were used for interstate and overseas communication between offices and used by the larger contractors with a turnover in excess of $A400 million.
Communication with subcontractors, suppliers and consultants via electronic means such as fax modems, e-mail, video conferencing and phone conferencing did not occur. Moreover, the use of external information sources via on-line services and the internet were extremely limited.

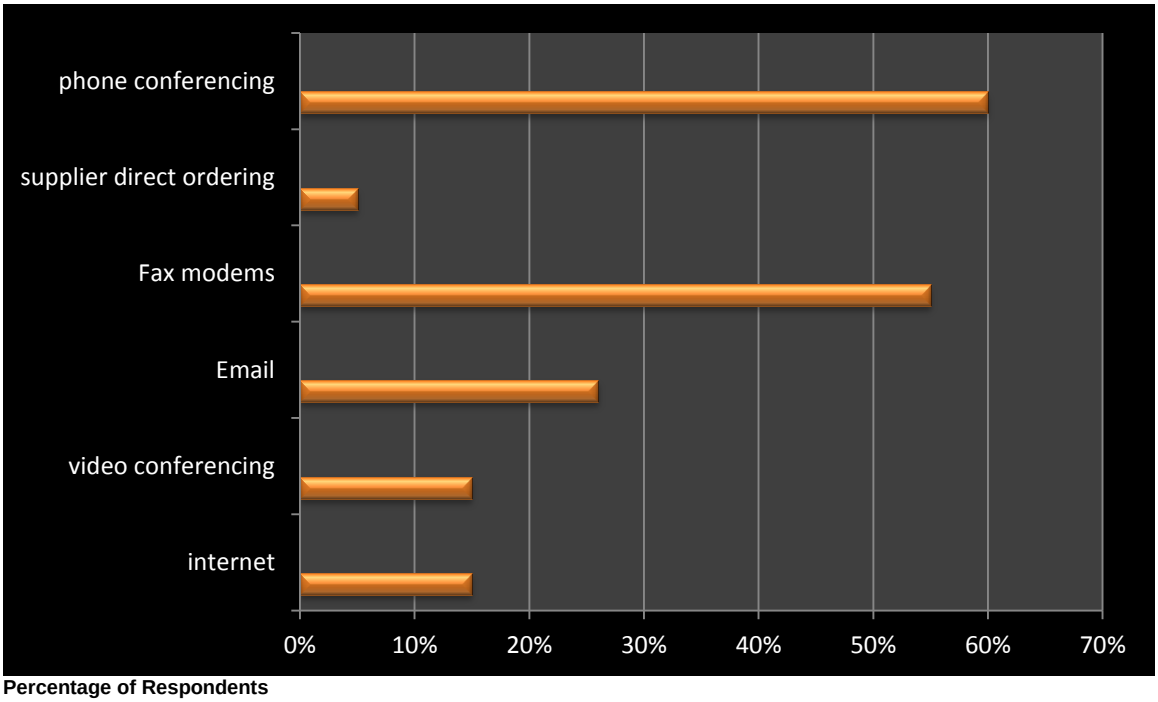


Figure 3: Communication and information sources – organizational level

4- Problems and benefits associated with the implementation of IT:

Each contractor identified the major problems which they had experienced with the implementation of IT (hardware and software). Figure 4 indicates that the most common problems experienced with IT were: the lack of systems knowledge, with 68% of contractors perceiving this to be a problem; and the lack of training associated with its implementation, perceived to be problem with 62% of contractors. Implicitly contractors were unaware of the impact that potential advanced applications of IT could have on the organization's competitive position. This was found to be the case with more than 50% of contractors using highly specialized planning and scheduling software for simply doing bar charts. This lack of systems knowledge of the particular software meant that in a number of cases planning and scheduling of construction projects was undertaken externally by consultants.

The security of hardware was perceived to be a problem with 28% of contractors. Typically, hardware applications were kept to a minimum on site because of the increasing incidence of theft that had been experienced. This appears to be the main reason for the differential between the use of IT at the organizational and project levels. Environmental conditions were not considered to be problem at the organizational level, but at the project level, keeping hardware away from dust was seen to be a problem for 30% of contractors. Lack of support for users was considered to be a problem for 26% of contractors, all of whom experienced problems relating to a lack of systems knowledge and training.

Generally the respondent being interviewed held a senior position within their organization.

Consequently, it was difficult to ascertain that a lack of management commitment was seen to be a problem for IT implementation. However, there was a consensus amongst respondents interviewed toward the lack of management commitment for the internet, e-mail, and advanced applications such as knowledge-based expert systems and simulation, inasmuch as the respondents (management) lacked education in their usefulness.

Several contractors commented that it was difficult to keep up to date with the advancement and innovations in both technological and software developments, expressing their concern that the economic climate of the industry did not enable them to devote the necessary time and money to follow advancements in IT.

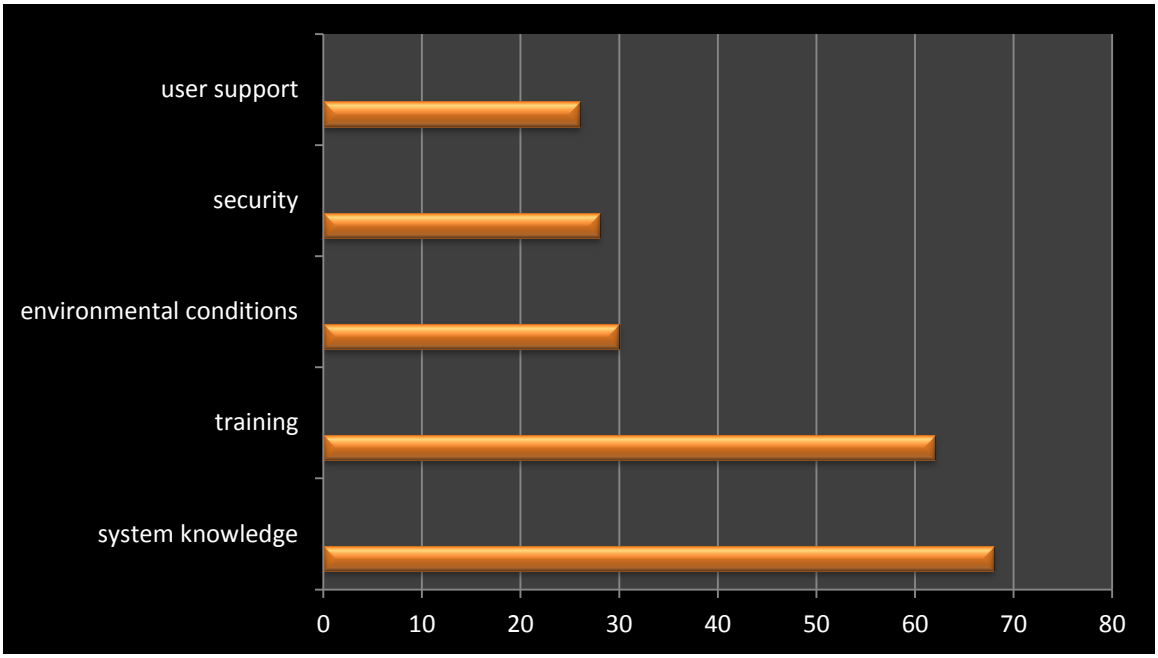


Figure 4: Problems experienced with IT

Hampson and Tatum (1994) suggest that contractors are traditionally accustomed to intense price competition and focus on the bottom line, thus facing difficulties in justifying investments in advanced technology. Other problems mentioned by respondents during the interviews included: considerable reluctance on the part of some employees, who through lack of systems knowledge and understanding did not realize the benefits that may accrue from IT applications; and the loss of productivity from employees because they lacked a thorough understanding of the usefulness of IT.

In contrast to the problems associated with the implementation of IT, respondents identified that benefits were gained in: decision making; productivity; information storage, handling and transfer; and information access and retrieval. For each IT application identified, more than 70% of contractors experienced benefits from using IT.

It is well understood that the majority of construction practitioners are interested in construction management applications rather than what the IT tool can offer (Tucker & Mohamed, 1996). This was made quite clear during the interviews, by practitioners who do not consider IT tools as being an integral part of their decision-making processes.

SECTION 3
Decision making

2-3-1 Some Definitions of Decision Making

- Decision making is the study of identifying and choosing alternatives based on the values and preferences of the decision maker. Making a decision implies that there are alternative choices to be considered, and in such a case we want not only to identify as many of these alternatives as possible but to choose the one that has the highest probability of success or effectiveness best fits with our goals, desires, lifestyle, values, and so on.
- Decision making is the process of sufficiently reducing uncertainty and doubt about alternatives to allow a reasonable choice to be made from among them. This definition stresses the information-gathering function of decision making. It should be noted here that uncertainty is reduced rather than eliminated. Very few decisions are made with absolute certainty because complete knowledge about all the alternatives is seldom possible. Thus, every decision involves a certain amount of risk. If there is no uncertainty, you do not have a decision; you have an algorithm--a set of steps or a recipe that is followed to bring about a fixed result.

2-3-2 Kinds of Decisions

There are several basic kinds of decisions.

- Decisions wither. This is the yes/no, either/or decision that must be made before we proceed with the selection of an alternative. Should I buy a new TV? Should I travel this summer? Decisions whether are made by weighing reasons pro and con. The PMI technique discussed in the next chapter is ideal for this kind of decision.

  It is important to be aware of having made a decision whether, since too often we assume that decision making begins with the identification of alternatives, assuming that the decision to choose one has already been made.
- Decisions which. These decisions involve a choice of one or more alternatives from among a set of possibilities, the choice being based on how well each alternative measures up to a set of predefined criteria.
- Contingent decisions. These are decisions that have been made but put on hold until some condition is met.

For example, I have decided to buy that car if I can get it for the right price; I have decided to write that article if I can work the necessary time for it into my schedule. OR even, we'll take the route through the valley if we can control the ridge and if we detect no enemy activity to the north.

2-3-3 The Components of Decision Making

The Decision Environment

Every decision is made within a decision environment, which is defined as the collection of information, alternatives, values, and preferences available at the time of the decision. An ideal decision environment would include all possible information, all of it accurate, and every possible alternative. However, both information and alternatives are constrained because the time and effort to gain information or identify alternatives are limited. The time constraint simply means that a decision must be made by a certain time. The effort constraint reflects the limits of manpower, money, and priorities. (You wouldn't want to spend three hours and half a tank of gas trying to find the very best parking place at the mall.) Since decisions must be made within this constrained environment, we can say that the major challenge of decision making is uncertainty, and a major goal of decision analysis is to reduce uncertainty. We can almost never have all information needed to make a decision with certainty, so most decisions involve an undeniable amount of risk.

The fact that decisions must be made within a limiting decision environment suggests two things. First, it explains why hindsight is so much more accurate and better at making decisions that foresight. As time passes, the decision environment continues to grow and expand. New information and new alternatives appear--even after the decision must be made. Armed with new information after the fact, the hind slighter can many times look back and make a much better decision than the original maker, because the decision environment has continued to expand.

The second thing suggested by the decision-within-an-environment idea follows from the above point. Since the decision environment continues to expand as time passes, it is often advisable to put off making a decision until close to the deadline. Information and alternatives continue to grow as time passes, so to have access to the most information and to the best alternatives, do not make the decision too soon. Now, since we are dealing with real life, it is obvious that some alternatives might no longer be available if too much time passes; that is a tension we have to work with, a tension that helps to shape the cutoff date for the decision.

Delaying a decision as long as reasonably possible, then, provides three benefits:

- The decision environment will be larger, providing more information. There is also time for more thoughtful and extended analysis.
- New alternatives might be recognized or created. Version 2.0 might be released.

- The decision maker's preferences might change. With further thought, wisdom, and maturity, you may decide not to buy car X and instead to buy car Y

Delaying a decision involves several risks:

- As the decision environment continues to grow, the decision maker might become overwhelmed with too much information and either makes a poorer decision or else face decision paralysis.
- Some alternatives might become unavailable because of events occurring during the delay. In a few cases, where the decision was between two alternatives (attack the pass or circle around behind the large rock), both alternatives might become unavailable, leaving the decision maker with nothing. And we have all had the experience of seeing some amazing bargain only to hesitate and find that when we go back to buy the item, it is sold out.
- In a competitive environment, a faster rival might make the decision and gain advantage. Another manufacturer might bring a similar product to market before you (because that company didn't delay the decision) or the opposing army might have seized the pass while the other army was "letting the decision environment grow."

2-3-4 Approaches to Decision Making

There are two major approaches to decision making in an organization, the authoritarian method in which an executive figure makes a decision for the group and the group method in which the group decides what to do.

1. Authoritarian. The manager makes the decision based on the knowledge he can gather. He then must explain the decision to the group and gain their acceptance of it. In some studies, the time breakdown for a typical operating decision is something like this:

Make decision, 5 min.; explain decision, 30 min.; gain acceptance, 30 min.

2. Group. The group shares ideas and analyses, and agrees upon a decision to implement. Studies show that the group often has values, feelings, and reactions quite different from those the manager supposes they have. No one knows the group and its tastes and preferences as well as the group itself. And, interestingly, the time breakdown is something like this:

Group makes decision, 30 min.; explain decision, 0 min.; gain acceptance, 0 min.

Clearly, just from an efficiency standpoint, group decision making is better. More than this, it has been shown many times that people prefer to implement the ideas they themselves think of. They will work harder and more energetically to implement their own idea than they would to implement an idea imposed on them by others. We all have a love for our own ideas and solutions, and we will always work harder on a solution supported by our own vision and our own ego than we will on a solution we have little creative involvement with.

There are two types of group decision making sessions. First is free discussion in which the problem is simply put on the table for the group to talk about. For example, Joe has been offered a job change from shift supervisor to maintenance foreman. Should he take the job?

The other kind of group decision making is developmental discussion or structured discussion. Here the problem is broken down into steps, smaller parts with specific goals. For example, instead of asking generally whether Joe should take the job, the group works on sub questions: What are Joe's skills? What skills does the new job require? How does Joe rate on each of the skills required? Notice that these questions seek specific information rather than more general impressionistic opinions.

Developmental discussion (1) insures systematic coverage of a topic and (2) insures that all members of the group are talking about the same aspect of the problem at the same time.

2-3-5 Some Decision Making Strategies

As you know, there are often many solutions to a given problem, and the decision maker's task is to choose one of them. The task of choosing can be as simple or as complex as the importance of the decision warrants, and the number and quality of alternatives can also be adjusted according to importance, time, and resources and so on. There are several strategies used for choosing. Among them are the following:

1. Optimizing. This is the strategy of choosing the best possible solution to the problem, discovering as many alternatives as possible and choosing the very best. How thoroughly optimizing can be done is dependent on

A. importance of the problem
B. time available for solving it
C. cost involved with alternative solutions
D. availability of resources, knowledge
E. personal psychology, values

Note that the collection of complete information and the consideration of all alternatives is seldom possible for most major decisions, so that limitations must be placed on alternatives.

2. Satisfying. In this strategy, the first satisfactory alternative is chosen rather than the best alternative. If you are very hungry, you might choose to stop at the first decent looking restaurant in the next town rather than attempting to choose the best restaurant from among all (the optimizing strategy). The word satisfying was coined by combining satisfactory and sufficient. For many small decisions, such as where to park, what to drink, which pen to use, which tie to wear, and so on, the satisfying strategy is perfect.

3. Maxim ax. This stands for "maximize the maximums." This strategy focuses on evaluating and then choosing the alternatives based on their maximum possible payoff. This is sometimes described as the strategy of the optimist, because favorable outcomes and high potentials are the areas of concern. It is a good strategy for use when risk taking is most acceptable, when the go-for-broke philosophy is reigning freely.

4. Maximum. This stands for "maximize the minimums." In this strategy, that of the pessimist, the worst possible outcome of each decision is considered and the decision with the highest minimum is chosen. The Maximum orientation is good when the consequences of a failed decision are particularly harmful or undesirable. Maximum concentrates on the salvage value of a decision, or of the guaranteed return of the decision. It's the philosophy behind the saying, "A bird in the hand is worth two in the bush."

Quiz shows exploit the uncertainty many people feel when they are not quite sure whether to go with a maxima strategy or a maximum one: "Okay, Mrs. Freon, you can now choose to take what you've already won and go home, or risk losing it all and find out what's behind door number three."

Example: I could put my $10,000 in a genetic engineering company, and if it creates and patents new bacteria that help plants resist frost, I could make $50,000. But I could also lose the whole $10,000. But if I invest in a soap company, I might make only $20,000, but if the company goes completely broke and gets liquidated, I'll still get back $7,000 of my investment, based on its book value.

Example: its fourth down and ten yards to go on your twenty yard line. Do you go for a long pass or punt? Maxima would be to pass; Maximum would be to punt.

2-3-6 Decision Making Procedure:-

As you read this procedure, remember our discussion earlier about the recursive nature of decision making. In a typical decision making situation, as you move from step to step here, you will probably find yourself moving back and forth also.

1. Identify the decision to be made together with the goals it should achieve. Determine the scope and limitations of the decision. Is the new job to be permanent or temporary or is that not yet known (thus requiring another decision later)? Is the new package for the product to be put into all markets or just into a test market? How might the scope of the decision be changed--that is, what are its possible parameters?

When thinking about the decision, be sure to include a clarification of goals: We must decide whom to hire for our new secretary, one who will be able to create an efficient and organized office. Or, We must decide where to go on vacation, where we can relax and get some rest from the fast pace of society.

2.Get the facts. But remember that you cannot get all the facts. Get as many facts as possible about a decision within the limits of time imposed on you and your ability to process them, but remember that virtually every decision must be made in partial ignorance. Lack of complete information must not be allowed to paralyze your decision. A decision based on partial knowledge is usually better than not making the decision when a decision is really needed. The proverb that "any decision is better than no decision," while perhaps extreme, shows the importance of choosing. When you are racing toward a bridge support, you must decide to turn away to the right or to the left. Which way you turn is less important than the fact that you do indeed turn.

As part of your collection of facts, list your feelings, hunches, and intuitive urges. Many decisions must ultimately rely on or be influenced by intuition because of the remaining degree of uncertainty involved in the situation.

Also as part of your collection of facts, consult those who will be affected by and who will have to implement your decision. Input from these people not only helps supply you with information and help in making the decision but it begins to produce the acceptance necessary in the implementers because they feel that they are part of the decision making process. As Russell Ackoff noted in The Art of Problem Solving, not consulting people involved in a decision is often perceived as an act of aggression.

3. Develop alternatives. Make a list of all the possible choices you have, including the choice of doing nothing. Not choosing one of the candidates or one of the building sites is in itself a decision. Often a non decision is harmful as we mentioned above--not choosing to turn either right or left is to choose to drive into

the bridge. But sometimes the decision to do nothing is useful or at least better than the alternatives, so it should always be consciously included in the decision making process.

Also be sure to think about not just identifying available alternatives but creating alternatives that don't yet exist. For example, if you want to choose which major to pursue in college, think not only of the available ones in the catalog, but of designing your own course of study.

4.Rate each alternative. This is the evaluation of the value of each alternative. Consider the negative of each alternative (cost, consequences, problems created, time needed, etc.) and the positive of each (money saved, time saved, added creativity or happiness to company or employees, etc.). Remember here that the alternative that you might like best or that would in the best of all possible worlds be an obvious choice will, however, not be functional in the real world because of too much cost, time, or lack of acceptance by others.

Also don't forget to include indirect factors in the rating. If you are deciding between machines X, Y, and Z and you already have an employee who knows how to operate machine Z, that fact should be considered. If you are choosing an investigative team to send to Japan to look at plant sites and you have very qualified candidates A, B, and C, the fact that B is a very fast typist, a superior photographer or has some other side benefit in addition to being a qualified team member, should be considered. In fact, what you put on your hobbies and interests line on your resume can be quite important when you apply for a job just because employers are interested in getting people with a good collection of additional abilities.

5. Rate the risk of each alternative. In problem solving, you hunt around for a solution that best solves a particular problem, and by such a hunt you are pretty sure that the solution will work. In decision making, however, there is always some degree of uncertainty in any choice. Will Bill really work out as the new supervisor? If we decide to expand into Canada, will our sales and profits really increase? If we let Jane date Fred at age fifteen, will the experience be good? If you decide to marry person X or buy car Y or go to school Z, will that be the best or at least a successful choice?

Risks can be rated as percentages, ratios, rankings, grades or in any other form that allows them to be compared. See the section on risk evaluation for more details on risking.

6. Make the decision. If you are making an individual decision, apply your preferences (which may take into account the preferences of others). Choose the

path to follow, whether it includes one of the alternatives, more than one of them (a multiple decision) or the decision to choose none.

And of course, don't forget to implement the decision and then evaluate the implementation, just as you would in a problem solving experience.

One important item often overlooked in implementation is that when explaining the decision to those involved in carrying it out or those who will be affected by it, don't just list the projected benefits: frankly explain the risks and the drawbacks involved and tell why you believe the proposed benefits outweigh the negatives. Implementers are much more willing to support decisions when they (1) understand the risks and (2) believe that they are being treated with honesty and like adults.

Remember also that very few decisions are irrevocable. Don't cancel a decision prematurely because many new plans require time to work--it may take years for your new branch office in Paris to get profitable--but don't hesitate to change directions if a particular decision clearly is not working out or is being somehow harmful. You can always make another decision to do something else.

2-3-7 IT in decision making

1- Introduction

The dependency on information technology (IT) has increased progressively for organizations as a strategically important competitive advantage. If planned, developed, and managed properly, IT can bring about greater efficiency in organizational operations, better working environments, and effective decision-making processes Therefore; many organizations are trying to catch up the development gap with the industry by means of technology acquisition. Technology acquisition process is essential in developing a good management information system for an organization. Many IT projects have failed because of poor design planning, false selection of the development, and a lack of follow up on key milestones addressed in the acquisition process. This research paper discusses proper steps and key factors in planning, acquiring, developing, and reviewing the IT acquisition.

2- Decision Making Strategy in IT Acquisition

The term ‘acquisition’ refers to all the stages from buying, introducing, applying, adopting, adapting, localizing, and developing through to diffusion. The acquisition issue is multifaceted for various reasons including large variety of IT applications, rapid change in new technology, and involvement of several business entities in the organization. The set of processes for the build, lease, or buy decision must be identical for every instance or business opportunity that arises. The processes determine the strategic value and potential savings of the proposed project, as well as factors like business transformation versus drive for competitive advantage.

The range of IT applications stipulates a variety of advance approaches. The application itself can be acquired by in-house development, buy, lease, outsource, or any combination of two. For example, a company website can be developed in-house with HTML, JAVA, or any other web programming languages. Some other alternatives would be implementing commercial web development packages, leasing a web application from application service providers (ASPs) with some monthly or yearly fees, or purchasing on-demand application from a vendor. If we look at larger applications such as enterprise-wide application, building such system would require more extensive integration with existing information systems such as corporate databases, intranets, enterprise resource planning (ERP), and other application programs. Thus, implementing accurate IT application involves critical control process that need to be in place in order to support and protect company’s best-interest.

For an organization, the major reason of acquiring IT applications is to effectively and efficiently support one or more business process. Prior to the acquisition process, the detail requirements of the process should have already been identified clearly. More importantly, the business objectives should be identified for the solution being sought and the management decision whether building, leasing, or buying the IT application should consider a value-versus-risk matrix to determine which options can be applied. Both IT auditors and corporate management should evaluate offerings over the long term and compare the "trickling" investment over time to the one-time cost of buying and implementing a system. Moreover, this technology acquisition process requires an extensive evaluation considering the system requirements, feasibility analysis, and risk management assessment. Therefore, the decision here is not as easy as to make, lease,-or-buy the solutions, but then supposed if we decide to buy, the next question should be, “how to create company’s competitive advantages through such decision?” Decision making science requires that management understand the

fundamentals of how IS acquisition decisions related to management information system (MIS) are made. What are the expectations and how they will be achieved? The value of using managerial sciences to approach this decision is to understand the motivation drivers that justify MIS and IT acquisition decision.

3- IT Acquisition Process

The acquisition process should involve the identification and analysis of alternative solutions that are each compared with the established business requirements. The decision making to acquire a typical IT application primarily consists of the following stages:

Stage1:

Identifying, planning and justifying the information system requirements

One of the most essential assessments in decision making process is identifying the business objective after first knowing the problems being solved. The management should primarily identify the business processes involved in the organization. Information systems are usually developed as enablers of the business processes. The first phase of the acquisition process should align the business process with the company objectives and the business plan. Note that specific process may need to be prioritized to fully obtain the benefits of IT implementation. Moreover, each process should be carefully analyzed to ensure that it will have the certain functionality to meet the requirements of the business process and the users, as well as the benefits which can be justified with its cost.

Another big challenge in the procuring information systems is to define the system requirements. System requirements describe the objectives of the system. They define the problem to be solved, business, and system goals, system process to be accomplished, user expectations, and the deliverables for the system. Furthermore, the requirements should incorporate information about system inputs, information being processed in the system, and the information expected out the system. Each of this information should be clearly defined so that later gaps in requirements and expectations are avoided. Information system requirements can be gathered through interviews, questionnaires, existing system derivation, benchmarking with related system, prototyping, and Rapid Application Development (RAD)

The output of this step is a decision to go with specific application, timetable, budget, and system expectations. As Small Business Television (SBTV) Network Chief Operating Officer, Michael Kelley, explains, "Before we went and purchased

anything, we developed a business plan with a three-year outlook on what we thought we needed for the business. During the planning process, we knew that we were going to have to make a change within a three-year period. So that was an 'x' on the side of 'reasons not to buy, lease, or build in-house' because we now we might have to change our technology — probably in less than two years. As it turned out, it was about 14 months, and we had to make a lot of changes and reconfigurations.

Stage 2: Restructuring information system architecture

With the regards of system analysis approach, an organization which is still in the progress of acquiring IT should remodel its information system (IS) architecture. IS architecture is the conceptualization of how the organization's information objectives are met by the capabilities of the specific applications. This structural design however describes the flow of the information, data hierarchy, application functionality, technical feasibility, and organization architecture in the organization. The output from this phase should be a strategic planning level on how to develop specific application that meets the constrained defined by the IS architecture. Therefore, the application portfolio may be changed corresponding to this structure.

Stage 3: Identifying development alternative

There are several options in procuring software solutions. Some available alternatives are:

(1) Developing the system in-house,

(2) Off-the self solutions (Purchasing commercially available solution),

(3)Buying a custom made system for a vendor,

(4) Leasing software from an application service provider (ASP) or lease through utility computing (contracted development),

(5) Outsourcing a system from other companies

(6) Participating in auction, e-marketplace, or a public exchange (consortium)

(7)Use a combination of these listed options.

The consideration criteria and some critical factors upon various options will be discussed thoroughly later in the next section. While an organization is in the phase of deciding which alternative being selected, the management should carefully examine not only the advantages and disadvantages of each procuring option, but more importantly, the option must be best-fit with the organization business plan

that has been documented in the previous steps. Any system development project, whether the system is built in-house or purchased elsewhere, should support the company's business and IT strategy. The solution being sought associated with business requirements should align the business goals with IT strategy.

Stage 4: conducting feasibility analysis

As a part of the assessment in acquiring the solutions, a feasibility analysis is important to identify the constraints for each alternative from both technical and business perspective. Feasibility analysis incorporates the following categories:

Economic feasibility analysis provides cost-benefit justification with being regard to the expenses of a system, which include procurement, project-specific, start-up, and operational costs. Some cost examples are one-time and recurring cost, consultants, support staff, infrastructure, maintenance, training, and application software cost. This examination ensures that the solution won't exceed the budget limit as well as it increase the efficiency and better resource utilization.

Technical feasibility assessment analyzes the technical reasonableness of the proposed solution. Technical feasibility evaluates whether the company has the infrastructure and resources including hardware, software, and network capability to support the application. Meanwhile, it also assesses the consistency of the proposed system in terms of the technical requirements with the company technical resource. Therefore, this assessment guarantees the reliability and capacity for the future growth.

CHAPTER THREE

RESEARCH METHODOLOGY&QUESTIONNARE

3-1Research Methodology

3-1-1 Introduction

This chapter explains the research method and was designed questionnaire that was distributed for this study .The response was classified.

Distributed 50 questionnaires to contracting companies and consultants from different groups also years of experience and projects that have implemented, 40 of them responded from" consultants and contractors".

Sample size	Number of responses	Response rate
50	40	80%

3-1-2 Questionnaire Design

A questionnaire was conducted for the purpose of achieving the objective of the study. The questionnaire consisted of closed (multiple choice) and open-ended questions.

The questions Divided for four sections: section for general information on the status of the Company "company profile", the Department of information technology and its impact and the factors affected to it, also a section for management companies and the final section about the decision-making in the company .These sections were answered by the contracting companies and consultants.

3-1-3Analysis Survey

The data collected from the survey was statistically analyzed.

The statistical analysis for this study included descriptive analysis and test of hypothesis for the productivity factors in survey. Data from questionnaires were imported into SPSS to perform descriptive analysis and hypothesis testing. The outputs of the analysis are demonstrated in the next chapter.

3-2Results of Questionnaire

Questionnaire about the impact of information technologies can be used in the process of decision-making on the construction sector Master's degree program in construction management

Section I:

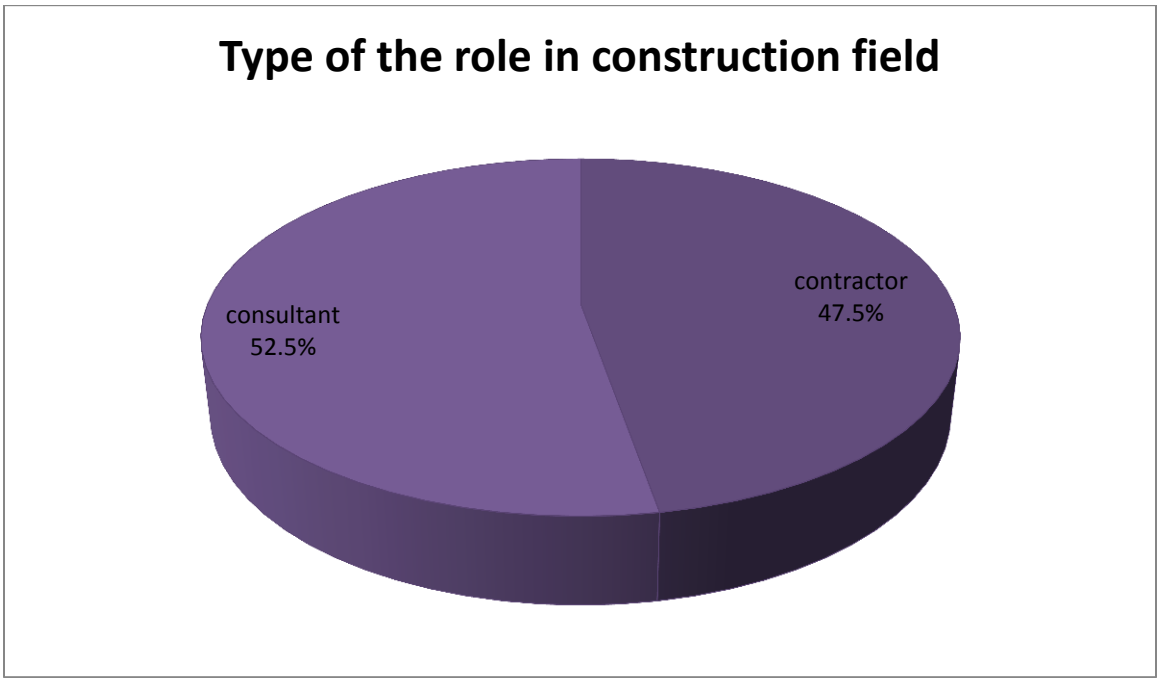
Information on practical experience

What the role that plays it in construction industry؟

In role that plays in the project found 52.5% consultants, contractors by 47.5%.

[Table 1-1]

	Frequency	Percent%
Contractor	19	47.5
Consultant	21	52.5

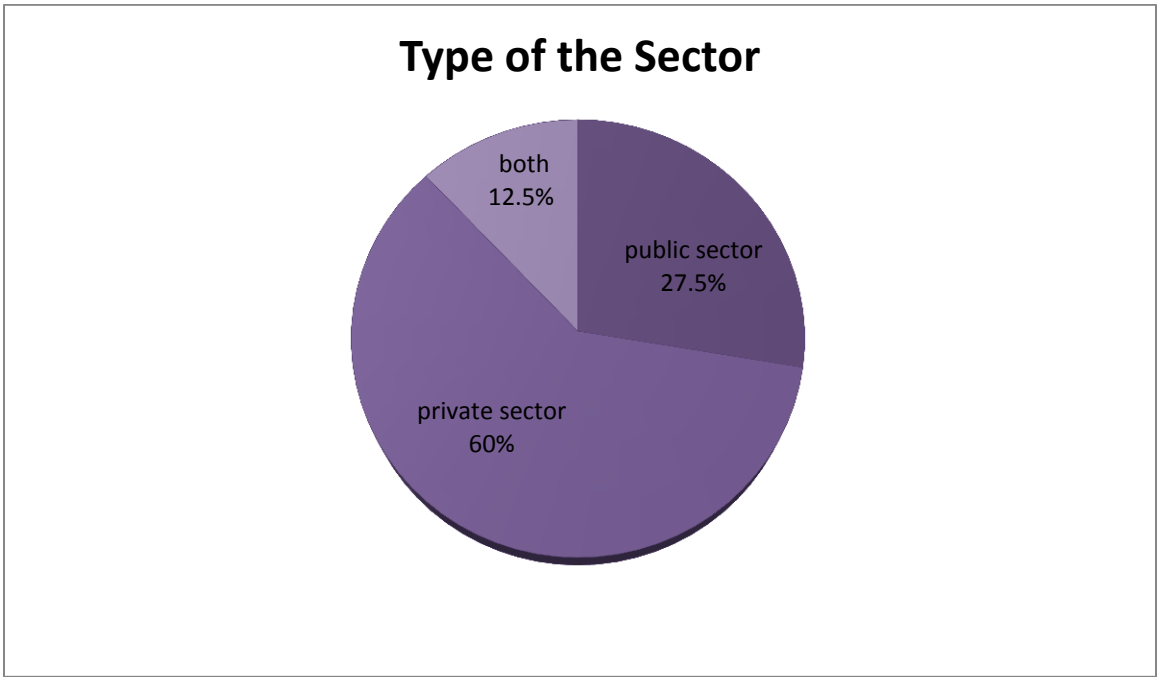


[Chart 1-1]

What is the sector in which they operate?
Found the private sector is the largest by 60%, followed by the public sector at 27.5% and the both sector accounted for 12.5%.

	Frequency	Percent%
Public sector	11	27.5
Private sector	24	60.0
Both them	5	12.5
Total	40	100.0

Table 1-2



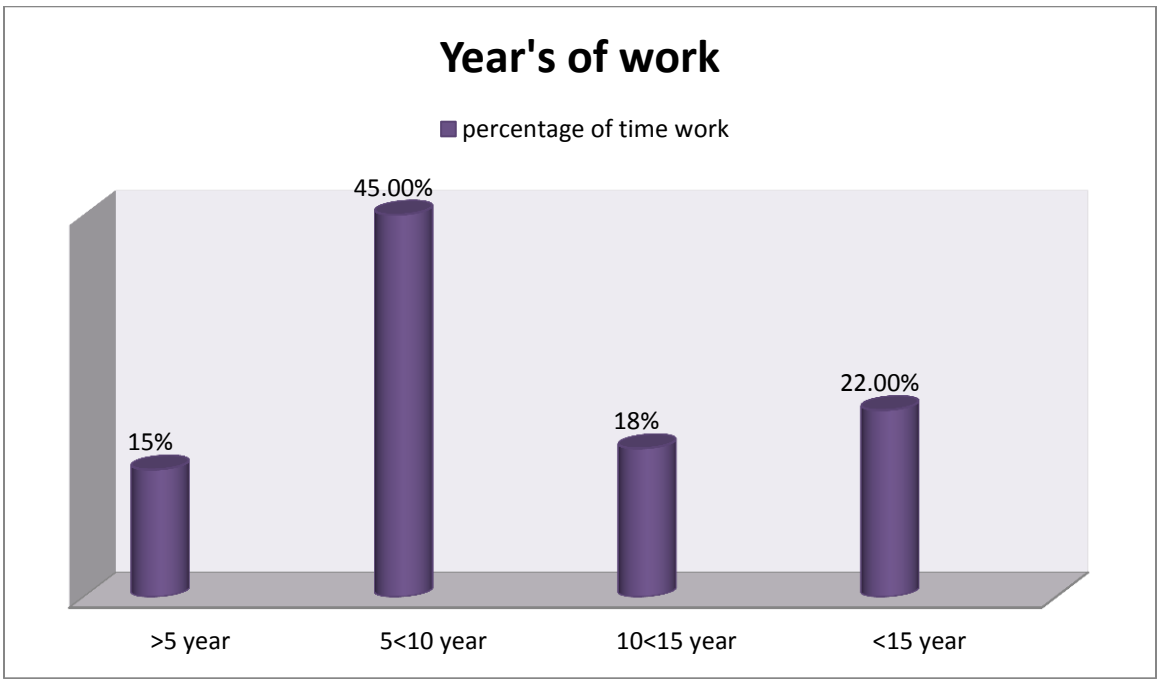
[Chart 1-2]

Time spent working in construction projects?

Most people their years experience between 6-10 years, this category constitutes 45% sequentially, followed people more than 15 years by 22.5%.

	Frequency	Percent%
5> years	6	15.0
10- 6 years	18	45.0
15- 11 years	7	17.5
>15	9	22.5
Total	40	100.0

[Table 1-3]

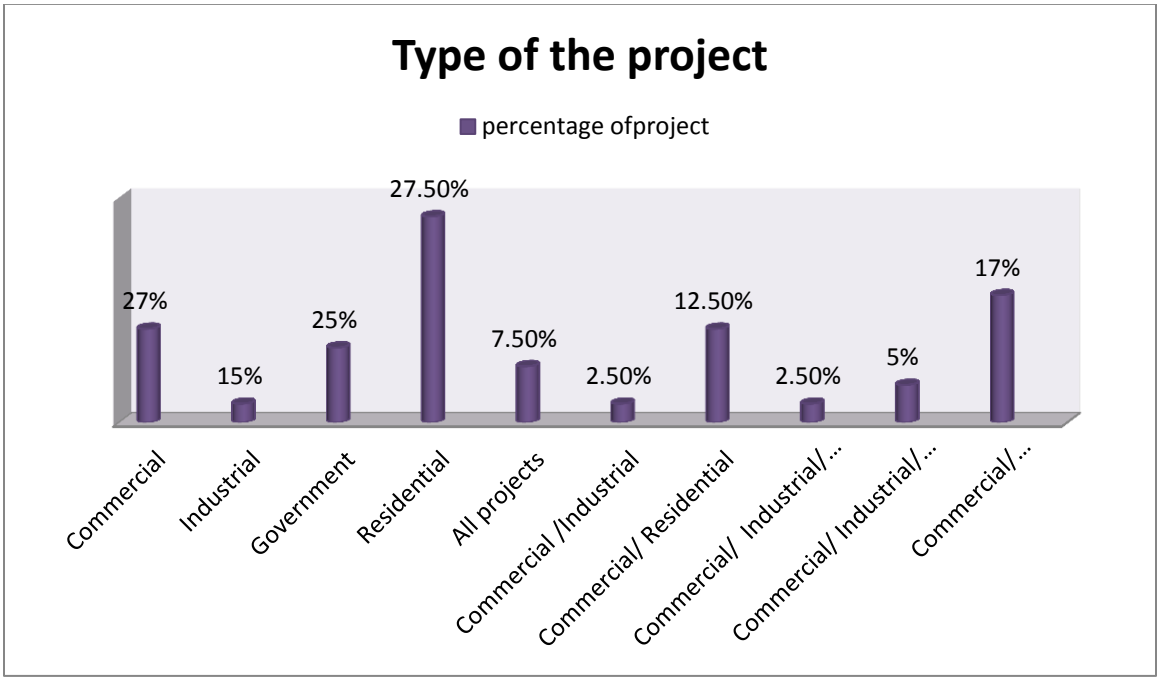


[Chart 1-3]

Type of construction projects undertaken by the company

	Frequency	Percent%
Commercial projects	5	12.5
Industrial projects	1	2.5
Government projects	4	10.0
Residential projects	11	27.5
All projects	3	7.5
Commercial /Industrial	1	2.5
Commercial/ Residential	5	12.5
Commercial/ Industrial/ Government	1	2.5
Commercial/ Industrial/ Residential	2	5.0
Commercial/ Government/ Residential	7	17.5
Total	40	100.0

[Table1-4]

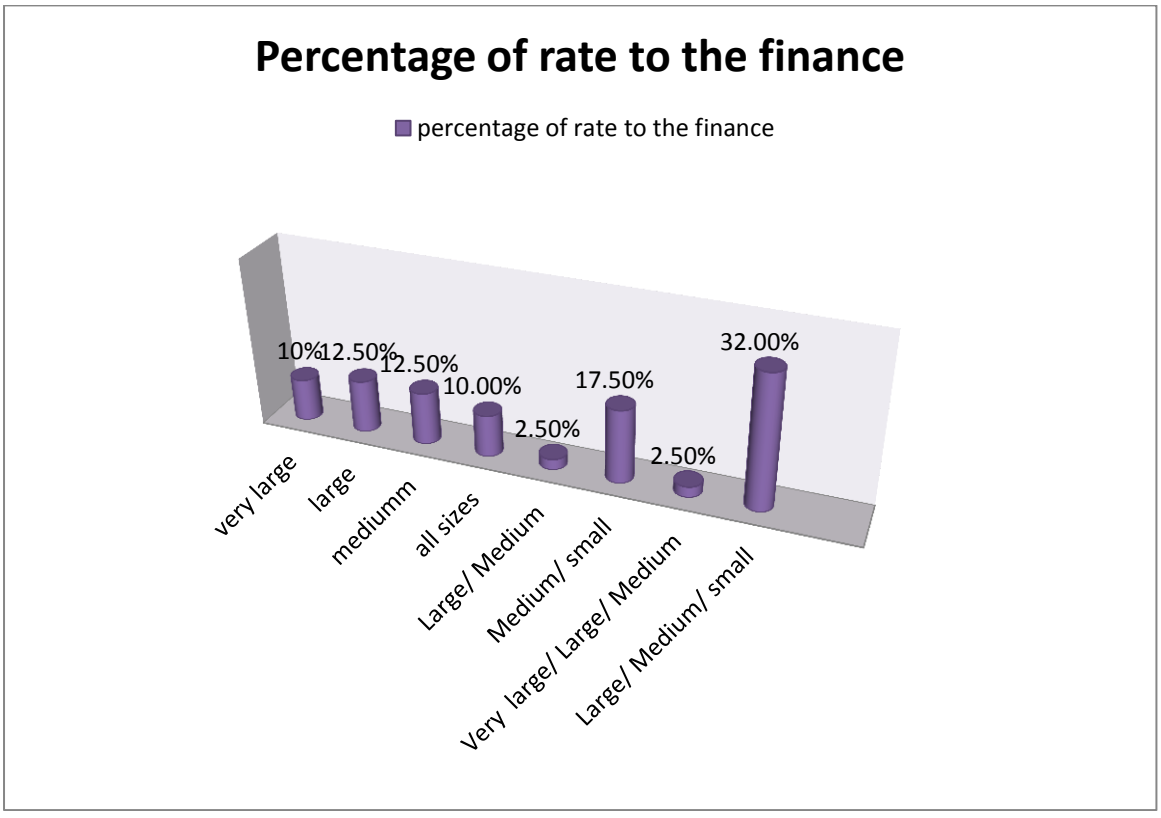


[Chart 1-4]

What is the size of finance projects that participated?

	Frequency	Percent%
Very large	4	10.0
Large	5	12.5
Medium	5	12.5
all sizes	4	10.0
Large/ Medium	1	2.5
Medium/ small	7	17.5
Very large/ Large/ Medium	1	2.5
Large/ Medium/ small	13	32.5
Total	40	100.0

Tabe1-5



[Chart 1-5]

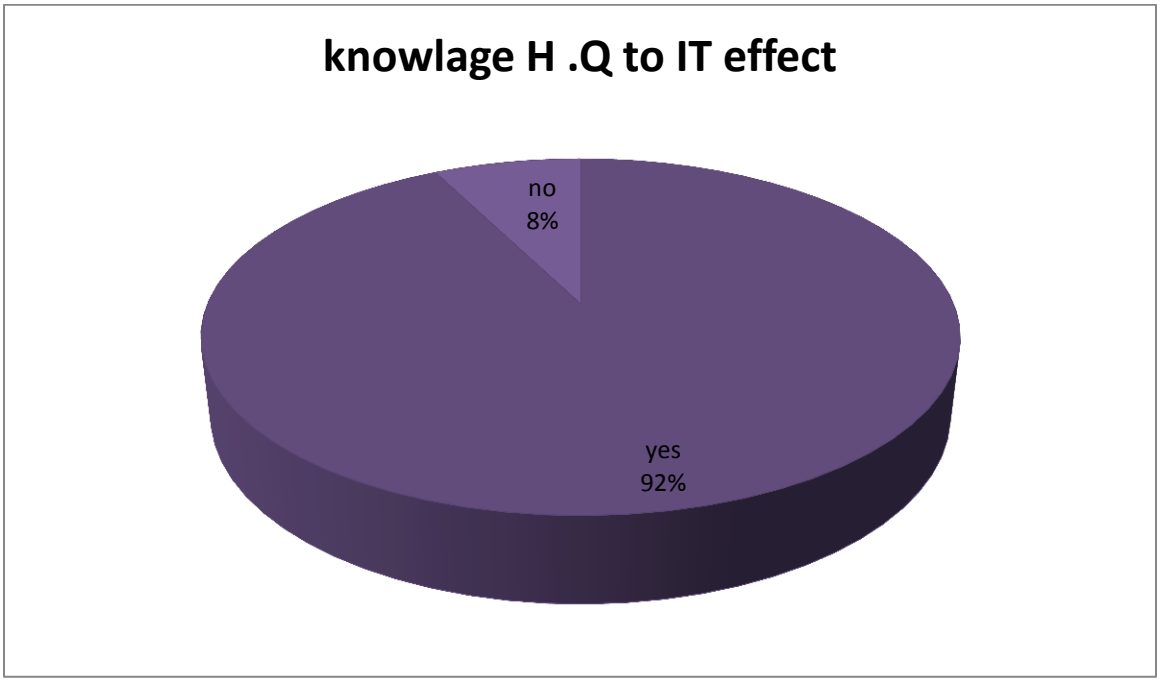
Section II

Information on the use of technology &Effect of IT

Is senior management aware of the effect of IT systems?
92% of top management recognizes the benefits of system of technique and impact of information in decision making.

	Frequency	Percent%
Yes	37	92.5
No	3	7.5
Total	40	100.0

[Table 2-1]



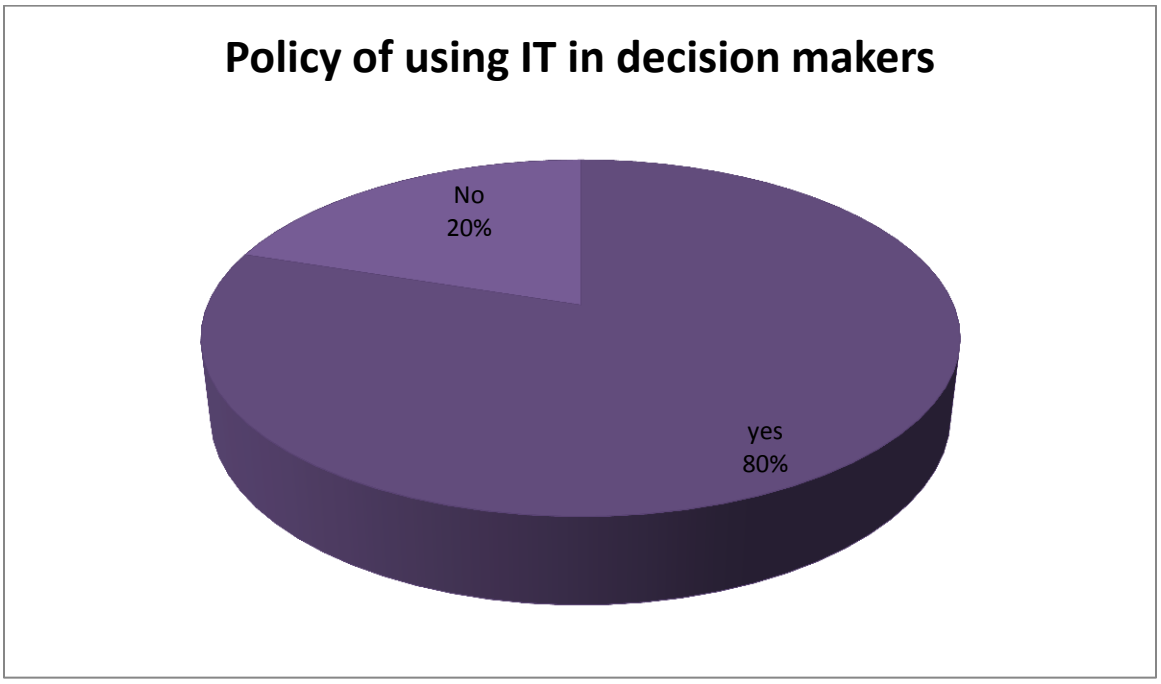
[Chart 2-1]

Do you have the institution's policy for the use of IT systems?

80% of the companies have policy of using IT systems in decision making, which is have an impact on decision making process.

	Frequency	Percent%
Yes	32	80.0
No	8	20.0
Total	40	100.0

[Table 2-2]



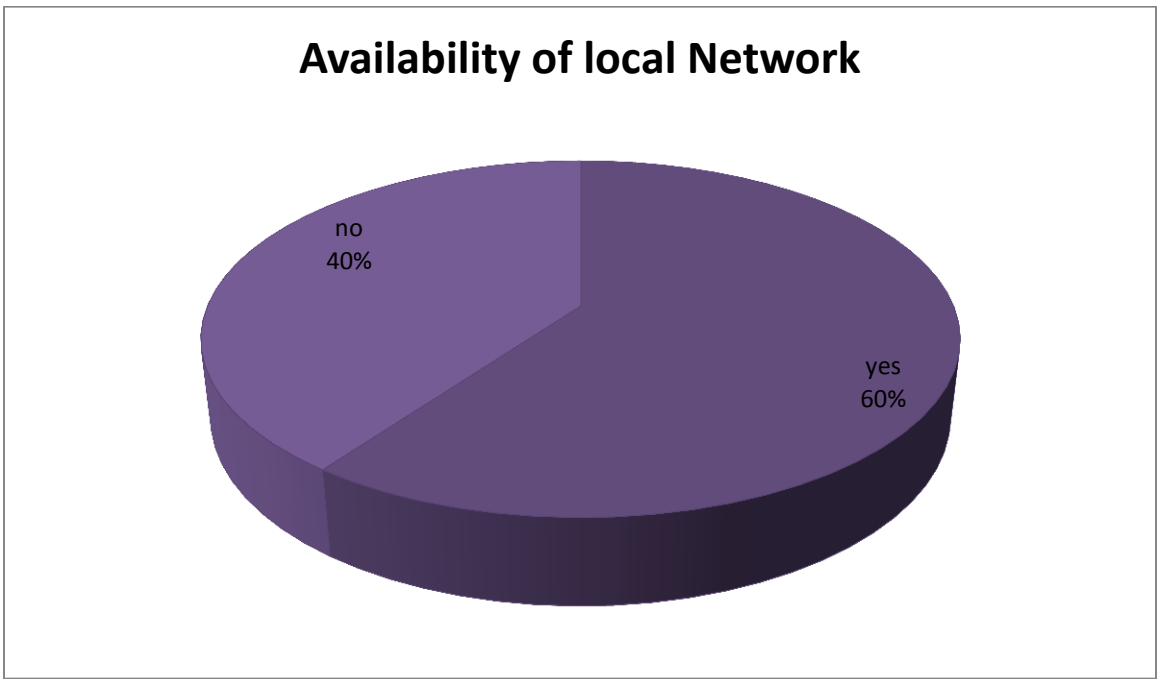
[Chart 2-2]

Does your organization have a local computer network?

Companies have internal network by 60%, and this supports decision-making within the company.

	Frequency	Percent
Yes	24	60.0
No	16	40.0
Total	40	100.0

[Table 2-3]



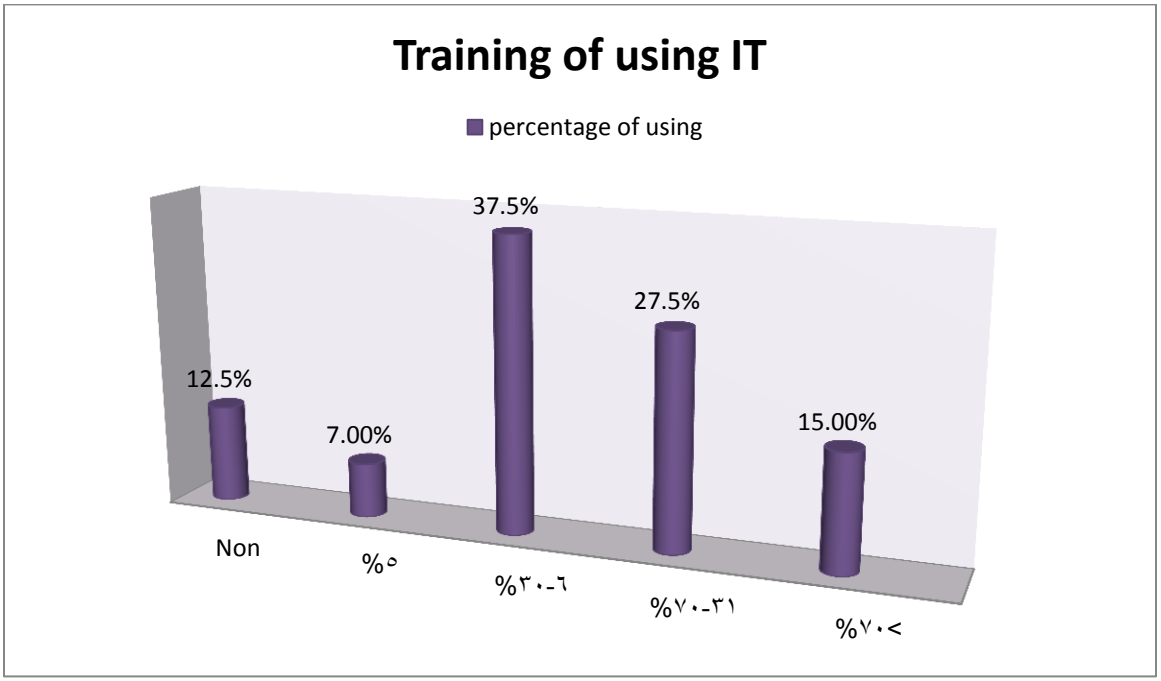
[Chart 2-3]

The extent of training on the use of technology programs within the company between employees.

More than 70% of the companies have training for using technology not exceed than 15%, is ratio it have negative effect in the decision-making, while fewer than 30% of companies have training by 38%.

	Frequency	Percent%
Non	5	12.5
5%	3	7.5
6-30%	15	37.5
31-70%	11	27.5
>70%	6	15.0
Total	40	100.0

[Table 2-4]



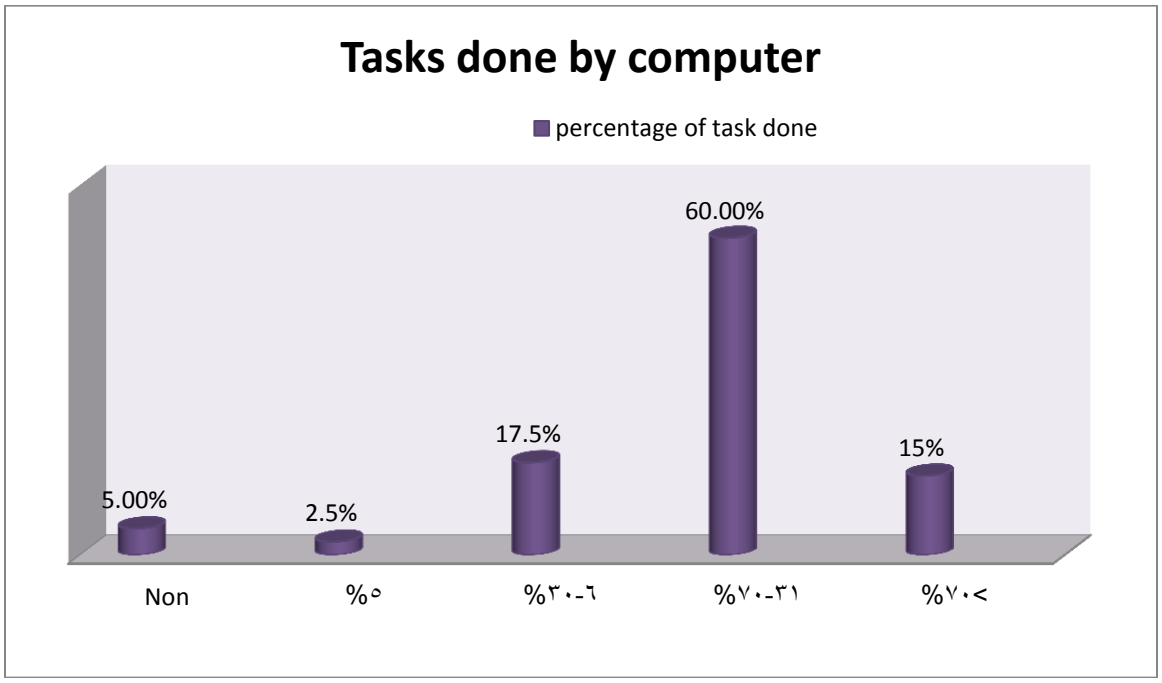
[Chart 2-4]

What percentage of tasks that are completed by computers in your organization?

70% of companies accomplish tasks for them by 60% through the computer which is impact on the speed of delivery and decision-making, while less than 70% of them use the computer by 15%.

	Frequency	Percent%
Non	2	5.0
5%	1	2.5
6-30%	7	17.5
31-70%	24	60.0
>70%	6	15.0
Total	40	100.0

[Table 2-5]

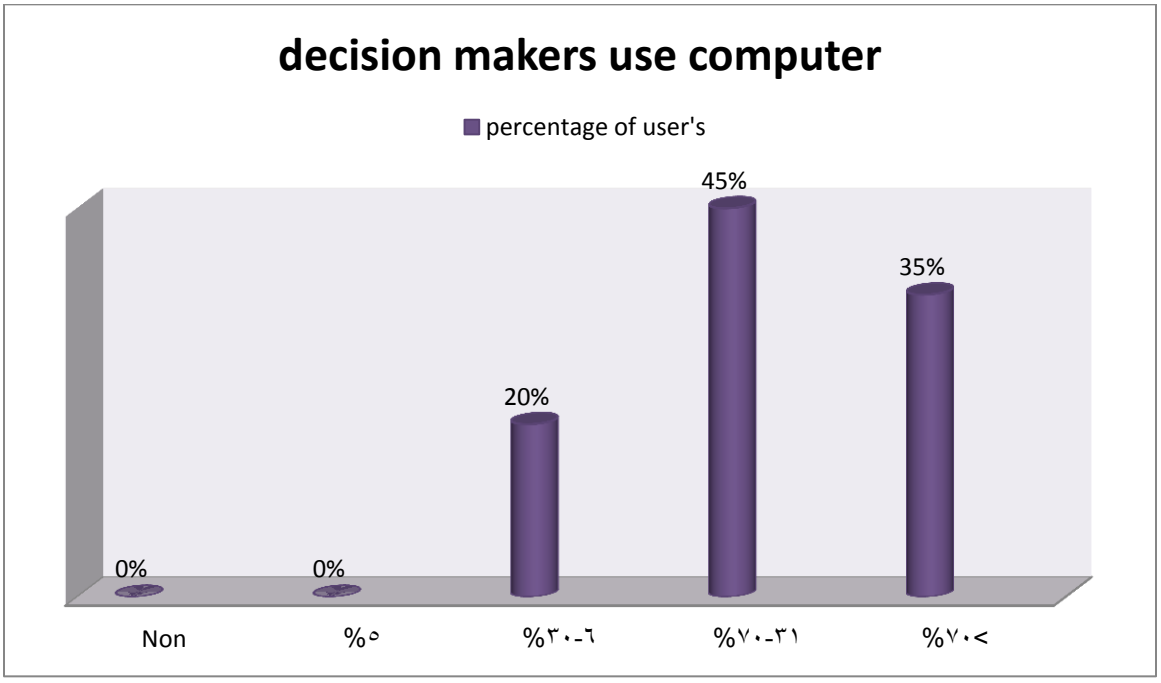


[Chart 2-5]

What percentage that who use the computer between decision-makers?
Less than 70% of decision makers in companies using Computer by 45%, more than 70% using it by 35%, this rate effective in decision-making.

Category	Percentage %
Non	0%
5%	0%
6-30%	20%
31-70%	45%
>70%	35%

[Table2-6]

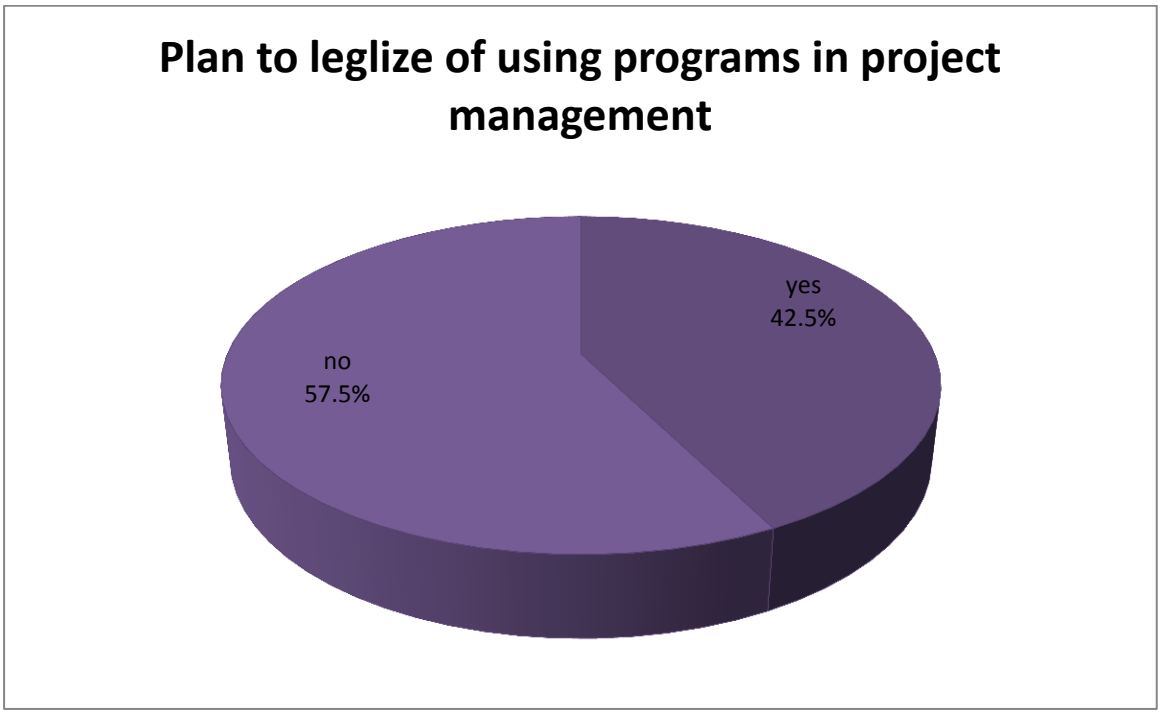


[Chart2-6]

Is there a plan to legalize the use of project management software?
43% of companies have plan to legalize the use of software project management, this Percent high and influential in decision-making.

	Frequency	Percent
Yes	17	42.5
No	23	57.5
Total	40	100.0

[Table2-7]

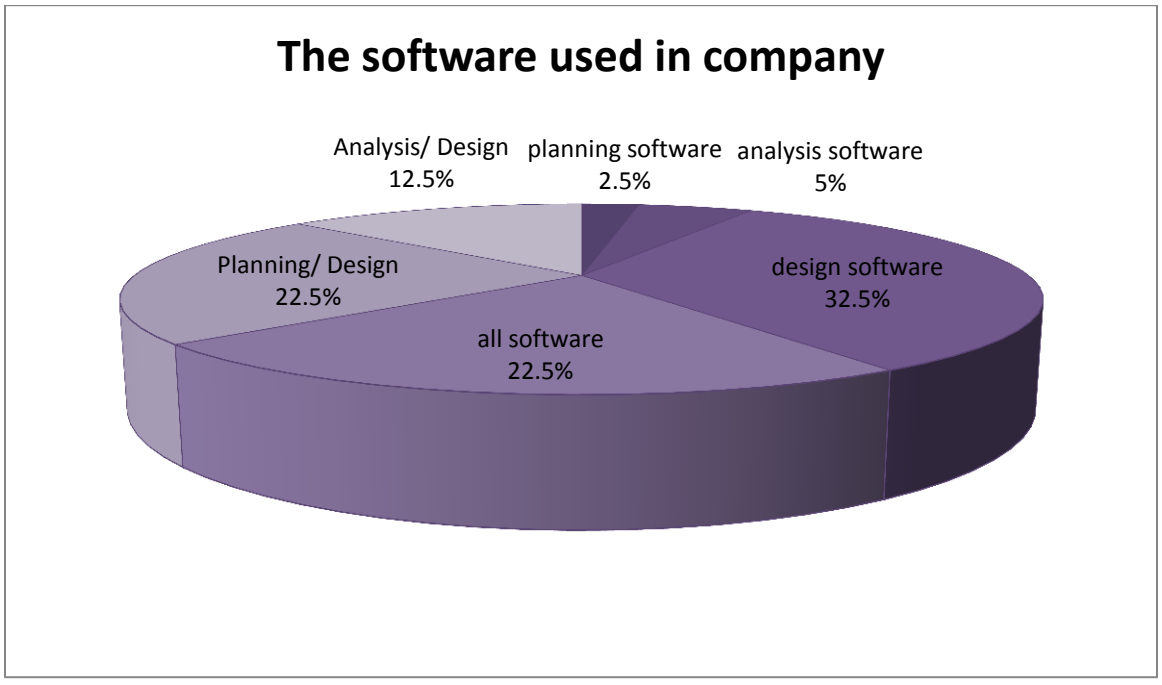


[Chart2-7]

Types of software used in the projects "can be set more than one answer"
Most programs that are use in people companies its design programs, although the planning and design programs using it by 22.5%.

	Frequency	Percent%
Planning software	1	2.5
Analysis software	2	5.0
Design software	13	32.5
all software	9	22.5
Planning/ Design	9	22.5
Analysis/ Design	5	12.5
others	1	2.5
Total	40	100.0

[Table 2-8]

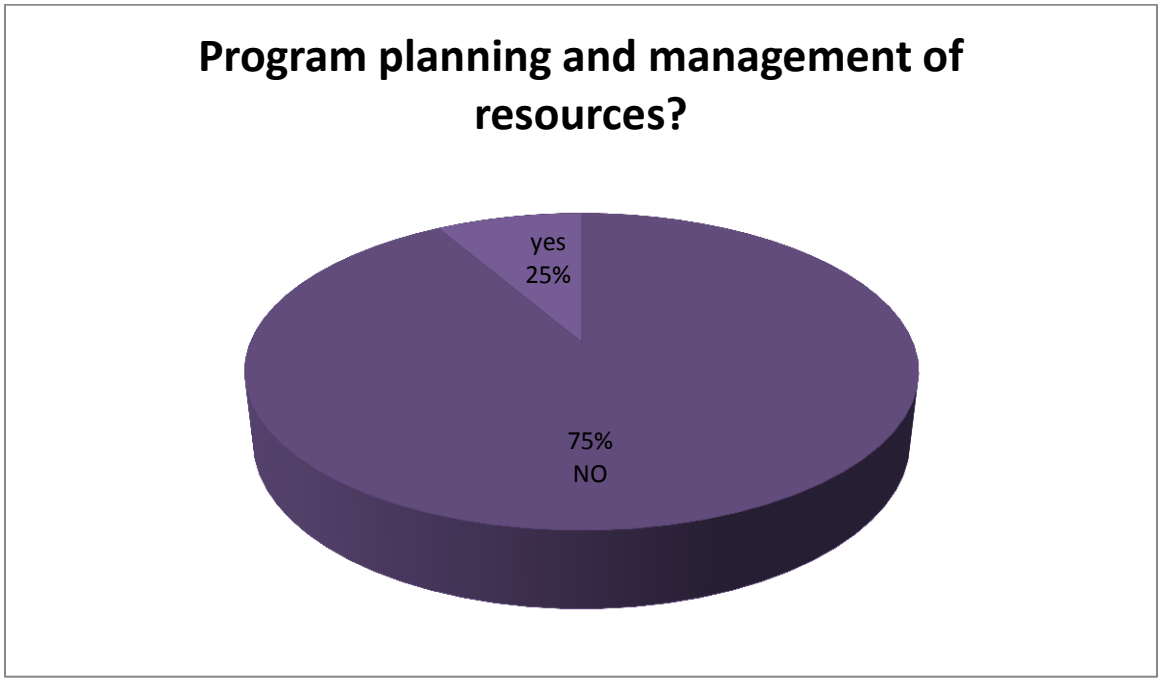


[Chart2-8]

Does your organization program planning and management of resources?
80% of companies do not have programs for the planning and management of resources and this ratio have negative impact on the use of technology.

	Frequency	Percent%
Yes	8	20.0
No	32	80.0
Total	40	100.0

[Table 2-9]



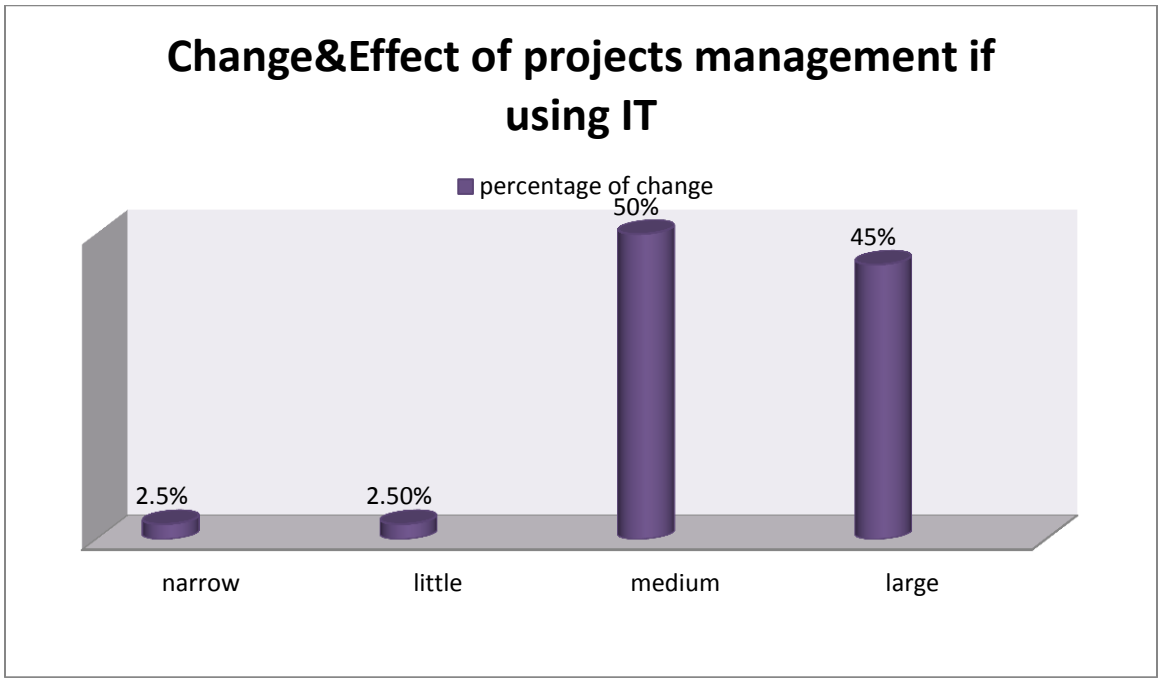
[Chart2-9]

The extent of influence and change brought about by the use of technology to manage projects

50% of companies the effect and change medium if using IT in project management, clear that using of information technology has an effective impact at the decision-making.

	Frequency	Percent%
Narrow	1	2.5
Little	1	2.5
Medium	20	50.0
Large	18	45.0
Total	40	100.0

[Table2-10]



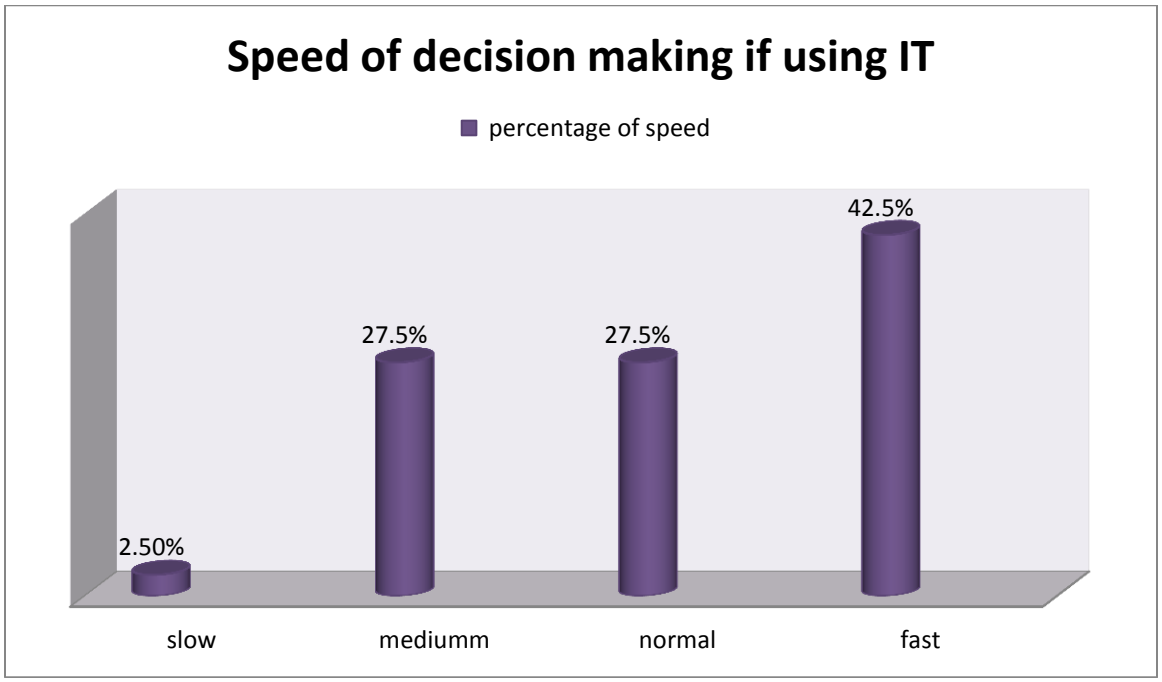
[Chart 2-10]

Speed of decision-making when using the technology

Decision-making was fast when using the technology at 42.5% in companies, a percentage influential in the decision-making

	Frequency	Percent%
Slow	1	2.5
Medium	11	27.5
Normal	11	27.5
Fast	17	42.5
Total	40	100.0

[Table 2-11]



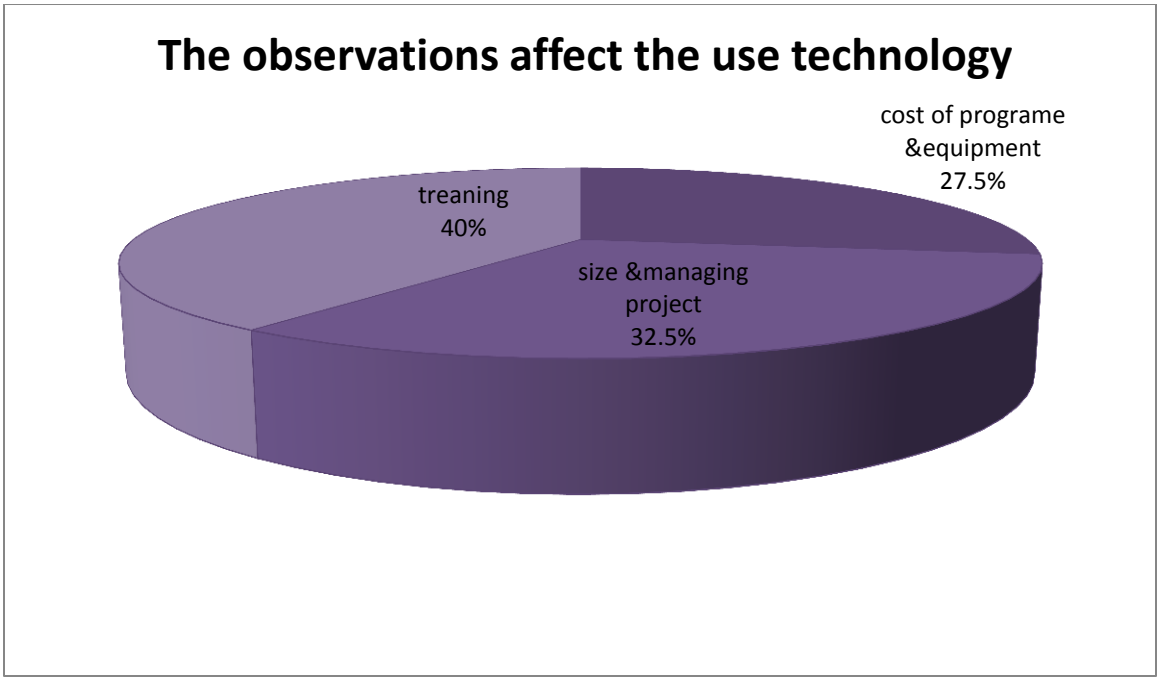
[Chart2-11]

Are there any other observations affect the use technology in the construction industry.

Factors have significant impact in use of technology construction industry is training , prices cost of the software used and size and management of projects company ,people see that the size of project too small to be managed by use of technology within companies, clear that lack of training affect the decision making in the companies.

	Frequency	Percent%
Rise in the value of software and hardware used	11	27.5
Size and project management	13	32.5
Training	16	40.0
Total	40	100.0

[Table2-12]



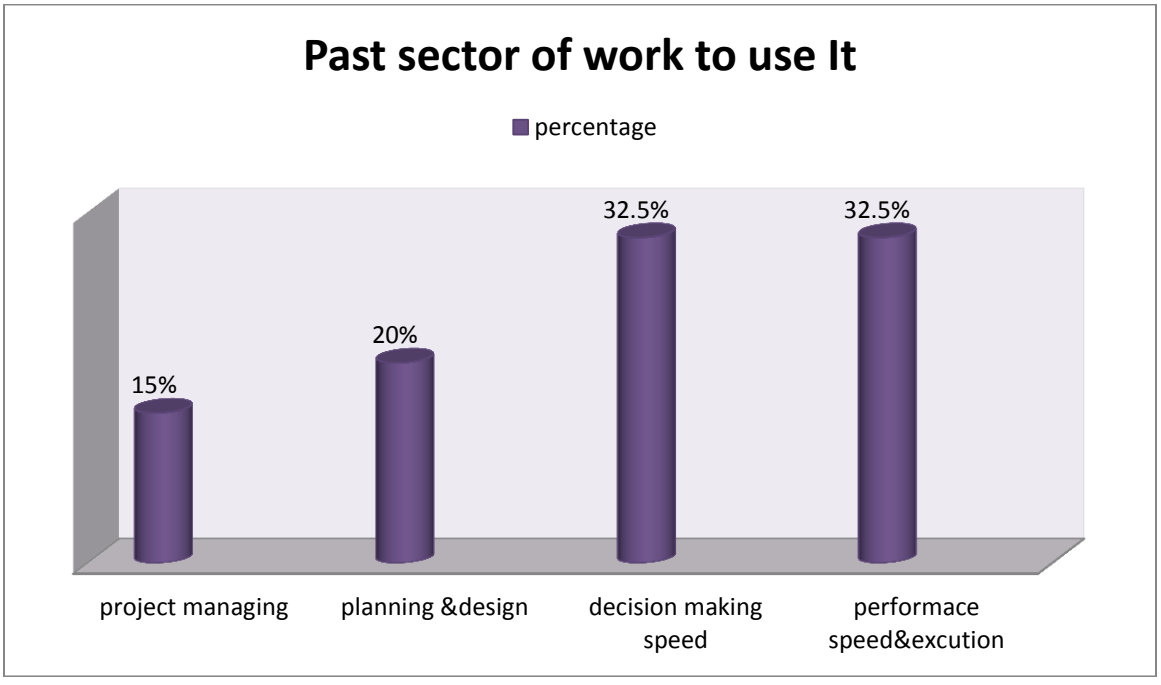
[Chart 2-12]

In what areas of your activities do you believe that the IT systems are to contribute in improving the performance of the production rate of the organization?

Factors that have significant impact in using technology on the construction industry is high prices cost of the software used and followed by training and the size and management of projects the company some see that the size of the project too small to be managed by the use of technology within companies, which already is clear that the lack of programs and training affect the decision making within the company.

	Frequency	Percent%
Project management	6	15.0
Design &planning	8	20.0
Speed of decision making	13	32.5
Performance speed and execution	13	32.5
Total	40	100.0

[Table 2-13]



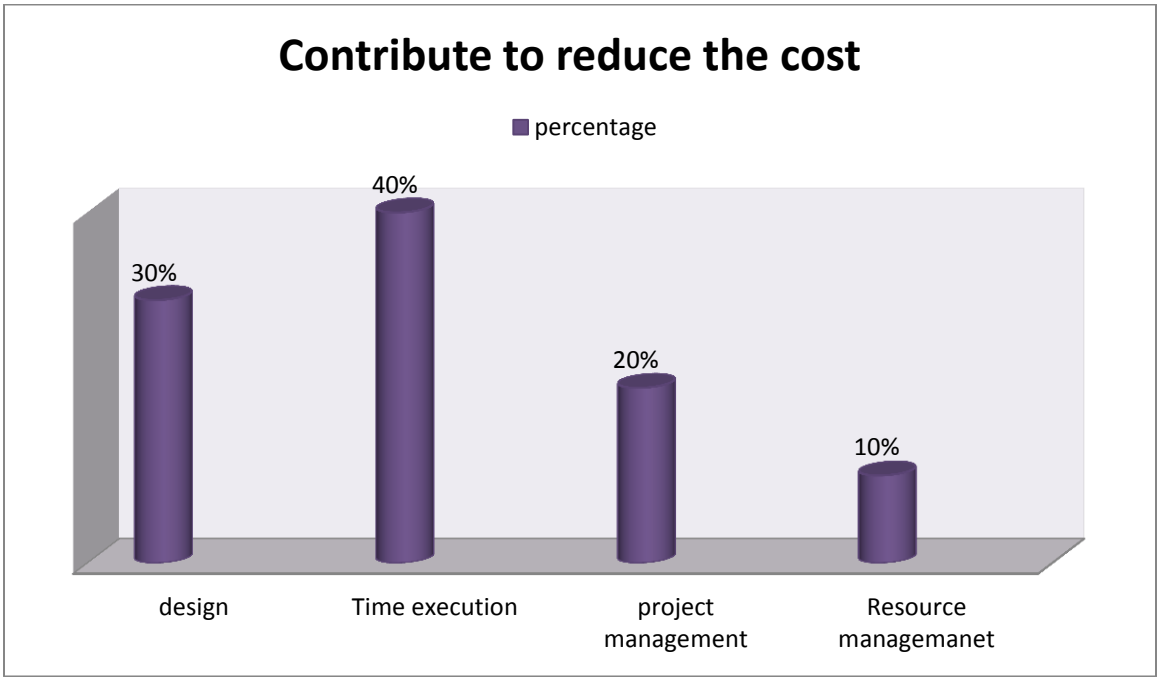
[Chart 2-13]

In what areas of your activities do you believe that IT systems can contribute to reduce the cost of expenses in the organization?

Provide time if using technology could contribute reducing the costs of expenditure within the company and its impact on decision-making compared to design, project management and resources.

	Frequency	Percent%
Design	12	30.0
Time execution	16	40.0
Project Management	8	20.0
Resource management	4	10.0
Total	40	100.0

[Table 2-14]



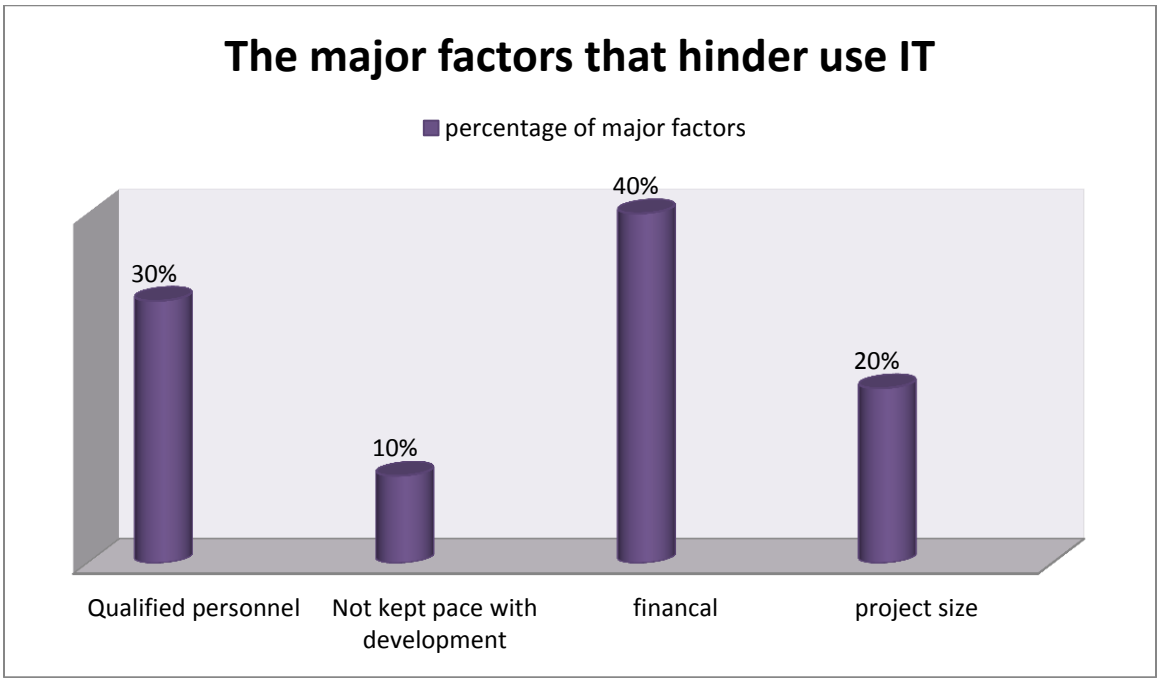
[Chart 2-14]

What the major factors that hinder the best use of IT systems in your organization?

More factors that hinder the optimal use of information technology and its impact on decision-making are financial ability of company, as well as qualified personnel.

	Frequency	Percent%
Qualified personnel	12	30.0
Not kept pace with development	4	10.0
The financial estimated	16	40.0
Project size	8	20.0
Total	40	100.0

[Table 2-15]



[Chart 2-15]

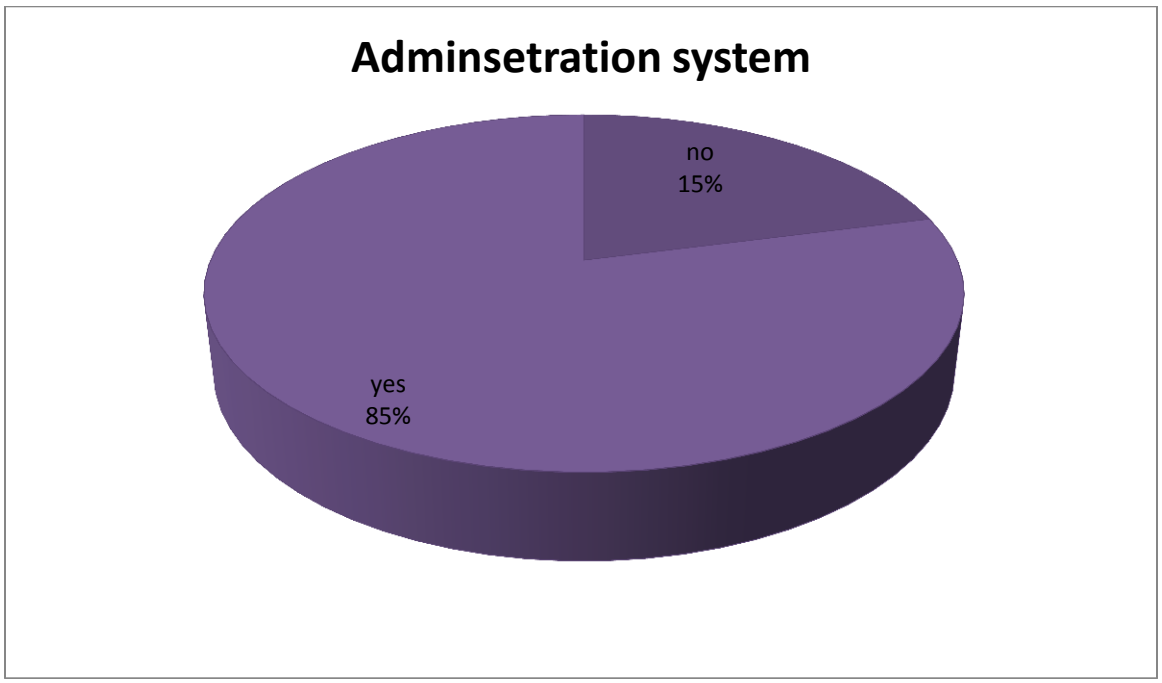
Section III

Management Information

Did you follow the sequence of management and administrative system?
The vast majority of companies have management system and sequence, which have high of influence in the decision.

	Frequency	Percent%
Yes	34	85.0
No	6	15.0
Total	40	100.0

[Table 3-1]



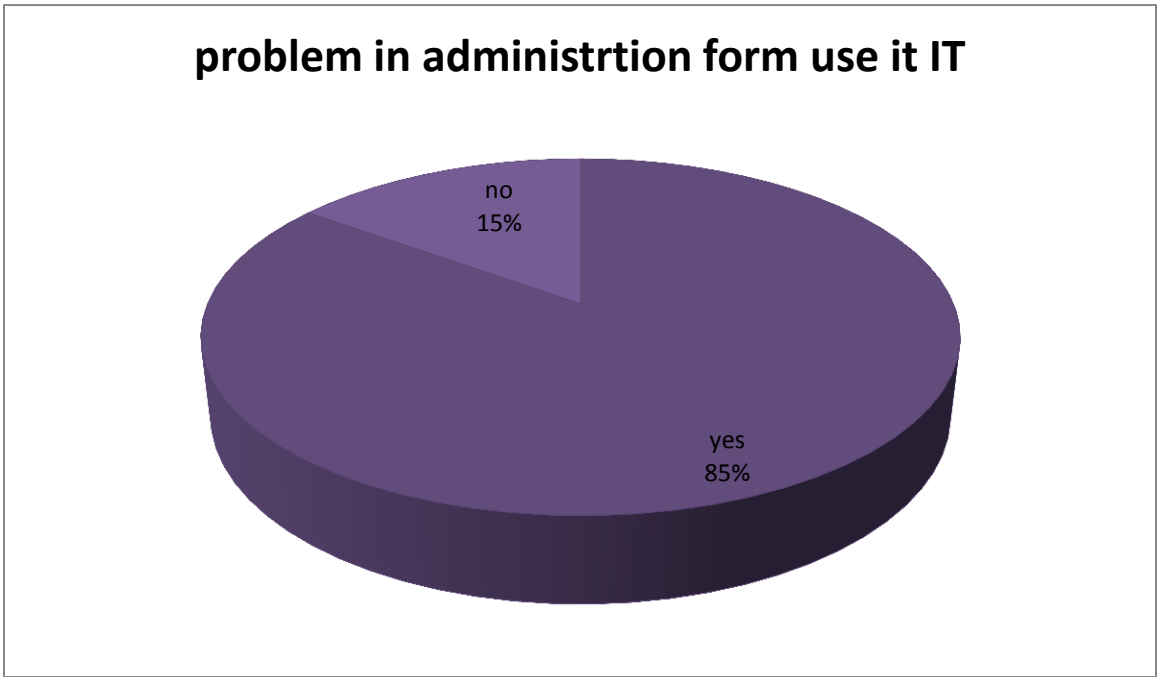
[Chart 3-1]

There are any problems in management if using IT

The company's management have problem when it use technology by 85%, which is a big influence in the decision.

	Frequency	Percent%
Yes	34	85.0
No	6	15.0
Total	40	100.0

[Table3-2]



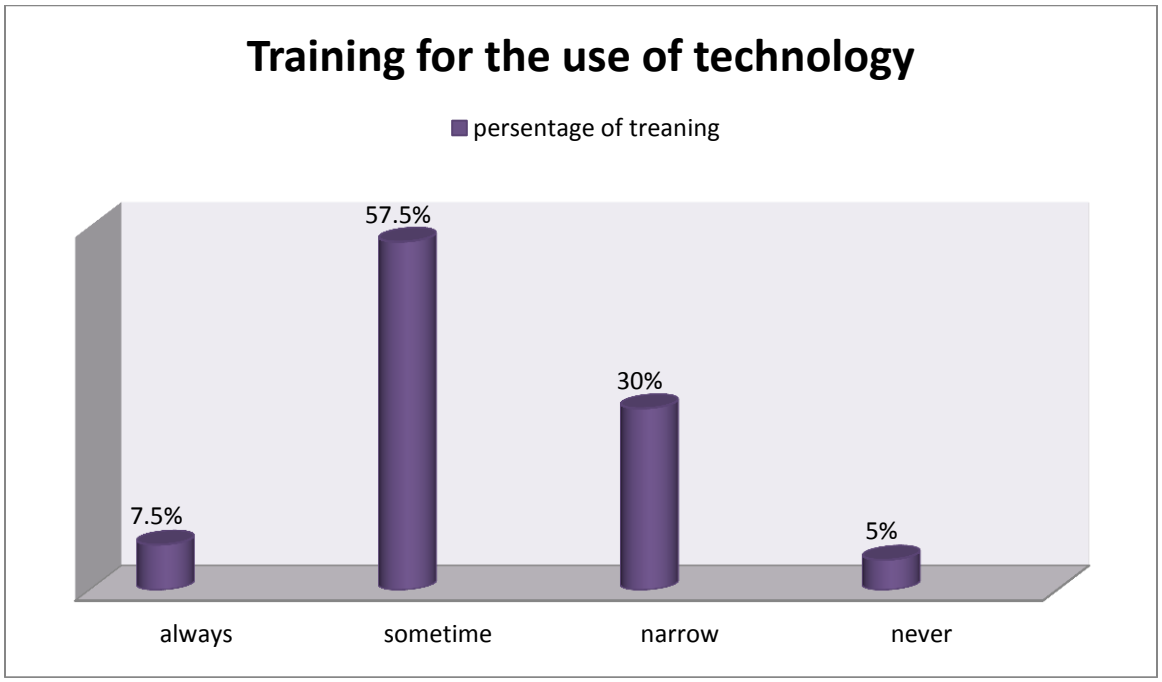
[Chart 3-2]

Is subject to Duarte Training for the use of technology

57.5% of the company departments train their employees sometimes on use of IT systems, this percentage influential in decision-making.

	Frequency	Percent%
Always	3	7.5
Sometime	23	57.5
Narrow	12	30.0
Never	2	5.0
Total	40	100.0

[Table 3-3]

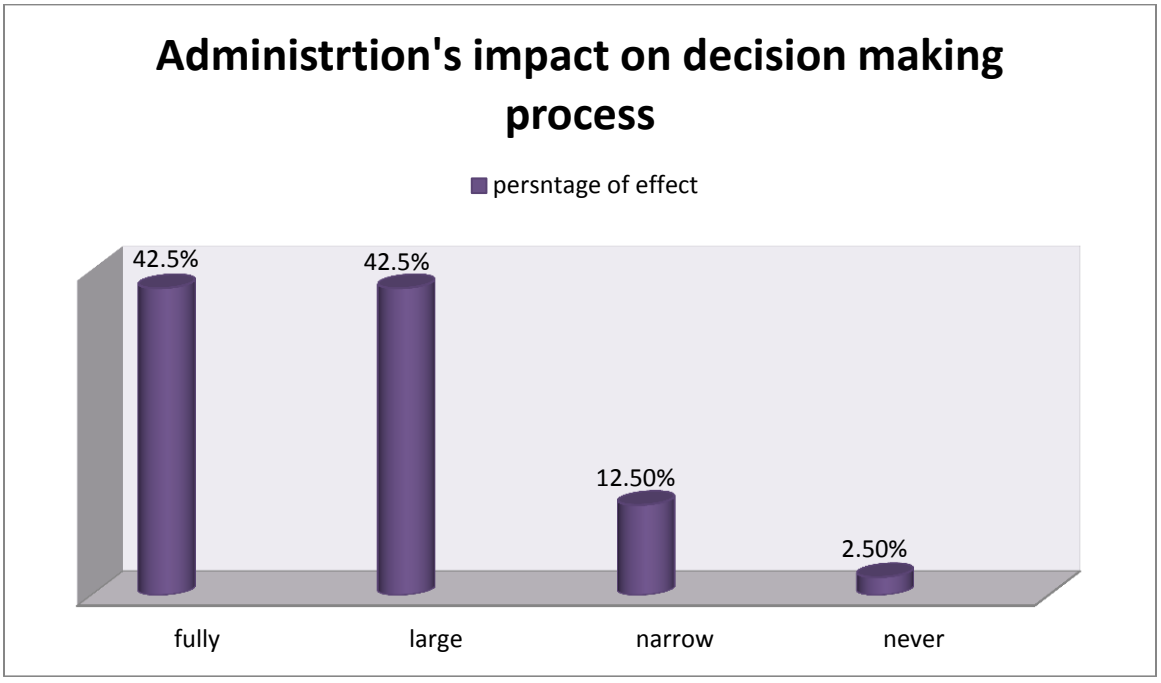


[Chart 3-3]

Is the administration have impact on decision-making process?
Administrations have major impact in decision-making process by 42.5%

	Frequency	Percent%
Fully	17	42.5
Large	17	42.5
Narrow	5	12.5
Never	1	2.5
Total	40	100.0

[Table 3-4]



[Chart 3-4]

Section v

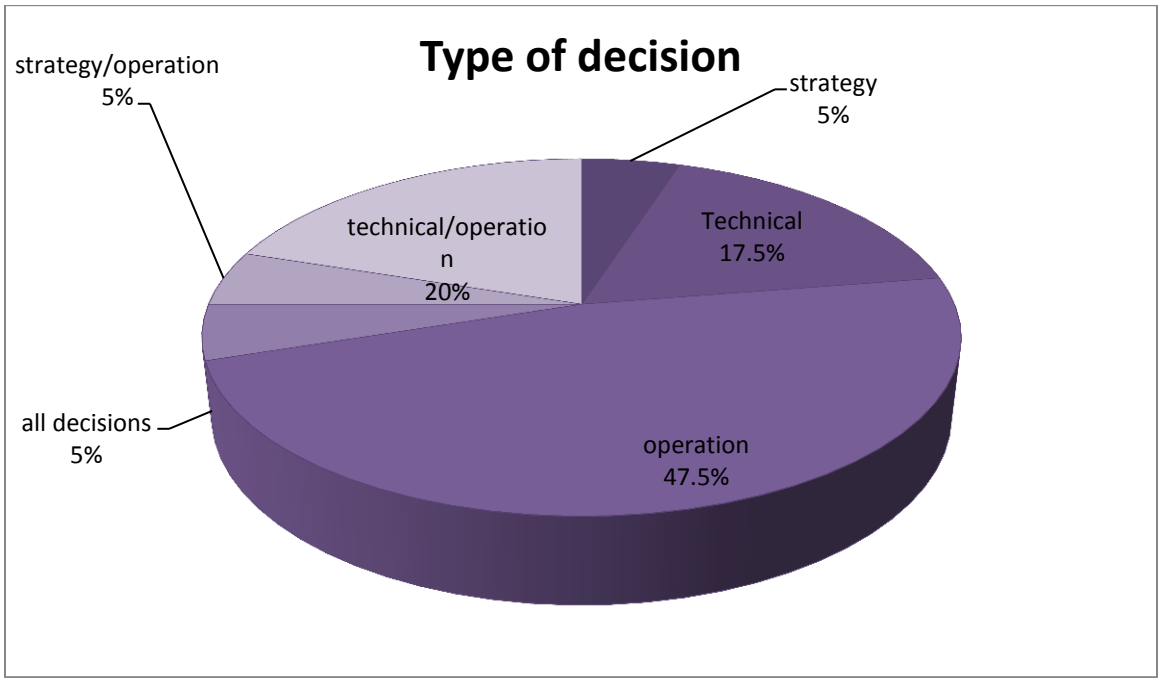
Decision making information

4-1 types of the decision make that take in the company

47.5% of companies taken operational decisions which influence decision making process

	Frequency	Percent%
Strategy	2	5.0
Technical	7	17.5
Operation	19	47.5
All decisions	2	5.0
Strategy\ operation	2	5.0
Technical\operation	8	20.0
Total	40	100.0

[Table4-1]



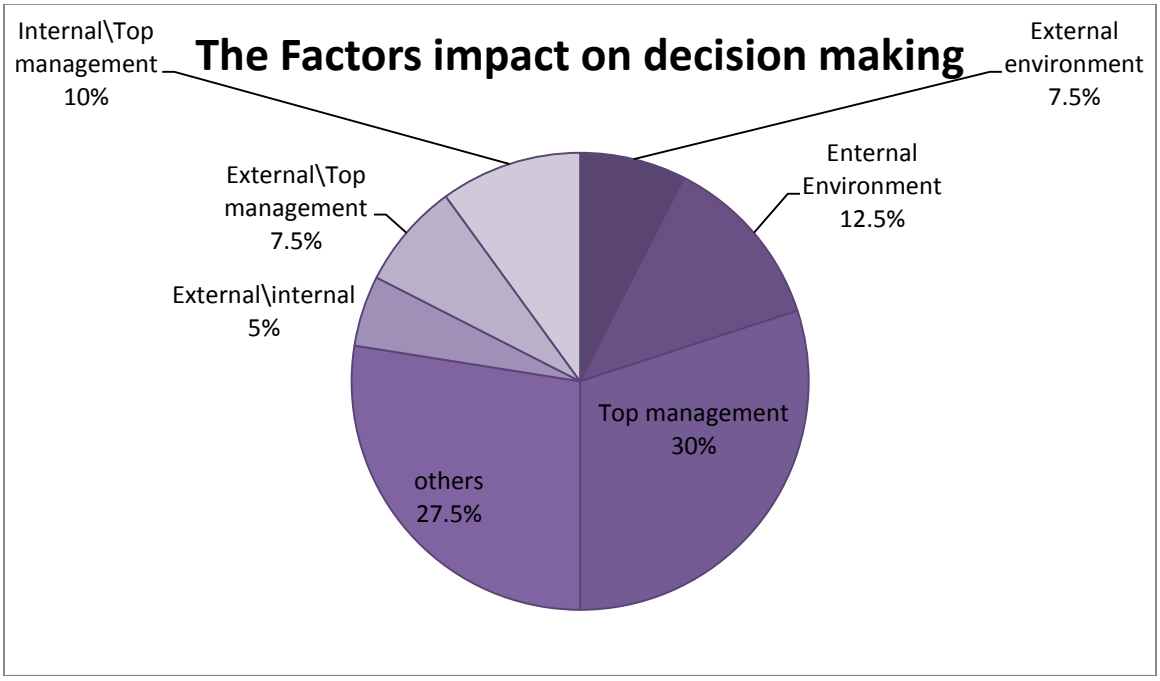
{Chart4-1}

The factors affecting the decision making process

Factors that have affected major impact in decision-making process are top management.

	Frequency	Percent%
The external environment	5	7.5
Internal environment	3	12.5
Top management	12	30.0
Others	11	27.5
External\internal	2	5.0
External\Top management	3	7.5
Internal\Top management	4	10.0
Total	40	100.0

[Table 4-2]

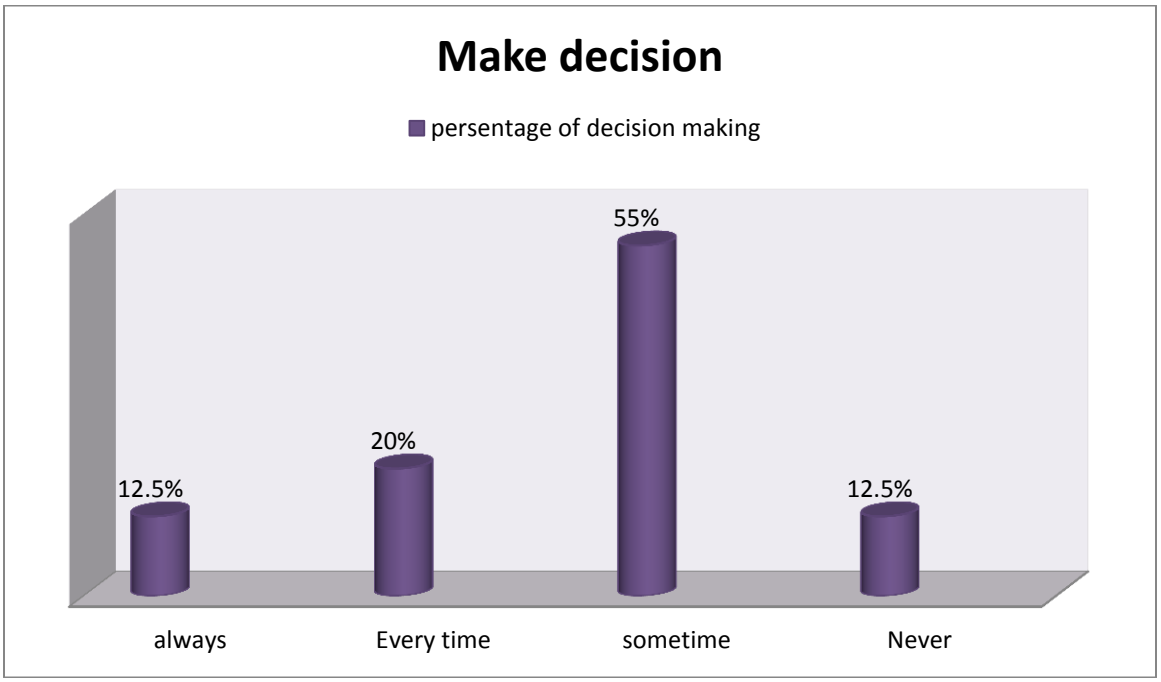


[Chart 4-2]

You make a decision contrary to the regulations valid

	Frequency	Percent%
Always	5	12.5
Every time	8	20.0
sometime	22	55.0
Never	5	12.5
Total	40	100.0

[Table4-3]



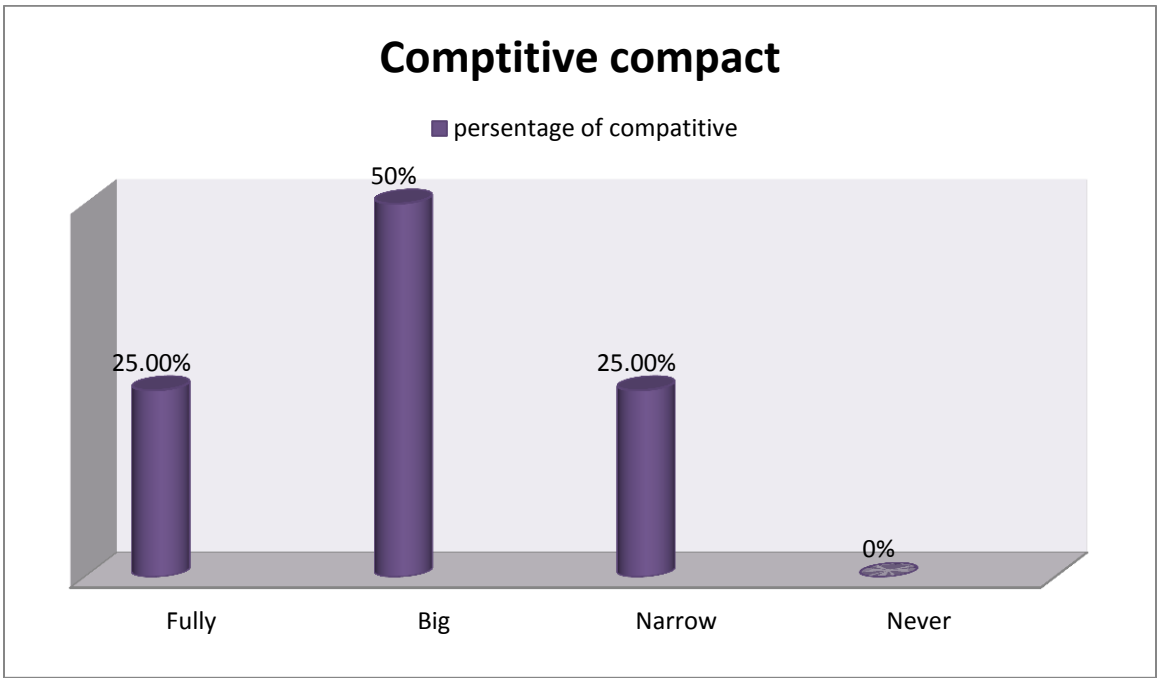
[Chart 4-3]

Competition plays an active role in decision-making in the use of technology

Competition plays significant role in the decision-making process when using technology

	Frequency	Percent%
Fully	10	25.0
Large	20	50.0
Narrow	10	25.0
Never	0	00.0
Total	40	100.0

[Table 4-4]



[Chart 4-4]

CHAPTAER FOUR

INTERPRETATION OF THE RESULTE

&

Test HYPOTHESES TEST

4-1 Interpretation of the results

The questionnaire was Answered through engineers from several disciplines and different age groups and diverse, and this diversity from workers in the construction industry.

Through the questionnaire was reaching the following results, according to the analysis:-

80% of Companies have a policy of using information technology systems, which is very high, and this means that information technology has a positive impact within companies.

93% of the top management is aware for the benefits of the IT systems and this shows that top management is fully aware of the role and impact of information technology in decision-making process.

60% of the companies have local network to facilitate the flow of information between departments.

Training of using technology programs in the companies is most important elements for development, but through the survey found that the weak rate not exceeding 38% of the 6-30% of engineers within the company.

70% of the companies accomplish their tasks by 60% through the computer, these rate have effective an impact on speed of delivery and decision-making.

Less than 70% of decision makers in the companies its use Computer by 45%.

There is discrepancy between plan and regulate of using the software of project management within companies where that 58% of them didn't have plan for technical programs.

Most programs that are use in people companies its design programs, although the planning and design programs using it by 22.5%, the cost of programs that have affect in decision-making process is high.

The companies have adopt for program planning and resource management by rate not exceeding than 20% and this has impact decision-making in terms of speed.

50% of companies the effect and change medium if using IT in project management, clear that using of information technology has an effective impact at the decision-making.

When you use technology, found the rate of decision-making rapidly in 43% of the companies and this shows the importance of use.

Factors have significant impact in use of technology construction industry is training , prices cost of the software used and size and management of projects company ,people see that the size of project too small to be managed by use of technology within companies, clear that lack of training affect the decision making in the companies.

Provide time if using technology could contribute reducing the costs of expenditure within the company and its impact on decision-making compared to design, project.

More factors that hinder the optimal use of information technology and its impact on decision-making are financial ability of company, as well as qualified personnel.

85% of the administration in companies have impact on decisions made by individual within company, there a problems to the management within the companies for use of technology at 85% of them and this results from lack of training courses to use the technology sometimes they have it by 57%.

The type of the decisions that taken by the departments within companies, mostly operational decisions by 48% and tactical decisions and run together, this signifies its importance.

Top management within companies is most important factors affecting in the decision making process, as well as play compete effective role in decision-making process when using technology in the companies.

From the above, we find that the use of information technology have clear Positive impact in decision-making process when used within companies in order to shred the alternative decision

4-2 Test of Hypotheses

Keywords:
N = sample size
Mean = the mean

Std. Deviation = Standard deviation, which indicates how more dispersed data was small compared with the mean indicates that accuracy of the results and dependence on the level of significance in the resolution and the more significant compared to the average does not depend on level of significance in the resolution.

Imposition of the middle = average standard, it may be binary scale, such as: 1 = Yes, 2 = No, it may be triple or Quartet, such as: 1 = very large, 2 = big, 3 = medium, 4 = small it may be five or it may be average of two scales or more of.

Sig. (2-tailed)= Significance level or level of morale that accepts or rejects him hypothesis, if the value of less than 0.05 and the average sample of respondents greater than the median imposed indicates that the presence of significant differences in favor of the sample i.e., that the sample may have agreed with the researcher on this hypothesis, but if the value of significance level less than 0.05 and the sample mean is less than the center is supposed indicates that the presence of significant differences in favor of the center should not that there is a significant proportion of respondents disagree with the researcher about the hypothesis in question, and if the value of the significance level is greater than o.o5 be the sample mean equal to the center should Aria, or it indicates that there was no significant difference between the center and imposed the sample mean and thus conclude that there is a significant proportion of respondents also vary with the researcher

Mean Difference = Average difference between the center and imposed the sample mean calculated

Percent= rate of acceptance of hypothesis

the use of unilateral test sample (one sample T-test) to check the compatibility between the perspective of the researcher and the respondents imposed on the study of different.

4-2 -1 Test of Hypotheses

1. **Construction companies lack proper IT capabilities in Sudan.**

- Consists of the following questions:
- Do you have the institution's policy for the use of IT systems؟
- , Does your organization have a local computer network?
- Did you follow the sequence of management and administrative system
- There are any problems in management if using IT

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	percent
Construction companies lack proper IT capabilities in Sudan	40	1.7750	.24547	89%

Table (1–1)

One-Sample Test

	Test Value = 1.5					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Construction companies lack proper IT capabilities in Sudan	7.085	39	.000	.27500	.1965	.3535

Table (1–2)

In Table (1-1), find that the average answer of respondents about hypothesis above is equal to (1.78) is greater than center-default (1.5) Since the value of the significance level in Table (1-2) = (0.00) is less than (0.05) Thus we can deduce the existence of differences moral for the benefit of any average sample of respondents that the respondents had agreed with the researcher on this hypothesis by (89%), see Table (1-1)

Construction companies do not consider information as a strategic resource.

Consists of the following questions:

- Is senior management aware of the benefits of IT systems?

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	percent
Construction companies do not consider information as a strategic resource	40	1.08	.267	54%

Table (2—1)

One-Sample Test

	Test Value = 1.5					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Construction companies do not consider information as a strategic resource	-10.077	39	.000	-.425	-.51	-.34

Table (2—2)

find that the average answer of respondents about hypothesis above is equal to (1.78) is greater than center-default (1.5) Since the value of the significance level in Table (1-2) = (0.00) is less than (0.05) Thus we can deduce the existence of differences moral for the benefit of any average sample of respondents that the respondents had agreed with the researcher on this hypothesis by (89%), see Table (1-1)

Construction companies do not use IT for decision support.

Consists of the following questions:

- What percentage of tasks that are completed by computers in your organization?
- Speed decision-making when you use the technology

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	percent
Construction companies do not use IT for decision support.	40	2.0875	.79168	46%

Table (3—1)

One-Sample Test

	Test Value = 2.75					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Construction companies do not use IT for decision support.	-5.293	39	.000	-.66250	-.9157	-.4093

Table (3—2)

In Table (3-1), find that the average answer of respondents about the hypothesis above is equal to (2.1) is less than the center-default (2.75) Since the value of the significance level in Table (3-2) = (0.00) is less than (0.05) Thus we can deduce the existence of differences moral center for the benefit of any default that there is a significant proportion of respondents have disagreed with the researcher on this hypothesis, we find that the percentage of accepted hypothesis is equal (46%), see Table (3-1)

Construction companies do not use IT for performance & evaluation.

Consists of the following questions:

- What percentage of tasks that are completed by computers in your organization?

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	percent
Construction companies do not use IT for performance & evaluation	40	2.23	.920	45%

Table (4-1)

One-Sample Test

	Test Value = 3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Construction companies do not use IT for performance & evaluation	-5.331	39	.000	-.775	-1.07	-.48

Table (4-2)

In Table (4-1), we find that the average answer of respondents about the hypothesis above is equal to (2.2) is less than the center-default (3) Since the value of the significance level in Table (4-2) = (0.00) is less than (0.05) Thus we can deduce the existence of differences moral center for the benefit of any default that there is a significant proportion of respondents have disagreed with the researcher on this hypothesis, we find that the percentage of accepted hypothesis is equal (45%), see Table (4-1)

Construction companies do not keep up with the changes they are not aware of the importance of information systems.

Consists of the following questions:

- Is there a plan to legalize the use of project management software?
- Does your organization program planning and management of resources?
- The extent of influence and change brought about by the use of technology to manage projects

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	percent
Construction companies do not keep up with the changes they are not aware of the importance of information systems.	40	1.6667	.36980	56%

Table (5—1)

One-Sample Test

	Test Value = 2					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Construction companies do not keep up with the changes they are not aware of the importance of information systems.	-5.701	39	.000	-.33333	-.4516	-.2151

Table (5—2)

In Table (5-1), we find that the average answer of respondents on the hypothesis above is equal to (1.67) is less than the center-default (2) Since the value of the significance level in Table (5-2) = (0.00) is less than (0.05) Thus we can deduce the existence of differences moral center for the benefit of any default that there is a significant proportion of respondents have disagreed with the researcher on this hypothesis, we find that the percentage of accepted hypothesis is equal (56%), see Table (5-1)

Construction companies personal are not well trained for utilizing of information systems.

Consists of the following questions:

- The extent of training on the use of technology programs within the company
- Is subject to Duarte Training for the use of technology

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	percent
Construction companies personal are not well trained for utilizing of information systems.	40	2.5375	.79572	56%

Table (6—1)

One-Sample Test

	Test Value = 2.75					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Construction companies personal are not well trained for utilizing of information systems.	-1.689	39	.099	-.21250	-.4670	.0420

Table (6—2)

In Table (6-1), we find that the average answer of respondents on the hypothesis above is equal to (2.54) is less than the center-default (2.75) Since the value of the significance level in Table (6-2) = (0.099) is greater than (0.05) therefore conclude that there is significant differences between the center and the average default sample of respondents and this in turn suggests that there is a significant proportion of respondents have disagreed with the researcher on this hypothesis, we find that the percentage of accepted hypothesis is equal (56%), see Table (6-1)

CHAPTER FIVE

CONCLUSIONS &RECOMMENDATIONS

5.1. INTRODUCTION

This chapter includes the conclusion and practical recommendations to the impact of the use of information technologies in decision-making in the Sudanese construction industry.

5-2 Conclusion

Through this research it became clear that using of Information Technology in construction industry has impact on decision-making through these:-

1- Use local networks, training, tasks that are accomplished by computer through the engineers as well as decision-makers in the companies.
2- - Most companies have plan to use software of project management to provide the effort and time, programs that use in companies is the design programs it ranked first and followed by analysis programs, and finally the planning programs.
3- Those programs that have been mentioned have a significant impact in decision making, with regard to resources programs, planning and management, we find it has no used in these most companies.
4- The impact and change when use of information technology to project management in decision-making is weak, although the speed of decision-making when used is faster on half of companies.
5- High cost of the programs has effect in used of technology in the construction industry, impact of training, the size and management of the project by equal proportions, and here clear that high cost have influenced the decision-making, speed of decision-making, performance
6- Provide time when using the technology of most important areas that affect improvement of increase the rate of production compared to project management, planning and design.
7- Provide time and design is most factors that contribute to the cost reduction when using technology.
8- Most companies have a system of administrative sequence and in spite of the existence of this system and the sequence in companies there is a defect in the use of technology due to lack of adequate training, with the knowledge that top management has a significant impact on the decision-making process.

9- the most important decisions made by the companies are operational decisions that have an impact on the decision, followed by tactical decisions in spite of the strategic decisions are not of great importance to them, senior management are more factors that influence the decision-making process, in addition to environmental externalities.

5-3 Recommendations

Through this research we put the following recommendations: -

- The awareness from decision makers within companies for the benefits of use of information technology within the various areas of construction that contribute effectively to the order and speed sequence of the administrative and decision-making and to provide time for them.
- Activate the internal networks that contribute speed up internal procedures, which in turn contribute decision-making.
- Use of computers to completion of all work within companies and to facilitate the decision making process.
- Put a plan of training for all engineers and managers in the companies within the optimal use of technology.
- The provision of qualified personnel and subject them to continuity of training on use of technology.
- Allocating large part of the budget of companies for the purchase of effective programs for Information Technology that helps in decision-making has an effect quick "programs design, planning and analysis..etc.".
- The full attention to the management of projects and size and speed of decision making and effective performance and provide the time of the most important factors that affect the increase in production rates.
- Top management we must leave some decisions for Project Managers to make it that conduct work.
- Create more competition within the construction sector..
- Keep abreast of developments in field of Information Technology.

ACCESSORIES

The Questionnaire

Questionnaire about the impact of information technologies can be used in the process of decision-making on the construction sector Master's degree program in construction management

Section I:
Information on practical experience

What the role that plays it in construction industry؟

1- Contractor
2- Consultant

What is the sector in which they operate?
1- Public sector
2- Private sector
3- Both of them

Time spent working in construction projects?
1- 5> years
2- 10> 5 years
3- 15> 10 years
4- >15

Type of construction projects undertaken by the company
1- Commercial projects
2- Industrial projects
3- Government buildings
4- Residential buildings

What is the size of the projects that participated in it?
1- Very large
2- Large
3- Medium
4- Small

Section II

Information on the use of technology & effect of it:

Is senior management aware of the benefits of IT systems?

1- Yes
2- No

Do you have the institution's policy for the use of IT systems?

1- Yes
2- No

Does your organization have a local computer network?

1- Yes
2- No

The extent of training on the use of technology programs within the company

1- None
2- 5%
3- 6-30%
4- 31-70%
5- >70%

What percentage of tasks that are completed by computers in your organization?

1- None
2- 5%
3- 6-30%
4- 31-70%
5- >70%

What percentage that use the computer between decision-makers?

1- None
2- 5%
3- 6-30%
4- 31-70%
5- >70%

Is there a plan to legalize the use of project management software?

1- Yes
2- No

Types of software used in the projects "can be set more than one answer"

1- Planning software
2- Analysis software
3- Design software

Does your organization program planning and management of resources?

1- Yes
2- No

The extent of influence and change brought about by the use of technology to manage projects

1- Narrow
2- Little
3- Medium
4- Large

Speed decision-making when you use the technology

1- Slow
2- Medium
3- Normal
4- Fast

Are there any other observations affect the use technology in the construction industry

……
……
……

In what areas of your activities believes that the IT systems is to contribute in improving the performance of the production rate of the organization?

……

……

In what areas of your activities do you believe that IT systems can contribute to reduce the cost of expenses in the organization?

……

……

What the major factors that hinder the best use of IT systems in your organization?

……
……
…….

Section III

Management Information

Did you follow the sequence of management and administrative system?

1- Yes
2- No

There are any problems in management if using IT

1- Yes
2- No

Is subject to Duarte Training for the use of technology

1- Always
2- Sometime
3- Narrow
4- Never

Is the administration have impact on decision-making process?

1- Fully
2- Large
3- Narrow
4- Never

Section v

Decision making information

Types of the decision make that take in the company

1- Strategy
2- Technical
3- Operation

The factors affecting the decision making process

1- The external environment
2- Internal environment
3- Top management
4- Others

You make a decision contrary to the regulations valid

1- Always
2- Every time
3- Sometime
4- Never

Competition plays an active role in decision-making in the use of technology

1- Full
2- Large
3- Narrow
4- Never

استبيان حول اثر استخدام تكنولجيا المعلومات في عملية اتخاذ القرار علي قطاع التشييد
لنيل درجة الماجستير في برنامج إدارة التشييد

ملاحظة:

·يجب ان تكون الاجابات مبنية على الخبرة في هذا المجال بدلا من الاستناد لمعلومات مشروع محدد

·سوف يتم الاخذ بالمعلومات المعطاة على اساس من الثقة وسيتم اعتمادها كشاهد في النتائج النهائية

للدراسة .

القسم الأول

معلومات عن الخبرة العملية.

ما هو الدور الذي تلعبه في المشاريع الانشائية

مقاول☐

استشاري☐

ما هو القطاع الذي تعمل به

القطاع العام☐

القطاع الخاص☐

كليهما☐

المدة التي قضيتها في العمل بالمشاريع الانشائية؟؟

أقل من خمس سنوات☐

من خمس الى عشر سنوات☐

من عشر الى خمسة عشر سنة☐

أكثر من خمسة عشر سنة☐

في اي من المشاريع المعمارية تخصصك؟

منشآت تجارية☐

منشآت صناعية☐

منشآت حكومية☐

مباني سكنية☐

ما هو حجم المشاريع التي تم تنفيذها من حيث التكلفة؟) قد تختاراكثرمن اجابة

كبيرة جدا☐

كبيرة☐

متوسطة☐

صغيرة☐

القسم الثاني

-معلومات عن استخدام التكنلوجيا

هل تمتلك المؤسسة سياسة استخدام تكنلوجيا المعلومات ؟

نعم ☐

لا☐

هل الادارة العليا مدركة لفوائد تكنلوجيا المعلومات ؟

نعم☐

لا☐

ماهى نسبة الذين يستخدمون الحاسب الآلى بين الادارة العليا ؟

لايوجد ☐

1- 5%☐

6- 30 %.☐

13 - 70% ☐

< 70%.☐.

.مدي التدريب علي استخدام برامج التكنلوجيا داخل المؤسسة

منعدم☐

1- 5%☐

6- 30 %.☐

13 - 70% ☐

□.%70 <

هل تمتلك مؤسستكم شبكة حاسوب داخلية ؟

نعم □

لا□

ماهى نسبة المهمات التى يتم انجازها بواسطة الحاسب الآلى فى مؤسستك؟

منعدم□

1- 5%□

6- 30 %.□

13- 70% □

□.%70 <

هل هناك خطة لتقنين استخدام برامج ادارة المشاريع

نعم □

لا□

انواع البرامج المستخدمة في المشاريع "يمكن ان تحدد اكثر من إجابة"

برامج تخطيط □

برامج تحليل□

برامج تصميم □

اخرى فضلا حددها_____

هل تعتمد مؤسستكم برنامج لتخطيط وادارة الموارد ؟

نعم .□

لا □

مدي التأثير والتغير الذي احدثه استخدام تكنلوجيا المعلومات علي ادارة المشاريع

ضعيف□

قليلً□

متوسط□

كبير□

سرعة اتخاذ القرار عند استخدام التكنلوجيا

بطىء☐

متوسطة☐

عادي☐

سريع☐

هل هنالك اي ملاحظات أخري تؤثر علي إستحدام التكنلوجيا في صناعة التشييد

.....

.....

.....

فى اى المجالات من عملك تعتقد أن نظم تقنية المعلومات يكمن أن يساهم فى تحسين اداء معدل انتاج المؤسسة ؟

.....

.....

.....

فى اى المجالات من عملك تعتقد أن نظم تقنية المعلومات يمكن أن يساهم فى خفض تكاليف منصرفات المؤسسة ؟

.....

.....

.....

اذكر العوامل الرئيسية التى تعيق الاستخدام الافضل لنظم تقنية المعلومات فى مؤسستك ؟

.....

.....

.....

القسم الثالث -

معلومات عن الإدارة

هل تتبع الإدارة نظام وتسلسل اداري

نعم☐ لا☐

هل للإدارة أثر علي القرارت التي تتخذها

نعم☐

لا☐

هل تواجه الإدارة أي مشاكل في استخدام التكنلوجيا

نعم☐

لا☐

فضلا حددها _____

هل تؤثر الإدارة علي عملية اتخاذ القرار

بشكل تام☐

بشكل كبير☐

بشكل ضعيف☐

ابدا☐

هل خضعت لدوارت تدريبة لاستخدام التكنلوجيا

دائما☐

احيانا☐

بشكل ضعيف☐

ابدا☐

القسم الرابع-

معلومات عن إتخاذ القرار

نو ع القرارات التي تتخذها

إستراتيجية☐

تكتيكية☐

تشغيلية☐

العوامل المؤثر في عملية إتخاذ القرار

البيئة الخارجية☐

الداخلية☐

الإدارة العليا☐

أخري فضلاً حددها___

تقوم بإتخاذ قرار صحيحا رغم انه يمكن أن يخالف اللوائح

دائما☐

كثير من الأحيان☐

احيانا☐

ابدا☐

تلعب المنافسة دورا فعالا في عملية اتخاذ القرار عند استخدام التكنلوجيا

بشكل تام☐

بشكل كبير☐

بشكل ضعيف☐

ابدا☐

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