# Sudan University of Science and Technology

# College of Graduate Studies

*A thesis Submitted in Partial fulfillment of the Requirement for the Degree of Master of Engineering in (Construction Management)*

## 'Application of Management Information System in construction projects in Sudan'

## تطبيق نظام المعلومات الإدارية في مشروعات التشييد في السودان


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# Dedication

I dedicate this work to my parents Abdallah Hassan Osman and Maha Abdulrahman Mahmoud for their invaluable encouragement and support throughout my life
and I could not arrive to this level without them and their support.

# Acknowledgement

This achievement would not have been possible without the guidance and the motivation from ALLAH (SWT). The encouragement of my father and prayers of my mother have further helped me to achieve another milestone in my career. I am thankful to Dr. Salaheldin Abdelaziz Ajbani for his supervision support during the thesis process.

# ABSTRACT:

Management information systems encompass a broad and complex topic. To make this topic more manageable, boundaries will be defined. Because of the vast number of activities relating to management information systems, a total review is not possible. Those discussed here is only a partial sampling of activities. Likewise where there were multiple effects in a similar area of development, only selected ones will be used to illustrate concepts. Also, the main focus of this research will be on information systems for use at the construction industry level.

Management Information System (MIS) provides information for the managerial activities in an organization. The main purpose of this research is, MIS provides accurate and timely information to facilitate the decision-making process and enable the organizations planning, control, and operational functions to be carried out effectively. Management Information System (MIS) is basically concerned with processing data into information and is then communicated to the various Departments in an organization for appropriate decision-making. MIS is a subset of the overall planning and control activities covering the application of humans, technologies, and procedures of the organization. . The information system is the mechanism to ensure that information is available to the managers in the form they want it and when they need it.

The population of the study comprises of engineers working in the construction industry in the State of Khartoum, A sample of 71 engineers was adopted where 50 of them sent back their feedback. Which almost constitutes 70 percent of the total sample, the obtained results indicated that there is a relationship between management information system and a number of factors affecting the application of this system, such as: the sources of information, information technology skills, the availability of qualified staff and facilities and the availability of technology.

The research ended with general recommendations in the field that indicate: provision of appropriate technology for the system in the organization, training and qualification the staff in relation to the skills of information technology, develop the information system on an ongoing basis, provide the necessary requirements for the system implementation, Documentation for all the information and information that can be utilized with the passage of time in digital document on the management information system.

**المستخلص :**

تشمل أنظمة المعلومات الإدارية موضوعاً واسعاً ومعقداً. لجعل هذا الموضوع أكثر قابلية للإدارة ، سيتم تحديد الحدود. نظراً للعدد الهائل من الأنشطة المتعلقة بأنظمة المعلومات الإدارية، لا يمكن إجراء مراجعة شـــاملة. تلك التي نوقشـــت هنا هي فقط أخذ عينات جزئية من الأنشـــطة. وبالمثل عندما تكون هناك آثار متعددة في مجال مماثل من مجالات التنمية ، سـيتم اسـتخدام بعض منها فقط لتوضـيح المفاهيم. أيضـاً، سيكون التركيز الرئيسي لهذا البحث على نظم المعلومات للاستخدام على مستوى صناعة البناء والتشييد.
يوفر نظام المعلومات الإدارية (MIS) معلومات للأنشطة الإدارية في المنظمة. الغرض الرئيسي من هذا البحث هو أن نظام المعلومات الإدارية يوفر معلومات دقيقة وفي الوقت المناسـب لتسـهيل عملية صـنع القرار وتمكين المنظمات من تخطيط ومراقبة وتشغيل الوظائف بشكل فعال. يهتم نظام المعلومات الإدارية (MIS) أساساً بمعالجة البيانات في المعلومات، ثم يتم إبلاغه إلى الأقسام المختلفة في المؤسسة لاتخاذ القرارات المناسبة. نظام المعلومات الإدارية هو مجموعة فرعية من أنشطة التخطيط والتحكم الشاملة التي تغطي تطبيق التقنيات البشـرية ، وإجراءات المنظمة. نظام المعلومات هو آلية لضـمان توافر المعلومات للمديرين بالشكل الذي يريدونه ومتى يحتاجون إليه.

يتألف مجتمع الدراسـة من المهندسـين الذين يعملون في صـناعة البناء في ولاية الخرطوم ، حيث بلغت عينة الدراسة 70 مهندسا حيث أعاد 50 منهم تعليقاتهم. والتي تشكل تقريبا 71٪ من العينة الكلية ، أشارت النتائج المتحصـل عليها إلى وجود علاقة بين نظام إدارة المعلومات وعدد من العوامل التي تؤثر على تطبيق هذا النظام ، مثل: مصـادر المعلومات ، ومهارات تكنولوجيا المعلومات ، وتوافر الموظفين والمرافق المؤهلة وتوفر التكنولوجيا.

انتهى البحث بتوصيات عامة في هذا المجال تشير إلى: توفير التكنولوجيا الملائمة للنظام في المؤسسة ، وتدريب وتأهيل الموظفين فيما يتعلق بمهارات تقنية المعلومات ، وتطوير نظام المعلومات بشكل مستمر ، وتوفير المتطلبات اللازمة. لتنفيذ النظام ، توثيق لجميع المعلومات والمعلومات التي يمكن اسـتخدامها مع مرور الوقت في المستند الرقمي لنظام إدارة المعلومات.

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# Chapter 1

# CHAPTER 1

# Identification of Problem

## 1.1 Background:

During the growth of a competitive global environment, there is considerable pressure on most organizations to make their operational, tactical, and strategic processes more efficient and effective. An information system (IS) is a group of components which can increase competitiveness and gain better information for decision making. Therefore, various organizations have chosen to apply this group of components to their associations (Spalding, 1998). Consequently, the organizations decide to implement IS in order to improve the effectiveness and efficiency of the organizations. Information systems have become a major function area of business administration. The systems, nowadays, plays a vital role in the e-business and e-commerce operations, enterprise collaboration and management, and strategic success of the business (Hevner et al., 2004).

According to (Ein-Dor and Segev 1978), an IS becomes a management information system (MIS) when it is applied to improve management by directors of the organization. This system can increase the performance of the management. MIS is a collection of manpower, tools, procedures and software to perform various business tasks at various levels in the organization (Tripathi, 2011). This system has three basic levels: operational, middle management and top management where the information is passed from bottom to top (Tripathi, 2011). Moreover, MIS is one of the important functions of management which plays an important role in providing information that is required for crucial decision making which directly affects the performance of the organization (Murthy, 2006).

Due to a fundamentally changing external environment, several organizations have decided to change their IS strategies by adopting application software packages rather than in-house development (Hong & Kim, 2002). According to (Davenport 1998), the most significant development in the corporate use of IS is the establishment of enterprise resource planning (ERP) systems. ERP systems are an information technology (IT) infrastructure that facilitate the flow of information between all supply chain processes in an organization (Al-Mashari & Zairi, 2000). ERP systems, moreover, provide the means for management to respond to increased business needs in more effective and efficient ways (Spathis & Constantinides, 2003). Nonetheless, a concern regarding ERP systems regards their flexibility and ability to meet

specific organization and industry requirements. As a result, some organizations still integrate their systems using conventional best of breed (BoB) or stand-alone system components of standard package and/or custom software without ERP systems (Davenport, 2000). In addition, some organizations have developed their own customized suites of enterprise applications, known as a best of breed (BoB) IT strategy, which offers greater flexibility and closer alignment of software with the business process of the organization (Light, Holland & Wills, 2001). Therefore, adoption and utilization of ERP and BoB systems should be considered as an important factor which should be suitable for the organizations and the current business processes.

In private organizations, IS are important factors in assuring the competitive advantage and eventual profitability of the firm. On the other hand, in governmental organizations IS are just as crucial, but from another perspective, in terms of responsiveness, efficiency, and productivity (Beaumaster, 1999). In defense organizations they also share the same objectives as many private-sector corporations: for instance they are striving to decrease costs by redesigning and integrating processes. Hence defense organizations require IS with the integrated system and technology platform both within and across the organization in order to achieve greater visibility and affordable operational readiness. For example, the Swedish Armed Forces (SAF) formalized an ERP project due to many old and bespoke systems, lack of integration, and high complexity of current IT systems. Moreover, efficiency and effectiveness can be increased in IS for maintenance of aircraft; SAF has implemented an aviation "best of breed" solutions information system called the Fenix System.

## 1-2 Problem Statement:

Many companies have been implementing IS in their respective organizations and re-organizing their business processes (Rajagopal, 2002). Computer-based IS mainly depend on IT; consequently, successful IS can be measured by the effectiveness of IT to support an organization's strategies (O'Brien, 2004). The demand for efficient and effective use of IT is also gradually increasing at the present time (Beaumaster, 2002). An organization that adopted an IT system to provide special attention to planning, acquisition, and implementation of these technologies. Those associates must be aware of the various number of issues which are a part of the ability of the organization to achieve effective IT implementation (Beaumaster, 2002).

It is important to note that more than 70 per cent of standard package (i.e. ERP system) implementation projects fail (Milis & Mercken, 2002). Therefore, IS implementation is surrounded with various problems regarding the implementation process and it is not easy to

succeed. There are several problems which occur during the implementation of IS. These problems can be observed in a series corresponding to each stage of the overall process. It appears that every layer is comprised of multiple issues that create or worsen the challenges (Beaumaster, 2002). MIS or IS have to provide an approach to deal with the ever-changing problems and be situated surrounding all aspects of the management of information (Theiruf, 1994). Moreover, the success of IS implementation in the organization also depends on a multitude of important and interrelated factors (Beaumaster, 2002). Hence it is a great significance to take into account this and observe the obstacles when implementing a new information system. In order to ensure success of MIS implementation, therefore, the key success factors should be determined and indicated on which issues will allow a project to be successful (Gargeya & Bardy, 2005).

As mentioned earlier, adopting IS is one factor which increases the effectiveness and efficiency in an organization. However, implementing IS affects the organization to a great degree and can be seen as a major change for an organization's processes; for instance, it requires employees to change (Chan, 2000; Davies, 2009). Many companies have found that implementing such changes is the most difficult part of IS implementation (Kroenke, 2007). In addition, IS can effect individuals, groups, and a whole organization when IS was introduced into that organization. This system can create both a positive and negative impact on these levels (Davies, 2009). The negative effect of IS occurs when the system fails. This failure can be analyzed on the technical, project, organizational and environmental level. Thus a good strategy is significantly concerned with avoiding the failure of the system and achieving a successful system (Davies, 2009).

Considering the aforementioned context, it is important to notice that a lack of awareness of numerous and varied challenging issues surrounding the implementation process could cause problems for the whole process of MIS development and deployment. Furthermore, the problem of a lack of key success issues seems to be a serious obstacle for the MIS implementation process. It is essential to define the success factors and manage them in order to carry out a successful the implementation. Additionally, MIS implementation effects an organization and these effects are related to the consequences of the business processes. Consequently, this issue is critical and crucial for an organization to consider when implementing a new MIS in the organization. The problem addressed in this study focus the challenges and key success issues regarding IS implementation. Additionally, the problem addressed in this research refers to effects and consequences on an organization and its business process.

## 1-3 Scope of Research:

The research scope covers constructors, workers and managers. The former is responsible for planning, organizing, mobilizing, implementing, supervising, monitoring and reporting. The studied projects are located in Khartoum, Sudan.

## 1-5 Research Questions:

In order to achieve the purpose of the study, the following research questions were identified:

- What problems/challenges have been faced in MIS implementation processes?
- What are the key issues that need to be identified in order to achieve a successful MIS implementation?
- What are the effects and consequences for an organization and its processes when implementing MIS?

## 1-4 Research Hypothesis:

The study includes a number of hypotheses related to the direct aim of the study that have been identified to describe and understand the problem research topic, which are:

- Lack of qualified information technology staff leading to weak implementation of the management information system.
- Facilities and information technology for the MIS implementation are not fully available.
- Not include the cost of implementing the MIS in the budget of the institution, which effects on the meeting the requirements of operation system.
- Organizational factors affect the effectiveness of MIS.
- It is difficult to understand and implementation management information system and it is difficult to understand how the MIS works.

## 1-5 Objective:

The purpose of this thesis is to present and describe MIS implementation challenges or problems as well as identifying the key issues to achieve successful implementation. Moreover, this research seeks to explain the implementation effects and consequences which impact the organization and its processes.

## 1-6 Research Methodology:

1. In this study the research conducted through several phases namely literature review, data collection, data analysis, discussion and conclusion. A literature review was conducted encompassing all various means available to obtain the widest range of the relevant information from books, papers and websites related to the management information system.
2. Interviews were held with experts in the Sudan construction industry. This provided a first impression of the situation in the practice, and use statistical method to review the role of management information system.
3. The researcher is follow the data collection by the questionnaires.

## 1-7 Research Organization:

1- **Chapter 1** : Identification of Problem

2- **Chapter 2**: Concept of Management Information System.

3- **Chapter 3**: Application of Management Information System in Construction Industry.

4- **Chapter 4**: Research Methodology and Data Analysis.

5- **Chapter 5**: Conclusions and Recommendations.

# Chapter 2

# CHAPTER 2
# LITERATURE REVIEW
# Concept of Management Information System

## 2-1 Introduction:

The literature about management information systems (MIS) has been developed since the 1960s. An evolution of MIS can be divided into three periods: data processing, management information systems, and strategic information systems (Somogyi & Galliers, 1987). The first era, "data processing", is mainly focused on improving the efficiency of business through automation of basic information processes with not too much control over planning or resources. The second era, "management information systems", was concerned about the enhancement of managerial effectiveness by satisfying widespread information requirements. Managers of each organization came to realize the capability of information technology resources and started to acquire their own systems to meet the requirements. The third era, "strategic information systems", focused on improving organizational competitiveness advantages by affecting the overall organizational business strategies. This period is an approach to use strategic management in MIS such as various and diverse information technologies, widespread user involvement, and significant planning and implementation strategies (Beaumaster, 1999).

A variety of the definitions of MIS have been indicated, for example Ives, Hamilton and Davis (1980) defined MIS as a "computer-based organizational information system which provides information support for management activities and functions" which is similar to Ein-Dor and Segev (1978) who described it thus: "MIS is a system for collecting, sorting, retrieving and processing information which is used, or desired, by one of more manager, in the performance of their duties". Furthermore, Davies (2009) claimed that MIS is one types of information system that support as the tactical decision-making of managers, and also monitors the current state of the organization. Moreover, Kroenke (2007) mentioned that MIS has three key elements including: development and use, information systems, and business goals and objectives. MIS can be named as an organizational information system, a computer-based information system, or an information system. (Ives et al., 1980)

Various characteristics of MIS are considered as important factors for the efficiency of MIS which is to report with fixed and standard information; to have reports developed and implemented using information system personnel, including systems analysts and computer

programmers; to require formal requests from user; and to produce scheduled and demanded reports. In addition, external data are used by the MIS while it is not captured by the organization (Asemi, Safari & Zavareh, 2011). Furthermore, Das (2012) discussed the same area and claimed that an efficient MIS should contain the following characteristics which include: system capability, modularity, simple, transparent, instinctive, online capability; integration; and support from well-established and committed suppliers. On the other hand, the roles of MIS have been described as a useful tool for making business decisions by gathering data and information from MIS systems (Asemi et al., 2011). This concept is relatively stated by Das (2012) that MIS is mainly concerned with processing data into information for appropriate decision-making.

The MIS literature, based primarily on private sector organizations, prescribes performance evaluation on the basis of the economic efficiency of hardware and software (Hamilton & Chervany, 1981). Public organizations also have strong incentives to consider economic costs in decision making, but most face other, equally important competing criteria, such as procedural equity (cited in Bretschneider, 1990).

In addition, Beaumaster (2002) claimed that MIS concentrate on the automation of many business activities that aim to provide better methods of planning, reporting, and operation control. Therefore MIS, which is often referred as “information system (IS)”, has attempted to provide methods to manage problems and situations around all perspectives of the management of information (Theiruf, 1994). Moreover, MIS is a facilitator for an organization and also supports management activities. MIS implementation, however, is high priced with costly assets, thus this implementation project requires detailed planning of its design, implementation and operation processes.

## 2-2 Definitions:

### I. Information Definition:

'A set of classified and interpreted data used in the decision making process"

### II. System Definition:

"A set of elements forming an activity or a procedure/scheme seeking a common goal or goals by operating on data and/or energy and/or matter in a time reference to yield information and/or energy and/or matter." (Hopkins, R.C. et al.)

### III. Managements Information System Definition:

"An integrated user-machine system for providing information to support operations, management and decision making functions in an organization. The system utilizes

computerized and manual procedures; models for analysis, planning, control and decision making; and a database." (Davis, G.B. 1985)

## 2-3 Concepts of Information:

### I. Mathematical definition of information:

It is the average number of binary digits which must be transmitted to identify a given message from the set of all possible messages to which it belongs.

### II. Information Presentation:

Communication of information for human use is affected by methods of transmission and message handling. These methods can be classified as:

- Methods that increase the sending and receiving efficiency of a system.
- Methods to exercise information content of distribution discretion.

## Methods that increase the sending and receiving efficiency of a system:

Two methods for more efficiently providing information are message summarization and message routing.

Message summarization is commonly utilized to reduce the amount of data transmission required without changing the essential meaning of the original message.

Message routing means distributing a particular message to only those individuals or organizational units which require the information for some action or decision.

## Methods to exercise information content of distribution discretion:

**Table 2.1** Methods to exercise information content of distribution discretion

| Method | Reasons for use |
|---|---|
| Message delay | To avoid overload. To distort, inhibit, or suppress transmission |
| Message modification | To modify by summarization |
| Message Filtering | To block certain data by filtering |
| Uncertainty absorption | To reduce data transmission (by removing recipient from contact with detail data) |
| Presentation bias | To bias by order and grouping in data presentation<br>To bias by selection of limits that determine whether items are presented<br>To bias by selection of graphics layout. |

### III. Quality of Information:

Some aspects of information quality in terms of the perceptions of the decision maker are:

- **Utility of Information:**

Andrus identifies four information utilities:

**Form Utility:** As the form of information more closely matches the requirements of the decision maker, its value increases

**Time Utility:** Information has greater value to decision maker if it is available when needed.

**Place Utility (physical accessibility):** Information has greater value if it can be accessed or delivered easily.

• **Possession Utility (organization location):** The possessor of information strongly affects its value by controlling its dissemination by others.

- **Information Satisfaction:**

It is the degree to which the decision maker is satisfied with the output of the formal information system.

- **Errors and Bias:**

Bias is caused by the ability of individuals to exercise discretion in information presentation.

Errors are more serious problem and may be a result of:

• Incorrect data measurement and collection methods.

• Failure to follow correct processing procedures.

• Loss or non-processing of data.

• Wrong recording or correcting of data.

• Incorrect history (master) file (or use of wrong history file).

• Mistakes in processing procedure.

• Deliberate falsification.

## IV. Age of Information:

- **Condition data** which pertains to a point in time.
- **Operating data** which reflects changes over a period of time

## V. Type of Information:

Before discussing management information systems, some time-tested concepts should be reviewed. Davis offers a commonly used concept in his distinction between data and information. Davis defines data as raw facts, figures, objects, etc. Information is used to make decisions. To transform data into information, processing is needed and it must be done while considering the context of a decision. We are often awash in data but lacking good information. However, the success achieved in supplying information to decision makers is highly variable. Barabba, expands this concept by also adding inference, knowledge and wisdom in his

modification of Haechel's hierarchy which places wisdom at the highest level and data at the lowest. As one moves up the hierarchy, the value is increased and volume decreased. Thus, as one acquires knowledge and wisdom the decision making process is refined. Management information systems attempt to address all levels of Haechel's hierarchy as well as converting data into information for the decision maker. As both Barabba and Haechel argue, however, just supplying more data and information may actually be making the decision making process more difficult. Emphasis should be placed on increasing the value of information by moving up Haechel's hierarchy.

Another important concept from Davis and Olsen is the value if information. They note that "in general, the value of information is the value of the change in decision behavior caused by the information, less the cost of the information." This statement implies that information is normally not a free good. Furthermore, if it does not change decisions to the better, it may have no value. Many assume that investing in a "better" management information system is a sound economic decision. Since it is possible that the better system may not change decisions or the cost of implementing the better system is high to the actual realized benefits, it could be a bad investment. Also, since before the investment is made, it is hard to predict the benefits and costs of the better system, the investment should be viewed as one with risk associated with it.

Another approach for describing information systems is that proposed by Harsh and colleagues. They define information as one of four types and all these types are important component of a management information system. Furthermore, the various types build upon and interact with each other. A common starting level is Descriptive information. (See Figure 2-1).

(Davis, G.B. 1985, Barabba, V.P. 1991, Harsh, Stephen B., et al 1981)

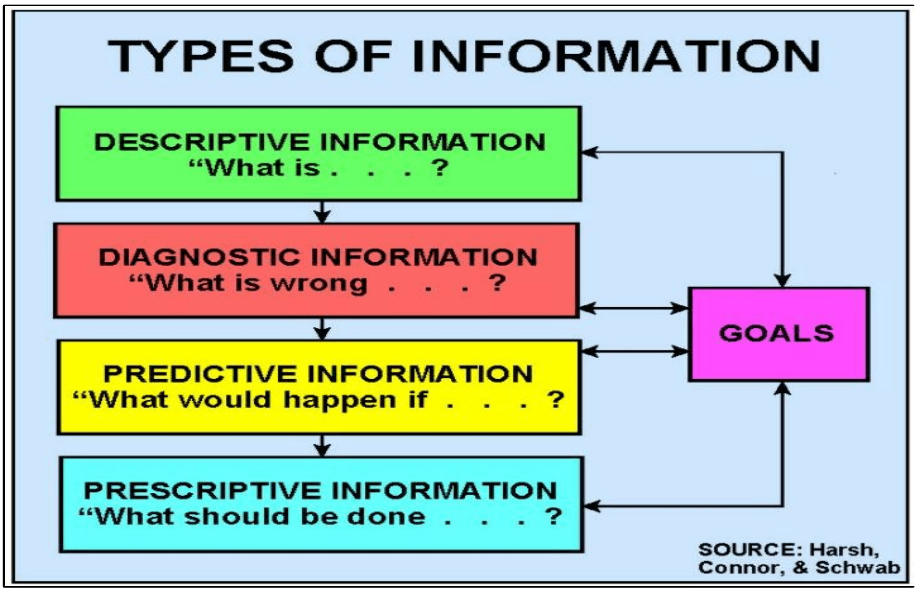


**Figure 2–1** Types of Information (Harsh, Stephen B., et al 1981)

This information portrays the “what is” condition of a business, and it describes the state of the business at a specified point in time. **Descriptive information** is very important to the business manager, because without it, many problems would not be identified. Descriptive information includes a variety of types of information including financial results, production records, test results, product marketing, and maintenance records. Descriptive information can also be used as inputs to secure other needed types of information. For example, “what is” information is needed for supplying restraints in analyzing farm adjustment alternatives. It can also be used to identify problems other than the “what is” condition. Descriptive information is necessary but not completely sufficient in identifying and addressing farm management problems.

The second type of information is **diagnostic information**, this information portrays this “what is wrong” condition, where “what is wrong” is measured as the disparity between “what is” and “what ought to be.” This assessment of how things are versus how they should be (a fact-value conflict) is probably our most common management problem. Diagnostic information has two major uses. It can first be used to define problems that develop in the business. Are production levels too low? Is the rate earned on investment too low? These types of question cannot be answered with descriptive information alone (such as with financial and production records). A manager may often be well supplied with facts about his business, yet be unable to recognize this type of problem. The manager must provide norms or standards which, when compared with the facts for a particular business, will reveal an area of concern. Once a problem has been identified, a manager may choose an appropriate course of action for dealing with the problem (including doing nothing). Corrective measures may be taken so as to better achieve the manager’s goals. Several pitfalls are involved for managers in obtaining diagnostic information. Adequate, reliable, descriptive information must be available along with appropriate norms or standards for particular business situations. Information is inadequate for problem solving if it does not fully describe both “what is” and “what ought to be.”

As description is concerned with “what is” and diagnostics with “what is wrong,” **prediction** is concerned with “what if...?” Predictive information is generated from an analysis of possible future events and is exceedingly valuable with “desirable” outcomes. With predictive information, one either defines problems or avoids problems in advance. Prediction also assists in analysis. When a problem is recognized, a manager will analyze the situation and specify at least one alternative (including doing nothing) to deal with it. Predictive information is needed by managers to reduce the risk and uncertainty concerning technology, prices, climate, institutions, and human relationships affecting the business. Such information is vital in

formulating production plans and examining related financial impacts. Predictive information takes many forms. What are the expected prices next year? What yields are anticipated? How much capital will be required to upgrade production technologies? What would be the difference in expected returns in switching from a livestock farm to a cropping farm? Management has long used various budgeting techniques, simulation models, and other tools to evaluate expected changes in the business.

Without detracting from the importance of problem identification and analysis in management, the crux of management tasks is decision making. For every problem a manager faces, there is a "right" course of action. However, the rightness of a decision can seldom, if ever, be measured in absolute terms. The choice is conditionally right, depending upon a farm manager's knowledge, assumptions, and conditions he wishes to impose on the decision. Prescriptive information is directed toward answering the "what should be done" question. Provision of this information requires the utilization of the **predictive information**. Predictive information by itself is not adequate for decision making. An evaluation of the predicted outcomes together with the goals and values of the manger provides that basis for making a decision. For example, suppose that a manager is considering a new changing marketing alternative. The new alternative being considered has higher "predicted" returns but also has higher risks and requires more management monitoring. The decision as to whether to change plans depends upon the managers' evaluation of the worth of additional income versus the commitment of additional time and higher risk. Thus, the goals and values of a farm manager will ultimately enter into any decision.

## 2-4 Management Information Systems (MIS):

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Various characteristics of MIS are considered as important factors for the efficiency of MIS which is to report with fixed and standard information; to have reports developed and implemented using information system personnel, including systems analysts and computer programmers; to require formal requests from user; and to produce scheduled and demanded reports. In addition, external data are used by the MIS while it is not captured by the organization (Asemi, Safari & Zavareh, 2011). Furthermore, Das (2012) discussed the same area and claimed that an efficient MIS should contain the following characteristics which include: system capability, modularity, simple, transparent, instinctive, online capability; integration; and support from well-established and committed suppliers. On the other hand, the roles of MIS have been described as a useful tool for making business decisions by gathering data and information from MIS systems (Asemi et al., 2011). This concept is relatively stated by Das (2012) that MIS is mainly concerned with processing data into information for appropriate decision making.

The MIS literature, based primarily on private sector organizations, prescribes performance evaluation on the basis of the economic efficiency of hardware and software (Hamilton & Chervany, 1981). Public organization's also have strong incentives to consider economic costs in decision making, but most face other, equally important competing criteria, such as procedural equity (cited in Bretschneider, 1990).

In addition, Beaumaster (2002) claimed that MIS concentrate on the automation of many business activities that aim to provide better methods of planning, reporting, and operation control. Therefore MIS, which is often referred as "information system (IS)", has attempted to provide methods to manage problems and situations around all perspectives of the management of information (Theiruf, 1994). Moreover, MIS is a facilitator for an organization and also supports management activities. MIS implementation, however, is high priced with costly assets, thus this implementation project requires detailed planning of its design, implementation and operation processes.

## 2-5 Information System (IS) and Information Technology (IT):

Information systems (IS) and information technologies (IT) are a vital component of successful businesses and organizations (O'Brien, 2004). The definition of both IS and IT are closely related to each other; however, they are different in their functions. IT relates to the products, methods, inventions, and standards that are used for the purpose of producing information. It can also be defined as "the preparation, collection, transport, retrieval, storage, access, presentation, and transformation of information in all its forms (voice, graphic, text, video, and image). Information movement can take place between humans, humans and machines, and/or between machines. Information management ensures the proper selection, deployment, administration, operation, maintenance, and evolution of the IT assets consistent with organizational goals and objectives" (Boar, 1993). IT refers to the products, methods, inventions, and standards that are used for the purpose of producing information (Kroenke, 2007). IS "consists of the information technology infrastructure, application systems, and personnel who employ information technology to deliver information and communications services for transaction processing/operations and administration/management of an organization" (Baskerville, Stage, & DeGross, 2000). Therefore IS is a set of components which interact to produce information, which include hardware, software, data, procedures, and people, whereas these components can be found in every information system (Kroenke, 2007). According to Figure 2-2. The main elements of IS consist of hardware, software, data, procedures, and people. Hardware refers to computers, storage disks, keyboards, and communication devices while software is relevant to word-processing programs. Data or information is included texts, words, sentences, and paragraphs in reports. Furthermore, procedures refer to the methods for using the program and involved activities. The last element is people. The important role of the five components is that IS is not only computers, programs, and communication devices, but it also focuses on the assembly of hardware, software, data,

procedures, and people; in other words, information system means a system of communication between people (Kroenke, 2007; Davies, 2009). Moreover, Gurbaxani and Whang (1991) claimed that there are many roles of information systems in an organization, for example to increase an operation's efficiency, to process business transactions, to provide decision support, to monitor and evaluate employees' performance, and to maintain documentation and communication channels.

Information technology (IT; i.e. hardware and software) is one significant component in an information system (IS). Nowadays, IT is an important factor to evolve in strategic planning of an organization. In addition, IT is the asset or capability base on which an enterprise constructs its business information system (Boar, 1993). On the other hand, the main roles of IT have been analyzed and presented by Chan (2000). He claimed that the key roles of IT include an initiator, a facilitator, and an enabler. The importance of an initiator in IT is to initiate a new operation, or initiate the change of IT. In addition, a facilitator of IT is a tool which helps to manage work which is easier to work. Finally, an enabler of IT offers the ability or the necessary support to achieve a goal.

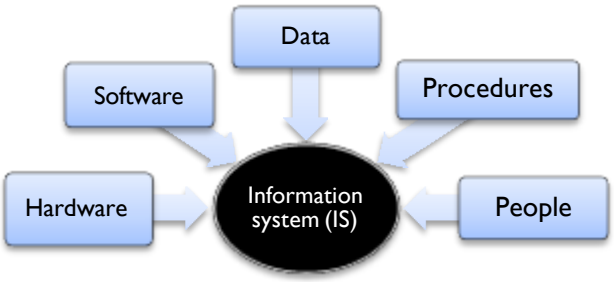


**Figure 2-2** Five Components of an Information System (IS) (Kroenke, 2007)

Organizations have radically changed their IT strategies and one of the strategies that they choose is to purchase standard package software instead of developing IT systems in-house (Holland & Light, 1999). The existing application software has been categorized by Kroenke (2007) as the following:

- Horizontal-market application software refers to a software that serves capabilities common across all organizations and is used in a wide variety of businesses such as Microsoft Office, Adobe Acrobat.
- Vertical-market application software provides for the specific industry requirement, for instance the programs that are used by parts of warehouses to track inventory, purchase and sales.

- One-of-a-kind application software is developed in order to support a unique need and fit only the organization.

In addition, Kroenke (2007) also explained how an organization acquires application software or sources of them. The first approach is to purchase the suit software, called off-the-shelf-software which provides the customer an exact cost. However, some applications in the suit do not fit the organizational requirements. The second software sources can be obtained by buying off-the-shelf with alterations software. This software is more expensive than the previous software; in spite of that, an altered suit will be more fit than pure off-the-shelf-software. The last software is called tailor-made application software or custom-developed software. This software is obtained by hiring a vendor to make a custom suit in order to get the applications that exactly fits with their requirements. The existing types and sources of application software were summarized in Figure 2-3 by (Kroenke 2007).

**Software Source**

| **Software Type** | Off-the-shelf | Off-the-shelf and then customized | Custom-developed |
|---|---|---|---|
| Horizontal applications | ■ | | |
| Vertical applications | ■ | ■ | |
| One-of-a-kind applications | | | ■ |

**Figure 2-3** Software Sources and Types (Kroenke, 2007)

Two ultimate approaches currently exist for enterprise software (ES) systems including ERP systems and "best of breed" (BoB) solutions (Mabert, Soni & Venkataramanan, 2003). Therefore, an organization should carefully make the decision to implement IT solutions and evaluate to ensure that it meets the requirements (Loh & Koh, 2004). For instance, ERP systems are the most preferable method whereas the businesses replace the legacy system (Holland & Light, 1999). However, ERP system implementation is one of the most challenging projects and is not easy to achieve (Gargeya & Brady, 2005). On the other hand, BoB is flexible and organizations are able to choose from a collection of software applications which are appropriated with the organization's requirements (Light et al., 2001). Nevertheless, Sledgianowski, Tafti, and Kierstead (2008) claimed that BoB is required to develop an infrastructure (i.e. hardware, software, expertise, etc.) which would be very expensive. These discussion of ES system approaches as well as implementation processes of IT solutions will be discussed in following sections.

## 2-6 (ERP) and (BoB) Solutions:

Many companies started to replace their legacy system with ERP packages in order to solve integration problems during the 1990s (Hyvönen, 2003). These systems are comprehensive packaged software solutions which aim for total integration of all business processes and functions. Gargeya and Brady (2005) stated that ERP systems had emerged as the core of successful information management and the enterprise backbone of the organization. The main benefit of these systems is to provide a common integrated software platform for business processes (Parr & Shanks, 2000). An ERP system might be used as a basic platform in many companies, but they also still use some standalone components, or ERP modules from different vendors (Themistocleous et al., 2001). On the other hand, some companies without an ERP system still integrate their systems using conventional best of breed (BoB) or standalone system components of standard package and/or custom software in order to reach flexibility and ability to meet specification organization and industry requirements (Hyvönen, 2003). In contrast, the increasing needs to integrate intra-organizational information systems is established. Consequently, many organizations are now seeking to integrate inter-organizational information systems and ERP systems provide internal integration. As a result, they are seeking to use ERP systems to establish integration with other supply chain stakeholders (MacKinnon, Grant & Cray, 2008).

Taking into account the definition of ERP systems and BoB solutions, ERP systems are single vendor software packages which provide best-practice business process functionality centered around a single database. Many companies attempt to modify ERP systems to match their existing processes. However, they have often caused a great deal of trouble, for instance delaying implementation, increasing staff requirements and hampering the upgradeability of the system. On the other hand, best of breed (BoB) solutions are combinations of different software packages which provide more limited and focused functionality, such as one system for finance, one for operations, one for human resource management, and so forth. Therefore many organizations try to mix and match what they consider to be the best collection of software packages to match their organizational needs. These packages are then integrated using some type of middleware. Various advantages of BoB implementation are considered to be less disruptive to an organization, require less process reengineering, and allow for greater flexibility. However, due to the fact that the packages come from different venders, there are extensive compatibility and integration issues (MacKinnon et al., 2008). In short, the strengths of the BoB approach can be seen as being centered on the ability of organizations to benefit from the most appropriate and the best in class software function available (Light et al., 2001).

Unfortunately, many organizations have faced a challenge with the systems integration which is not only an obstacle of the system, but also the supply chain partners consist of independent systems so that, in some cases, they cannot communicate with each other. In addition, there is a complexity of existing information systems, which in many cases have fixed and rigid structures for messages, interfaces and databases (Themistocleous, Irani, & Love, 2002). Therefore ERP systems have become the resource to support the business processes and increase efficiency and effectiveness of collaborative relationships with actors in the supply chain. However, ERP systems are not appropriate for every organization. Many organizations which haven't chosen ERP systems still have some problems with isolated systems. In order to solve these problems, enterprise application integration (EAI) is conducted. EAI or application integration (AI) is adopted to refer to the integration area and is defined as the "unrestricted sharing of information between two or more enterprise applications. A set of technologies that allow the movement and exchange of information between different applications and business processes within and between organizations" (Linthicum, 1999).

To conclude, both approaches are beneficial for an organization which implement an information system. However, there are many factors that the strategic level or top management should take into account in order to choose the proper information system for implementation within their organization. These MIS implementation aspects including implementation process, implementation challenges, and key issues for success implementation will be described in the following part.

## 2-7 Information System:

An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products.

Information systems contain information about significant people, places, and things within the organization or in the environment surrounding it. By information we mean data that have been shaped into a form that is meaningful and useful to human beings. Data, in contrast, are streams of raw facts representing events occurring in organizations or the physical environment before they have been organized and arranged into a form that people can understand and use.

A brief example contrasting information and data may prove useful. Supermarket checkout counters scan millions of pieces of data from bar codes, which describe each product. Such

pieces of data can be totaled and analyzed to provide meaningful information, such as the total number of bottles of dish detergent sold at a particular store, which brands of dish detergent were selling the most rapidly at that store or sales territory, or the total amount spent on that brand of dish detergent at that store or sales region (see Figure 2-4).
(Brynjolfsson, Erik and Lorin M. Hitt. 2000)

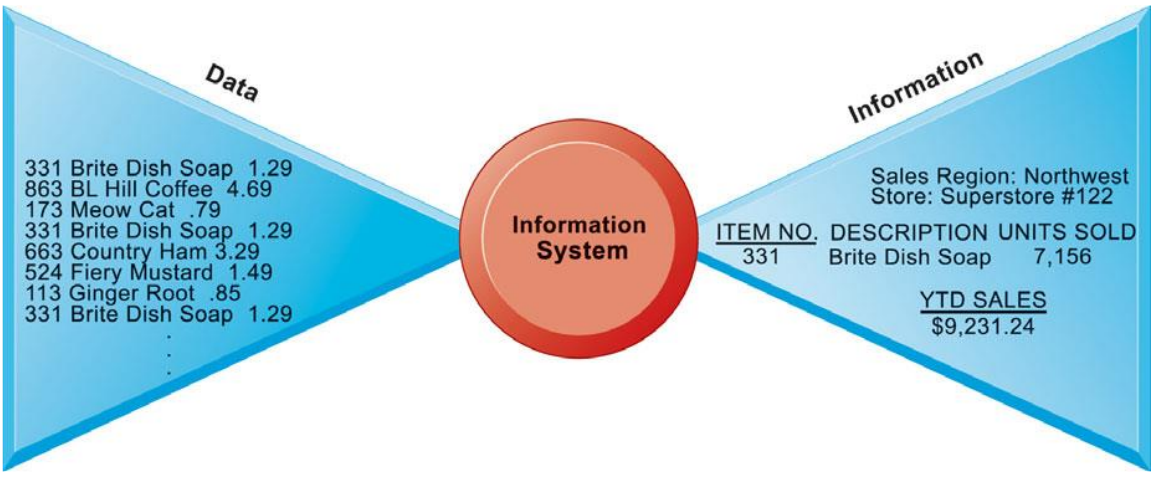


**Figure 2-4** Data and Information (Brynjolfsson, Erik and Lorin M. Hitt 2000)

Raw data from a supermarket checkout counter can be processed and organized to produce meaningful information, such as the total unit sales of dish detergent or the total sales revenue from dish detergent for a specific store or sales territory.

Three activities in an information system produce the information that organizations need to make decisions, control operations, analyze problems, and create new products or services. These activities are input, processing, and output (see Figure 2-5). **Input** captures or collects raw data from within the organization or from its external environment. **Processing** converts this raw input into a meaningful form. **Output** transfers the processed information to the people who will use it or to the activities for which it will be used. Information systems also require **feedback**, which is output that is returned to appropriate members of the organization to help them evaluate or correct the input stage.

Although computer-based information systems use computer technology to process raw data into meaningful information, there is a sharp distinction between a computer and a computer program on the one hand, and an information system on the other. Electronic computers and related software programs are the technical foundation, the tools and materials, of modern information systems. Computers provide the equipment for storing and processing information. Computer programs, or software, are sets of operating instructions that direct and control

computer processing. Knowing how computers and computer programs work is important in designing solutions to organizational problems, but computers are only part of an information system.

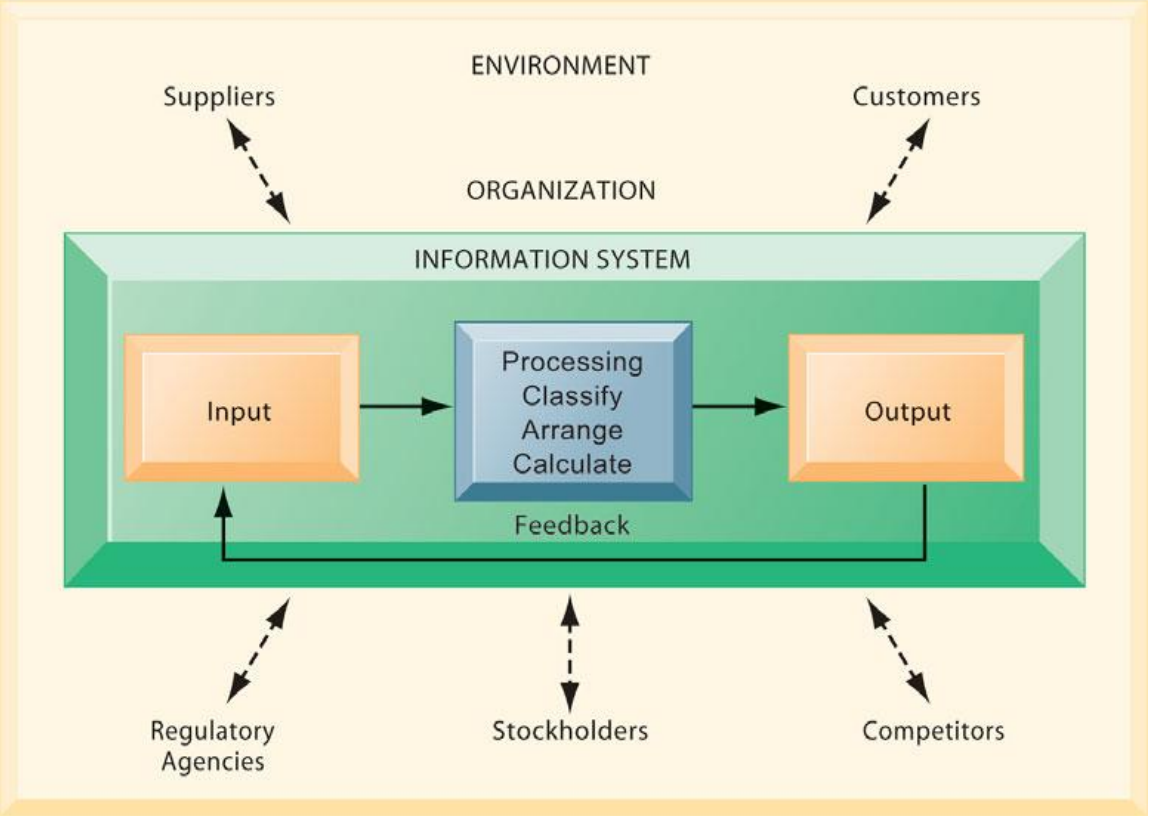


**Figure 2-5** Functions of an information system (Brynjolfsson, Erik and Lorin M. Hitt 2000)

An information system contains information about an organization and its surrounding environment. Three basic activities—input, processing, and output—produce the information organizations need. Feedback is output returned to appropriate people or activities in the organization to evaluate and refine the input. Environmental actors, such as customers, suppliers, competitors, stockholders, and regulatory agencies, interact with the organization and its information systems.

## 2-7-1 Dimensions of Information System:

To fully understand information systems, you must understand the broader organization, management, and information technology dimensions of systems (see Figure 2-6) and their power to provide solutions to challenges and problems in the business environment. We refer to this broader understanding of information systems, which encompasses an understanding of the management and organizational dimensions of systems as well as the technical dimensions of systems, as information systems literacy. Computer literacy, in contrast, focuses primarily

on knowledge of information technology. The field of management information systems (MIS) tries to achieve this broader information systems literacy. MIS deals with behavioral issues as well as technical issues surrounding the development, use, and impact of information systems used by managers and employees in the firm.

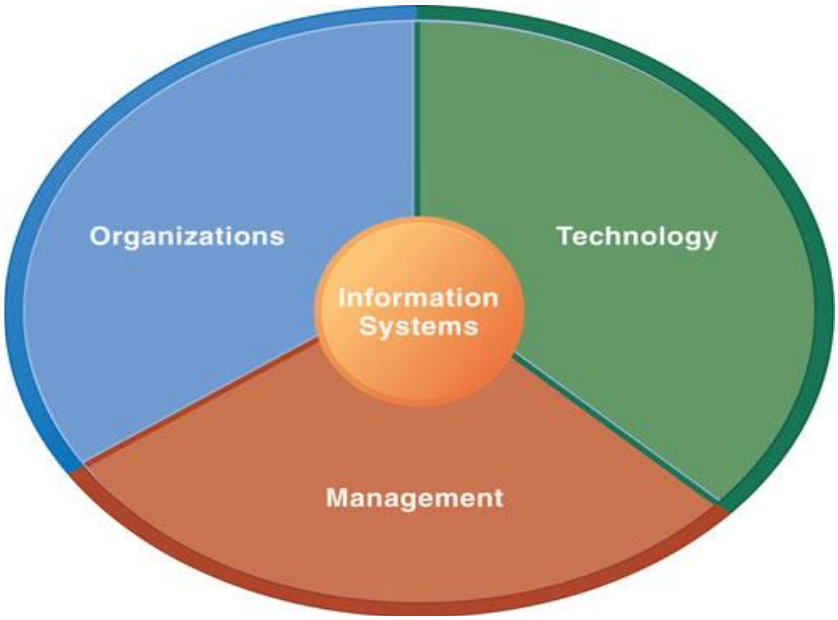


**Figure 2-6** Information system are more than Computers (Brynjolfsson, Erik. May 2005).

Using information systems effectively requires an understanding of the organization, management, and information technology shaping the systems. An information system creates value for the firm as an organizational and management solution to challenges posed by the environment.

Let's examine each of the dimensions of information systems—organizations, management, and information technology.

## I. Organizations of Information System:

Information systems are an integral part of organizations. Indeed, for some companies, such as credit reporting firms, there would be no business without an information system. The key elements of an organization are its people, structure, business processes, politics, and culture.

Organizations have a structure that is composed of different levels and specialties. Their structures reveal a clear-cut division of labor. Authority and responsibility in a business firm are organized as a hierarchy, or a pyramid structure. The upper levels of the hierarchy consist of managerial, professional, and technical employees, whereas the lower levels consist of operational personnel.

**Senior management** makes long-range strategic decisions about products and services as well as ensures financial performance of the firm. **Middle management** carries out the programs and plans of senior management and **operational management** is responsible for monitoring the daily activities of the business. **Knowledge workers**, such as engineers, scientists, or architects, design products or services and create new knowledge for the firm, whereas **data workers**, such as secretaries or clerks, assist with scheduling and communications at all levels of the firm. **Production or service workers** actually produce the product and deliver the service (see Figure 2-7).

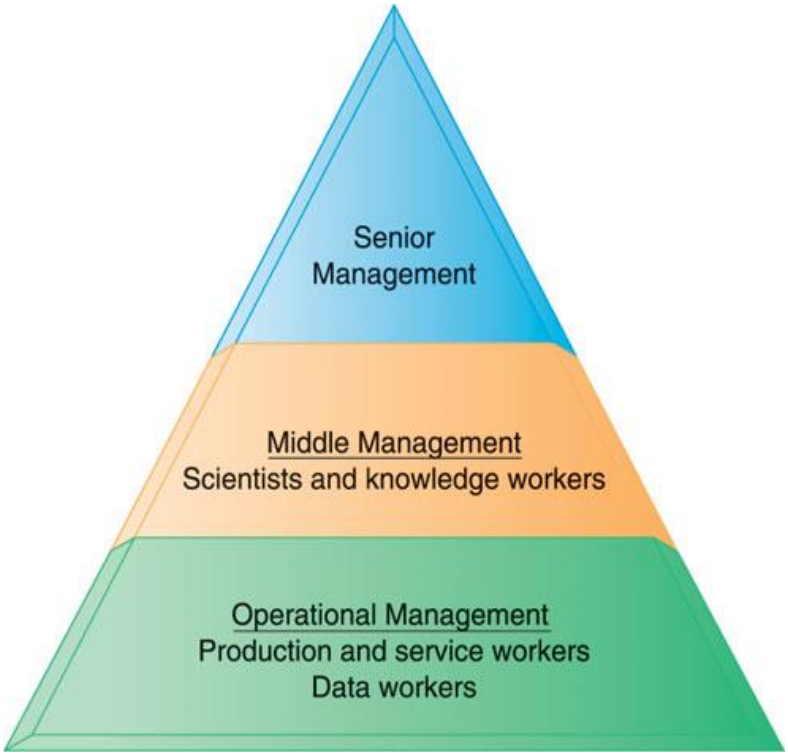


**Figure 2-7** Levels in a firm (Brynjolfsson, Erik. 2005)

Business organizations are hierarchies consisting of three principal levels: senior management, middle management, and operational management. Information systems serve each of these levels. Scientists and knowledge workers often work with middle management.

Finance and accounting, and human resources (see Table 2-2). An organization coordinates work through its hierarchy and through its business processes, which are logically related tasks and behaviors for accomplishing work. Developing a new product, fulfilling an order, and hiring a new employee are examples of business processes.

Most organizations' business processes include formal rules that have been developed over a long time for accomplishing tasks. These rules guide employees in a variety of procedures, from writing an invoice to responding to customer complaints. Some of these business processes have

been written down, but others are informal work practices, such as a requirement to return telephone calls from co-workers or customers, that are not formally documented. Information systems automate many business processes. For instance, how a customer receives credit or how a customer is billed is often determined by an information system that incorporates a set of formal business processes.

**Table 2-2** Major Business Functions (Brynjolfsson, Erik. May 2005).

| FUNCTION | PURPOSE |
|---|---|
| Sales and marketing | Selling the organization's products and services |
| Manufacturing and production | Producing and delivering products and services |
| Finance and accounting | Managing the organization's financial assets and maintaining the organization's financial records |
| Human resources | Attracting, developing, and maintaining the organization's labor force; maintaining employee records |

Each organization has a unique **culture**, or fundamental set of assumptions, values, and ways of doing things, that has been accepted by most of its members. Different levels and specialties in an organization create different interests and points of view. These views often conflict over how the company should be run and how resources and rewards should be distributed. Conflict is the basis for organizational politics. Information systems come out of this cauldron of differing perspectives, conflicts, compromises, and agreements that are a natural part of all organizations.

## II. Management of Information System:

Management's job is to make sense out of the many situations faced by organizations, make decisions, and formulate action plans to solve organizational problems. Managers perceive business challenges in the environment; they set the organizational strategy for responding to those challenges; and they allocate the human and financial resources to coordinate the work and achieve success. Throughout, they must exercise responsible leadership. The business information systems described in this book reflect the hopes, dreams, and realities of real-world managers.

But managers must do more than manage what already exists. They must also create new products and services and even re-create the organization from time to time. A substantial part

of management responsibility is creative work driven by new knowledge and information. Information technology can play a powerful role in helping managers design and deliver new products and services and redirecting and redesigning their organizations.

## III. Information Technology of Information System:

Information technology is one of many tools managers use to cope with change.

- **Computer hardware:** is the physical equipment used for input, processing, and output activities in an information system. It consists of the following: computers of various sizes and shapes (including mobile handheld devices); various input, output, and storage devices; and telecommunications devices that link computers together.
- **Computer software:** consists of the detailed, preprogrammed instructions that control and coordinate the computer hardware components in an information system
- **Data management:** technology consists of the software governing the organization of data on physical storage media.
- **Networking and telecommunications technology**: consisting of both physical devices and software, links the various pieces of hardware and transfers data from one physical location to another. Computers and communications equipment can be connected in networks for sharing voice, data, images, sound, and video. A network links two or more computers to share data or resources, such as a printer.

The world's largest and most widely used network is the Internet. The Internet is a global "network of networks" that uses universal standards to connect millions of different networks with more than 1.4 billion users in over 230 countries around the world. The Internet has created a new "universal" technology platform on which to build new products, services, strategies, and business models. This same technology platform has internal uses, providing the connectivity to link different systems and networks within the firm. Internal corporate networks based on Internet technology are called intranets. Private intranets extended to authorized users outside the organization are called extranets, and firms use such networks to coordinate their activities with other firms for making purchases, collaborating on design, and other interorganizational work. For most business firms today, using Internet technology is both a business necessity and a competitive advantage.

All of these technologies, along with the people required to run and manage them, represent resources that can be shared throughout the organization and constitute the firm's information technology (IT) infrastructure. The IT infrastructure provides the foundation, or platform, on which the firm can build its specific information systems. Each organization must carefully

design and manage its IT infrastructure so that it has the set of technology services it needs for the work it wants to accomplish with information systems. (Brynjolfsson, Erik. 2005)

## 2-7-2 Types of Information Systems:

In the real world, Information systems can be classified in several different ways, for example, several types of IS can be classified conceptually as either operation or management support IS. You'll see at the end of this discussion the integral role each type of system plays — from determining which kind of candy bar to make strategic level systems. (Kenneth C. Laudon Jane P. Laudon 2006)

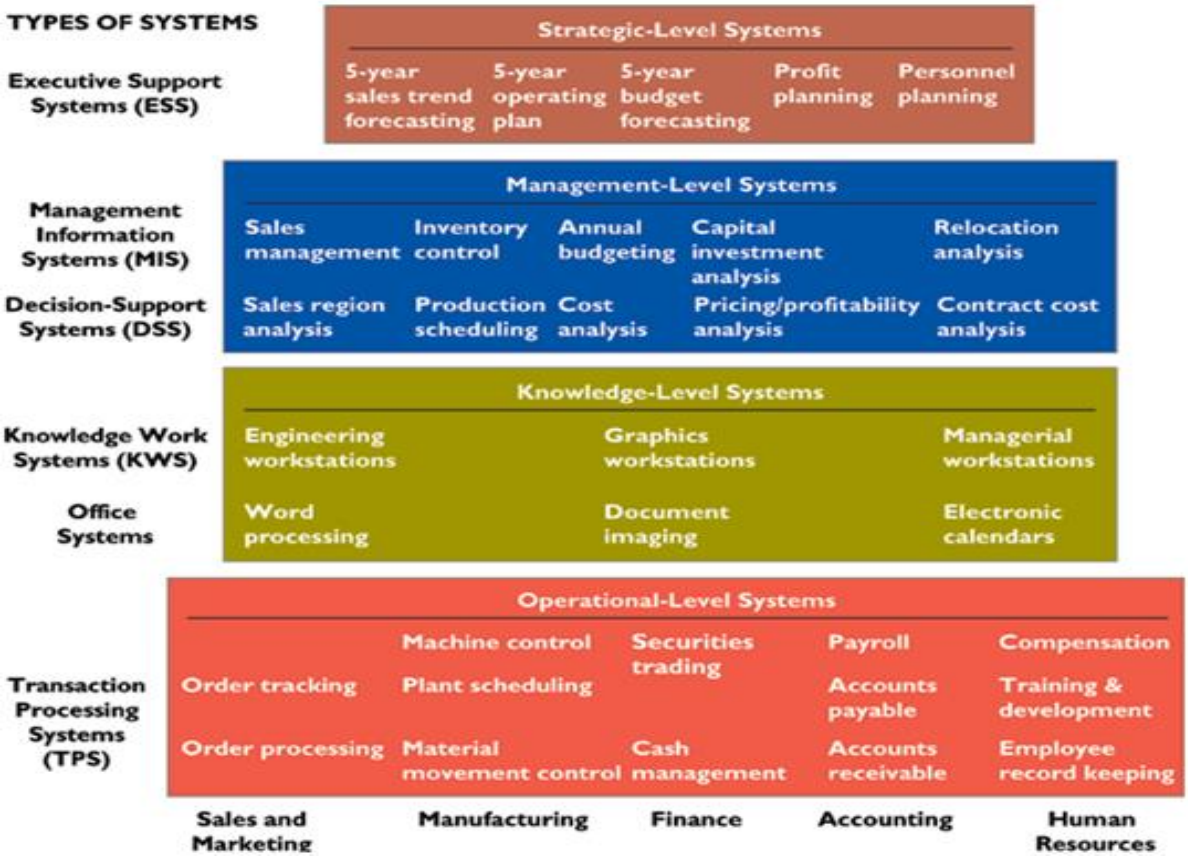


**Figure 2-8** the six major types of information system (Kenneth C. Laudon Jane P. Laudon 2006)

### I. Transaction Processing Systems:

The operational level of the organization includes the various units listed in Figure 2-9. And is responsible for daily operations. The information systems used in this level of the organization are transaction processing systems (TPS), so-called because they record the daily routine transactions that take place in everyday operations. TPS combine data in various ways to fulfill

the hundreds of information needs a company requires to be successful. The data are very detailed at this level.

People using transaction processing systems usually need information to help them answer routine questions such as: "How many products did we produce yesterday?" or "How much materials do we have on hand for today's production run?"

The operational level of an organization also includes functions not directly associated with the actual production of the, but vital in keeping the company running smoothly. But those workers that do appreciate the fact that they get a paycheck (salaries) every two weeks. Production workers also like to know that the human resource division is keeping track of training programs that may help them advance within the company. Each of these divisions requires an information system that helps it keep track of the many details that make the production worker happy and productive. The best transaction processing system will be integrated throughout the organization to supply useful information to those who need it when they need it.

The transaction processing system records the data from everyday operations throughout every division or department in the organization. Each division/department is tied and linked together through the TPS to provide useful information to management levels throughout the company.

## II. Management Information Systems:

Management Functions think about the functions of managers that you may have learned about in other classes: **Planning**, **Organizing**, **Directing**, **Controlling**, **Communicating**, and **Decision-making**. Each manager takes on these roles countless times in a day. Managers review endless amounts of data that make their jobs easier and more efficient.

Those using management information systems (MIS) require information on a periodic basis instead of on a daily recurring basis like those using a transaction processing system. Managers also require information on an exception basis. That is, they need to know if production is higher or lower than the targeted rate or if they are over or under their budgets. They also need to know about trends instead of straight numbers. The questions they may ask of the system would be: "How far behind in production are we for this quarter?"

Before integrated systems, managers received periodic printed reports that gave them lots of data, but often didn't supply information that they could utilize to make timely decisions. Planning was sometimes a wasted effort because the information the managers needed just wasn't there when they needed it.

With the integration of information systems up and down the management levels, and throughout the corporation, managers can often get needed information in a real-time mode. The data are kept online, the system can gather the precise information managers need to make a decision, and the information can be cross-integrated into all departments of the company. All divisions in the company can see what's going on throughout the corporation. Information can be passed from department to department so that they are all working "on the same page." The MIS will draw data from the transaction processing system to help managers answer structured. The human resources department alone can place vast amounts of personnel information, including job opportunities within the organization, on an intranet that workers can access when they find it convenient.

The greatest advantage of the new management information systems is that managers no longer have to wait until a specific time of the month or quarter to receive the information they need to perform their daily functions. The system can be configured to push the data to the appropriate manager instantaneously instead of relying on the managers to seek it out. And, managers can structure the reports to get only that information they deem necessary at the time. MIS summarize and report on the company's basic operations using data supplied by transaction processing systems. The basic transaction data from TPS are compressed and usually presented in reports that are produced on a regular schedule. Today, many of these reports are delivered online. Figure 2-9 shows how a typical MIS transforms transaction-level data from order processing, production, and accounting into MIS files that are used to provide managers with reports.

A management information system is used by managers throughout the organization to help them in directing, planning, coordinating, communicating, and decision making. The MIS will help answer structured questions on a periodic basis**.**

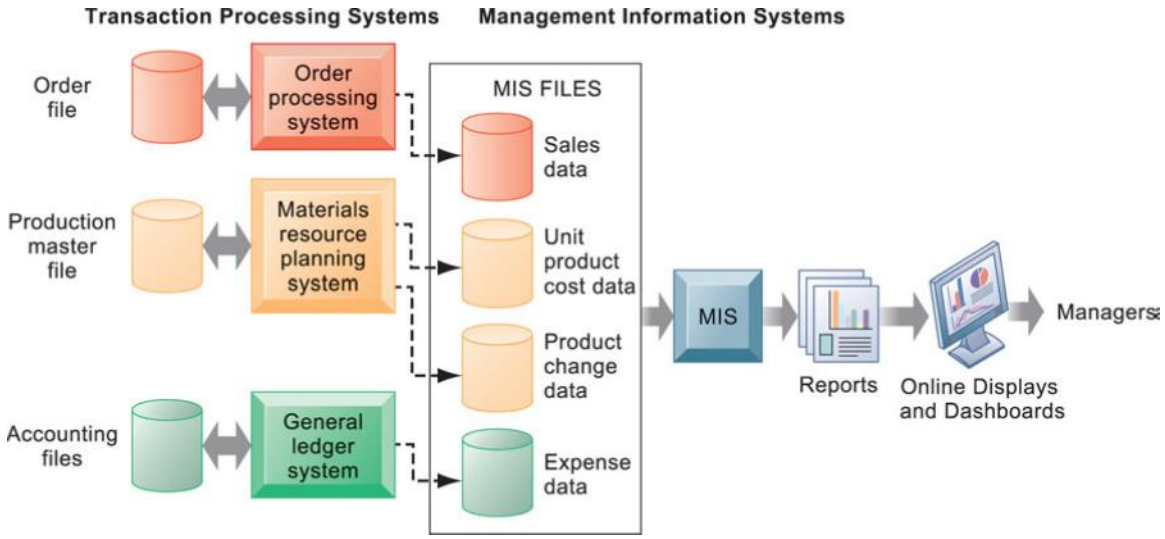


**Figure 2-9** How management information system obtain their data from the organizations TPS. (Kenneth C. Laudon Jane P. Laudon 2006)

## III. Decision Support Systems:

Decision-support systems (DSS) also serve the management level of an organization, but in a somewhat different way from an MIS. An MIS uses internal data to supply useful information. A DSS uses internal data but also combines it with external data to help analyze various decisions management must make. Analyzing complex, interactive decisions is the primary reason for a company to use a DSS.

You'll notice we describe decisions at this level as semi-structured. Not all decisions required for an organization to function smoothly are cut-and-dried. There are a lot of gray areas in successfully managing an organization and the larger the company, the more diverse the decision-making process becomes.

Decision-support systems also help those functions of an organization that may not be directly related to manufacturing the products. Remember the workers who were no longer required in manufacturing? What is the best way for the human resources department to handle this situation? Perhaps there is a planned increase in production coming up in the next quarter that will require the use of these workers. The human resources manager could use a decision-support system to determine if it is better to keep them on the payroll even if they won't be fully utilized for the next three months. When the unemployment rate is fairly low the company may have difficulty hiring new workers when they need them. Or perhaps the workers have specialized skills that aren't easy to find, so the company will actually save money in the long run by keeping these employees on the books.

Decision-support systems are used for complex "what-if" questions that require internal and external data. Decisions at this management level are mostly semi structured so the information system must respond to the unique requirements of the executives.

## IV. Executive Support Systems:

Executive support systems (ESS) are used at the very upper echelons of management. At the strategic level, the typical decision is unstructured. Often there is no specific question, but rather a series of undefined situations executives may face. There are no easy, definable answers. These executives require summarized, historical information gleaned (Collected) from all other levels of the organization, coupled with large amounts of external data gathered from many sources.

As executives haven't been using computers that long or don't have time to fiddle around learning how to type, executive support systems must be easy to use and the information must be easily manipulated. The ESS must be able to incorporate external information with internal data to offer concise, complete information for the imprecise and incomplete scenarios executives face. And most importantly, the systems must have a fast response time.

An executive support system helps managers make strategic decisions affecting the entire company. The decisions use internal and external data to give executives the information they need to determine the proper course of action in unstructured situations. (Kenneth C. Laudon Jane P. Laudon 2006)

## 2-8-3 Contemporary Approaches to Information System:

The study of information systems is a multidisciplinary field. No single theory or perspective dominates. Figure 2-10 illustrates the major disciplines that contribute problems, issues, and solutions in the study of information systems. In general, the field can be divided into technical and behavioral approaches. Information systems are sociotechnical systems. Though they are composed of machines, devices, and “hard” physical technology, they require substantial social, organizational, and intellectual investments to make them work properly. (Kenneth C. Laudon Jane P. Laudon 2012)

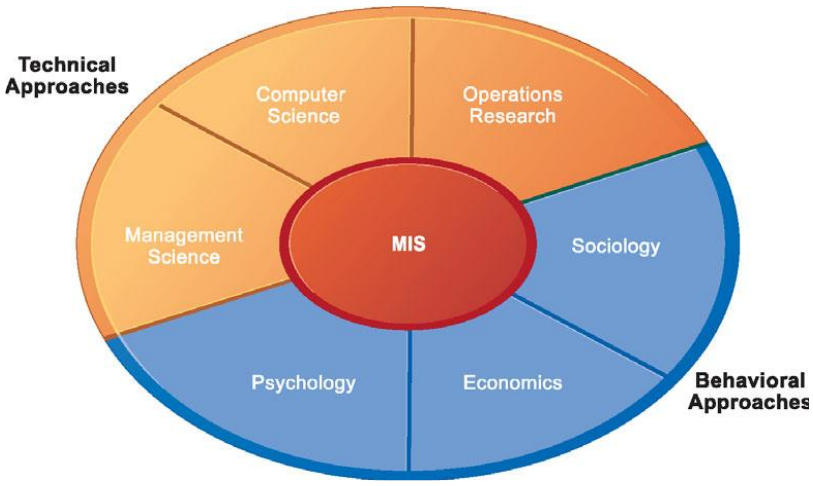


**Figure 2-10** Contemporary approaches to information system (Kenneth C. Laudon Jane P. Laudon 2012).

The study of information systems deals with issues and insights contributed from technical and behavioral disciplines.

## I. Technical Approach:

The technical approach to information systems emphasizes mathematically based models to study information systems, as well as the physical technology and formal capabilities of these systems. The disciplines that contribute to the technical approach are computer science, management science, and operations research. Computer science is concerned with establishing theories of computability, methods of computation, and methods of efficient data storage and access. Management science emphasizes the development of models for decision-making and management practices. Operations research focuses on mathematical techniques for optimizing selected parameters of organizations, such as transportation, inventory control, and transaction costs.

## II. Behavioral Approach:

An important part of the information systems field is concerned with behavioral issues that arise in the development and long-term maintenance of information systems. Issues such as strategic business integration, design, implementation, utilization, and management cannot be explored usefully with the models used in the technical approach. Other behavioral disciplines contribute important concepts and methods.

For instance, sociologists study information systems with an eye toward how groups and organizations shape the development of systems and also how systems affect individuals,

groups, and organizations. Psychologists study information systems with an interest in how human decision makers perceive and use formal information. Economists study information systems with an interest in understanding the production of digital goods, the dynamics of digital markets, and how new information systems change the control and cost structures within the firm.

The behavioral approach does not ignore technology. Indeed, information systems technology is often the stimulus for a behavioral problem or issue. But the focus of this approach is generally not on technical solutions. Instead, it concentrates on changes in attitudes, management and organizational policy, and behavior.

## III. Socio-technical Systems Approach:

The study of management information systems (MIS) arose to focus on the use of computer-based information systems in business firms and government agencies. MIS combines the work of computer science, management science, and operations research with a practical orientation toward developing system solutions to real-world problems and managing information technology resources. It is also concerned with behavioral issues surrounding the development, use, and impact of information systems, which are typically discussed in the fields of sociology, economics, and psychology.

No single approach effectively captures the reality of information systems. The successes and failures of information are rarely all technical or all behavioral. Indeed, the challenge and excitement of the information systems field is that it requires an appreciation and tolerance of many different approaches.

Adopting a sociotechnical systems perspective helps to avoid a purely technological approach to information systems. For instance, the fact that information technology is rapidly declining in cost and growing in power does not necessarily or easily translate into productivity enhancement or bottom-line profits. The fact that a firm has recently installed an enterprise-wide financial reporting system does not necessarily mean that it will be used, or used effectively. Likewise, the fact that a firm has recently introduced new business procedures and processes does not necessarily mean employees will be more productive in the absence of investments in new information systems to enable those processes.

Both the technical and behavioral components need attention. This means that technology must be changed and designed in such a way as to fit organizational and individual needs. Sometimes, the technology may have to be “de-optimized” to accomplish this fit. For instance, mobile phone

users adapt this technology to their personal needs, and as a result manufacturers quickly seek to adjust the technology to conform with user expectations. Organizations and individuals must also be changed through training, learning, and planned organizational change to allow the technology to operate and prosper. Figure 2-11 illustrates this process of mutual adjustment in a socio-technical system. (Kenneth C. Laudon Jane P. Laudon 2012)

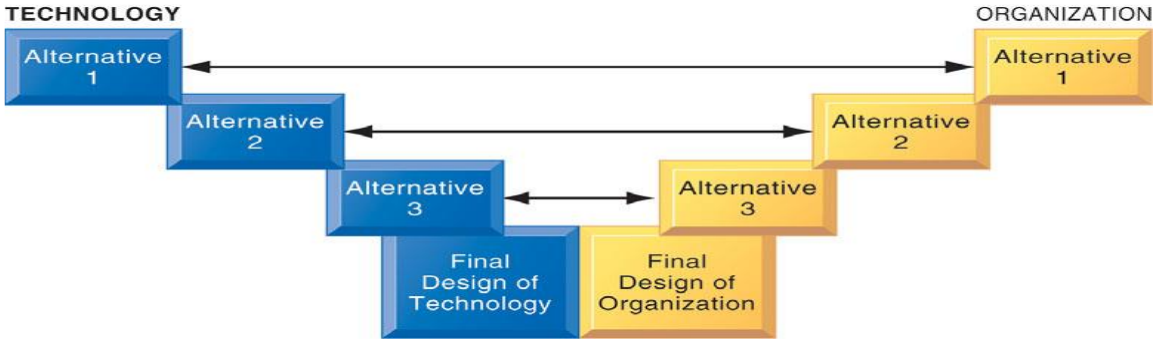


**Figure 2-11** A Socio-Technical Perspective on Information Systems (Kenneth C. Laudon Jane P. Laudon 2012).

In a socio-technical perspective, the performance of a system is optimized when both the technology and the organization mutually adjust to one another until a satisfactory fit is obtained.

## 2-8 Concept of Management Information System:

### I. Information and the MIS Concept:

Information is a set of classified and interpreted data used in decision making. It has also been defined as 'some tangible or intangible entity which serves to reduce uncertainty about future state or events' (Lucas, 1978). A management information system (MIS) is 'an integrated user-machine system for providing information to support operations, management and decision making functions in an organization. The system utilizes computers, manual procedures, models for analysis, planning, control and decision making, and a database' (Davis and Olson, 1984). MIS facilitates managerial functioning. Management information is an important input at every level in the organization for decision making, planning, organizing, implementing, and monitoring and controlling. MIS is valuable because of its content, form and timing of presentation. In the context of different levels of decision making, information can be described as:

- Source.
- Data.

- Inferences and predictions drawn from data.
- Value and choices (evaluation of inferences with regard to the objectives and then choosing a course of action).
- Action which involves course of action.

The MIS concept comprises three interrelated and interdependent key elements: management, system and information (Murdick and Ross, 1975).

## II. Management and the MIS Process:

An MIS is directed towards the managerial functions of planning, controlling and monitoring, and decision making.

Planning: Planning consists of five sequential and interactive steps (Kumar, 1989). These are:

- Selecting objectives.
- Identification of the activities which are required to achieve the stipulated objectives.
- Detailing the resources - including the various skills - required to undertake the activities.
- Determining the duration of each activity to be performed.
- Defining the sequence of the activities.

The basic requirements during the planning process of most importance in designing and implementing an MIS for an organization are (Kumar, 1989):


- Selecting objectives.
- Identification of the activities which are required to achieve the stipulated objectives.
- Detailing the resources - including the various skills - required to undertake the activities.
- Determining the duration of each activity to be performed.
- Defining the sequence of the activities.

The basic requirements during the planning process of most importance in designing and implementing an MIS for an organization are (Kumar, 1989):

- Providing the information required by the planner at each step of planning.
- Establishing procedures for obtaining the information.
- Arranging for storage of the approved plans, as these will provide the information requisite to monitoring and controlling.
- Evolving methods for communicating the plans to employees in the organization.

**Monitoring and controlling:** Controlling 'compels events to conform to plans' (Murdick and Ross, 1975). It involves:

Establishing standards of performance in order to reach the objective.

Measuring actual performance against the set standards.

Keeping actions on course by correcting deviations as they appear (mid-course corrections).

The requirements for successful development of a control system are:

- Defining expectations in terms of information attributes.
- Developing the logic for reporting deviations to all levels of management prior to the actual occurrence of the deviation.

**Decision making:** Decision making is the process of selecting the most desirable or optimum alternative to solve a problem or achieve an objective. The quality and soundness of managerial decisions is largely contingent upon the information available to the decision-maker. Gorry and Scott Morton (1971) classified decision making on three levels of a continuum:

Strategic decisions are future-oriented because of uncertainty. They are part of the planning activity.

Tactical decision making combines planning activities with controlling. It is for short-term activities and associated allocation of resources to them to achieve the objectives.

Technical decision making is a process of ensuring efficient and effective implementation of specific tasks.

**Elements of decision making:** The four components of the decision making process are (Burch and Strater, 1974):

- Model a model is an abstract description of the decision problem. The model may be quantitative or qualitative.
- Criteria The criteria must state how goals or objectives of the decision problem can be achieved. When there is a conflict between different criteria, a choice has to be made through compromise.
- Constraints. Constraints are limiting factors which define outer limits and have to be respected while making a decision. For example, limited availability of funds is a constraint with which most decision makers have to live.
- Optimization once the decision problem is fully described in a model, criteria for decision making stipulated and constraints identified, the decision-maker can select the best possible solution.

## III. Organizational Structure and MIS:

MIS has been described as a pyramidal structure, with four levels of information resources. The levels of information would depend upon the organizational structure. The top level supports strategic planning and policy making at the highest level of management. The second level of information resources aid tactical planning and decision making for management control. The third level supports day-to-day operations and control. The bottom level consists of information for transaction processing. It then follows that since decision making is specific to hierarchical levels in an organization, the information requirements at each level vary accordingly.

Thus, MIS as a support system draws upon:

- Concepts of organization.
- Organizational theories, principles, structure, behavior and processes such as communication, power and decision making.
- Motivation and leadership behavior.

Davis and Olson (1984) analyzed the implications of different characteristics of the organizational structure on the design of information systems (Table 2-3).

## 2-9 Information requirements for MIS:

### I. Assessing Information Needs:

A first step in designing and developing an MIS is to assess the information needs for decision making of management at different hierarchical levels, so that the requisite information can be made available in both timely and usable form to the people who need it. Such assessment of information needs is usually based on personality, positions, levels and functions of management. These determine the various levels of information requirements.

**Table 2-3** Organizational structural implications for information systems (Davis and Olson, 1984.)

| **Concept** | **Implications for Information Systems** |
|---|---|
| Hierarchy of authority | A tall hierarchy with narrow span of control requires more formal control information at upper levels than a flat hierarchy with wide span of control. |
| Specialization | Information system applications have to fit the specialization of the organization. |
| Formalization | Information systems are a major method for increasing formalization. |
| Centralization | Information systems can be designed to suit any level of centralization. |
| Information model of organization | Organizational mechanisms reduce the need for information processing and communication. Vertical information systems are an alternative to lateral relations. Information systems are used to coordinate lateral activities. |
| Organizational culture | Organizational culture affects information requirements and system acceptance. |
| Organizational power | Organizational power affects organizational behavior during information system planning, resource allocation and implementation. Computer systems can be an instrument of organizational power through access to information. |
| Organizational growth | The information system may need to change at different stages of growth. |
| Goal displacement | When identifying goals during requirements determination, care should be taken to avoid displaced goals. |
| Organizational learning | Suggests need for information system design for efficiency measures to promote single loop learning and effectiveness measures for double loop learning. |
| Project model of organizational change | Describes general concepts for managing change with information system projects. |
| Case for stable system | Establish control over frequency of information system changes. |
| Systems that promote organizational change | Reporting critical change variables, organizational change, or relationships, and use of multiple channels in a semi-confusing system may be useful for promoting responses to a changing environment. |
| Organizations as socio-technical systems | Provides approach to requirements determination and job design when both social and technical considerations are involved. |

## II. Levels of Information Requirements:

There are three levels of information requirements for designing an MIS (Davis and Olson 1984). They are:

- At the organizational level, information requirements define an overall structure for the information system and specific applications and database.
- Application level requirements include social or behavioral - covering work organization objectives, individual roles and responsibility assumptions, and organizational policies - and technical, which are based on the information needed for the job to be performed. A significant part of the technical requirement is related to outputs, inputs, stored data, structure and format of data and information processes.
- At the user level, database requirements can be classified as perceived by the user or as required for physical design of the database.

## III. Strategies for Determining Information Requirements:

Davis and Olson (1984) suggested six steps in selecting a strategy and method for determining information requirements (Table 2-4).

**Table 2-4** Strategies for determining information requirements. (Davis and Olson, 1984)

| |
|---|
| 1. Identify elements in the development process<br>□ Utilizing systems<br>□ Information system or application<br>□ Users<br>□ Analysis |
| 2. Identify characteristics of the four elements (in 1, above) in the development process which could affect uncertainty in the information requirements. |
| 3. Identify the process uncertainties<br>□ Existence and availability of a set of usable requirements.<br>□ Ability of users to specify requirements.<br>□ Ability of the analyst to elicit and evaluate information requirements.<br>Assess how the characteristics of the four elements in the development process (listed under 1, above) will affect these process uncertainties. |
| 4. Determine how the overall requirements uncertainties would be affected by the combined effects of the process uncertainties. |

5. Considering the overall requirements uncertainty, choose a primary strategy for information requirements.
If uncertainty is low, then the strategy should be to:
 Ask the users what their requirements are. This presupposes that the users are able to structure their requirements and express them objectively. Asking can be done through
- questions, which may be closed or open,
- brainstorming sessions, totally open or guided, and
- group consensus as aimed at in Delphi methods and group norming.
 Wherever there are close similarities in the organization and easy replication is possible, information requirements can be derived from the existing system.
 Characteristics of the utilizing system should be analyzed and synthesized. This is particularly useful if the utilizing system is undergoing change.
If uncertainty is high, discover from experimentation by instituting an information system and learning through that the additional information requirements. This is 'prototyping' or 'heuristic development' of an information system.

6. Select an appropriate method.

## 2-10 MIS Implementation:

### I. MIS Implementation Process:

The implementation of new information systems is a significant investment for organizations. Since information systems are sociotechnical systems, development involves the joint design of activity systems and ICT systems (Davies, 2009). It is important to define the key stages of the information system implementation process. Consequently, Davies (2009) presented information system implementation stages which are concerned with a number of key activities in the process. In addition, this information system implementation process concept is similar to O'Brien (2004) who explained a five-step process called the information systems development cycle which includes the steps of:

(1) Investigation; (2) analysis; (3) design ;( 4) implementation; and (5) maintenance (see Figure 2-12).

The first phase of information system development process is systems investigation or system conception which is aimed to determine how, based on informatics planning and management, to develop a project management plan and obtain management approval. Systems analysis is focused on identifying the information needs and developing the functional requirements of a system. Systems design is the process of planning a technical artefact and developing specifications for hardware, software, data, people, and network. In addition, this phase involves building the information system to its specifications. System implementation

involves delivery of systems, testing the system, training people to use the system, and converting to the new business system. Finally, system maintenance is the process of making necessary changes to the functionality of an information system. (O'Brien, 2004; Davies, 2009)

Nontehless, Zmud and Cox (1979) defined, traditionally, the MIS implementation stage which involves different related activities including: initiation, strategic design, technical design, development, conversion, and evaluation. Each implementation stage can be described as follows: initiation includes project definition and justification; strategic design refers to establishing the scope and requirement of a project (i.e. design attribute visible to the users); technical design involves translating the strategic design into hardware, software, and process specifications (i.e. design attributes not visible to the users); development concerns the acquisition of hardware, the acquisition and construction of software, and the testing of both hardware and software; conversion relates to the insertion of the new information system into the organization; finally, evaluation assesses the effectiveness and efficiency of the MIS.

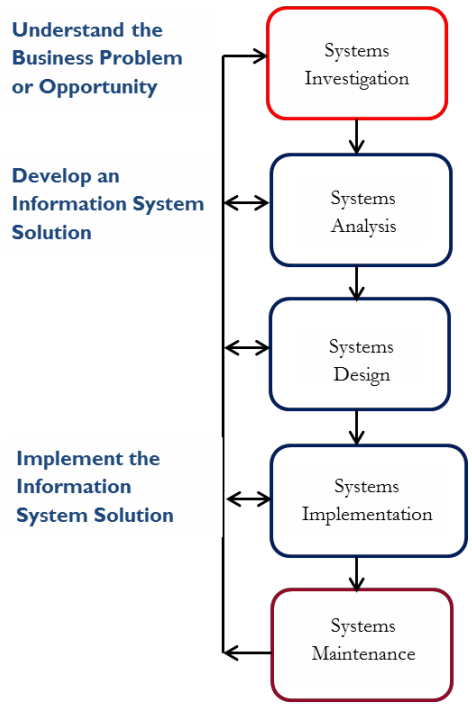


**Figure 2-12** Information System Development Cycles (O'Brien, 2004.)

One of the most important processes of IT implementation is the initial part of the project or strategic planning of IT. Nowadays, many companies focus on their strategic planning with aims to develop long-term plans, change their organization, and improve their competitiveness

(Gunasekaran & Ngai, 2004). Planning is a major issue for the IT implementation process, and IT planning can be defined as "organizational activities directed toward:
(1) Recognizing organizational opportunities for using information technology;
(2) Determining the resource requirements to exploit these opportunities; and
(3) Developing strategies and action plans for realizing these opportunities and meeting the resource needs" (Boynton & Zmud, 1987).

However, before implementation, it is important to view the business model, and then identify suitable IT systems requirements (Gunasekaran & Ngai, 2004). In order to increase the effective IT planning process, therefore, Boynton and Zmud (1987) suggested nine planning agenda. This IT planning agenda points out various issues that managers or organizations require giving attention to, including:

- Intra-organizational political analysis.
- Intra-organizational market analysis.
- Business strategy analysis.
- Business market analysis.
- Technology analysis.
- Organizational learning analysis.
- Organizational culture.
- IT infrastructure analysis.
- IT risk-taking analysis.

In IT projects management, IT planning is a significant process and Bailey (1998) also mentioned three approaches for planning in project management which are: linear planning, exploratory planning, and personal planning. Furthermore, implementation of IT systems requires a project management approach administrated by the right team for the planning and implementation of the IT project. This process should be supported by top management in order to achieve the successful IT project. (Gunasekaran & Ngai, 2004)

On the IT procurement process, Beaumaster (2002) claimed that IT procurement involves all aspects of IT acquisition not only the software and hardware, but also various services, support personnel, intellectual properties, and items related to information technologies. Furthermore, Beaumaster (2002) provided the necessary functions in this process including: investment analysis, risk assessment analysis, life cycle planning, and systems acquisition.

Various factors required, according to Beaumaster (2002) regarding IT implementation, concern putting the system into practice, managing change, developing skills, training and evaluation. In order to achieve implementation goals and objectives, Gunasekaran and Ngai (2004) claimed that successful implementation of IT needs a strong project team which can include key and IT knowledge managers from all functional areas. Moreover, they suggested that education and training are the most important factors of any change process in an organization and the users need to be motivated to work in a transparent and open communication environment. One of the important factors in IT implementation is that top management support and are involved in order to successfully implement the IT solution (Gunasekaran & Ngai, 2004).

According to O'Brien (2004), the information systems implementation activities involve hardware and software acquisition, software development, testing of programs and procedures, development of documentation, and a variety of conversation alternatives. Also, education and training of end-users and specialists who will operate a new information system are involved. The first step, acquisition of hardware, software, and services, concerns how the organizations evaluate and select the hardware, software, and IT services; thus all hardware and software requirements are set up. Most large organizations both in private and public sectors formalize these requirements by listing them in a document called an RFP (request for proposal) or RFQ (request for quotation). Then these requirement documents are sent to the suitable vendors and the agreement is signed. The next step is concerned with development or modification of software application in order to meet the organization's requirements. The third stage is a vital implementation activity which involves the education of and training of the IS personnel such as end-users and user consultants. They have to learn how the new technology impacts the organization's business processes and management. The fourth step concerns developing documentation for the system's users. Finally, the last step is the conversion process which concerns changing the approaches from the old systems to new systems. Conversions can be achieved on a parallel basis, phases basis, pilot conversion, and plunging in to a new system. (O'Brien, 2004).

Another perspective of implementation process was stated by Kuruppuarachchi, Mandal and Smoth (2002), who presented the phases and main functions of IT projects that are similar as the literature mentioned previously. These phases consist of project initiation, requirement definition, acquisition/development, implementation, and termination. In addition, they claimed that every IT project should carry out quality control, risk management, and change

management over the entire life cycle of the project. In order to achieve IT project implementation, Kuruppuarachchi et al. (2002) also explained that the manager should meet these three basic requirements that include: (1) a clear business objective; (2) understand the nature of the change; and (3) understanding the project risk, in order to achieve IT project implementation. This section has presented various views and perspectives of MIS implementation or "IS development and deployment" processes which provide general knowledge in order to perceive this study. In the following section, MIS implementation challenges are described.

## II. MIS Implementation Challenges:

From previous research, Beaumaster (1999) identified and categorized problematics issues regarding the IT implementation. These issues create or worsen the implementation problems (summarized in Table 2-5). The more specific categorizations of the issues can be viewed as: management process issues, organizational environment issues, leadership issues, technical systems issues, and personnel issues.

Management process issues speak to the functional operation of an organization such as budgeting, personnel, and general management.

Organizational environment issues are identified as factors which are less tangible such as organizational culture, change, and behavior.

Leadership issues relate to the areas which involve the interaction and direction of the organization executive.

Technical systems issues are mainly those referring to the hardware and software considerations of information technologies.

Personnel issues are those issues surrounding each individual in the organization.

These issues impact the planning, procurement, and deployment of information systems in their organizations. In this study, these categorizations of information system issues will be the frame of study in terms of challenges or problems that an organization faces when a new information system is implemented.

In addition, Kwon and Zmud (1987) claimed that MIS implementation processes are not easy to achieve. They also identified some issues which many organizations have faced and these factors also impact organizational processes and products associated with each implementation stage. These factors include characteristics of the organization (specialization, centralization,

formalization), characteristics of the technology being adopted (complexity), characteristics of the task to which the technology is being applied (task uncertainty, autonomy and responsibility of person performing the task, task variety), and characteristics of the organizational environment (uncertainty, interorganizational dependence). Another perspective of MIS implementation challenges is also presented by Lucey (2005) that the problems relate to MIS implementation include the following: lack of management in the design phase of the MIS, inappropriate emphasis of the computer system, undue focus on low-level data processing applications particularly in the accounting area, lack of management knowledge of computers, poor appreciation by information specialists of management's true information requirements and of organizational problems, and lack of top management support.

The categorization of implementation challenge issues in Table 2-5 Presented by Beaumaster (1990), will be used as a framework.

**Table 2-5** Categorization of Information System (IS) Implementation Challenge Issues (Beaumaster, 1999.)

| **Leadership Issue** | **Management Process Issues** | **Organization Environment Issues** | **Technical Systems Issues** | **Personnel Issues** |
|---|---|---|---|---|
| Inter-departmental Coordination | Strategic Planning | Organizational Culture | Existing Systems | Organizational Expertise |
| Individual Support | Budgeting | Internal and External Politics | Standardization | Individual Expertise |
| Organizational Support | Organizational Directives | Contracts | Compatibility | Internal Leadership |
| Timeframes and Scheduling | Written Guidelines | Changing Technologies | | Staffing |
| | | External Consultants | | Resistance to Change |
| | | | | Training |

## III. Key Issues for MIS Implementation Success:

The key issues to successfully achieve MIS implementation can be defined in the same meaning as success factors. Most concepts of success factors in the IS literature are described as critical success factors (CSFs). CSFs in the information system (IS) literature is well established for numerous contexts such as requirement analysis, IS planning, and project management (Somers

& Nelson, 2001). Most of the literature in CSFs have been identified for ERP systems implementation which are favorites and worldwide information systems in many companies. These CSFs are investigated by many researchers such as Nah, Lau and Kuang (2001) who presented 11 factors that were critical to ERP implementation success. Moreover, Motwani, Subramanian, and Gopalakrishna (2005) investigated the factors facilitating and inhibiting the success of ERP projects and identified CSFs during ERP implementation stages. The CSFs can be viewed as situated exemplars that help extend the boundaries of process improvement, and whose effect is much richer if viewed within the context of their importance in each stage of the implementation process (Somers & Nelson, 2001). Boynton and Zmud (1984) claim that the CSFs method can be applied as a means of supporting both MIS planning and requirements analysis. In addition, they described the concept of CSFs as those few things that must go well to ensure success for a manager or an organization. According to Gargeya and Brady (2005), they identified six factors both for success and failure of ERP implementation and they also claimed that the managers should concentrate on these factors which contribute to avoid the failure and guarantee the success of ERP implementation. Referring to Lucey( 2005), CSFs may also help to clarify and refine the organization's information requirements. When the CSFs are identified the information system should be tailored to provide specific, detailed information that enables management to monitor progress towards meeting those objectives.

There are many investigations of IT project implementation success factors. One study from Slevin and Pinto (1986) presented a list of success factors which are the same as the Project Management Institute's Project Management Handbook. Also, Tan (1996) presented a set of success factors including technical characteristics, user involvement, communications, management support, project team characteristics, difference between technology provider and receiver, incentives, infrastructure support and obstacles, to identify their effects on external technology transfer project. Moreover, a list of success factors are also drawn up by Milis and Mercken (2002), who found a large number of possible success factors and also provided an overview of the possible success factors regarding IT project implementation. However, in conclusion, they can group the success factors into four categories as follows. The first category integrates factors which influence goal congruency. The second category contains the components that relate to project team in order to improve the motivation and cooperation of the team. The third category concentrates on the acceptance of the project and the result. Finally, the fourth category is concerned with the implementation process which deals with implementation politics and planning.

## IV. Organizational Impacts of an Implementation:

In order to understand effects and consequences by implementing IS which affect an organization and its processes, it is essential to describe various perspectives of impacts originated by adopting IS. Once an information system (IS) is introduced, IS has affected their context of use in activity system in an organization. Activity system is defined as a community system which a combination between a logical collection of activities and processes or tasks that performed by a group of people in pursuit of a goal. According to Figure 2-13, it illustrates various dimensions of impact including intended effects, unintended effects, positive effects, negative effects, and impacts on individuals, groups, and organizations. The effects can be positive or negative depending on how well the system is aligned with its context. In other words, both intended and unintended positive effects are created when the IS is closely aligned with their activity system, whereas, if it is misaligned with an activity system, as a result, it can generate negative effects (Davies, 2009).

In today's business environment, many companies expect that a positive impact is established when they decide to implement an information system. However, a manager should consider some factors in order to perceive the impact, for instance Gurbaxani and Whang (1991) described that it is important to categorize the role of the information system in an organization as mentioned previously, and to determine with other organizational and environmental factors in order to analyze the impact of the information system on an organization.

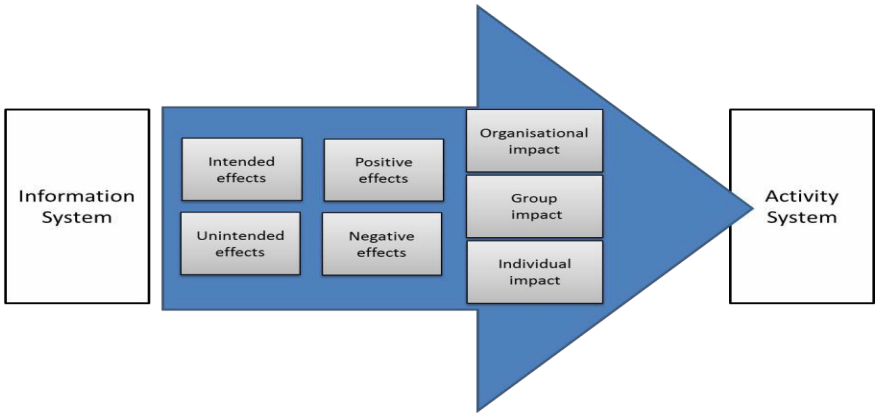


**Figure 2-13** Dimensions of Impact (Davies, 2009)

# Chapter 3

# CHAPTER 3

# Application MIS in Construction Projects

## 3-1 Introduction:

There are many millions of documents (such as drawings, specifications, bills of quantities, correspondence, schedules, programmes) currently exchanged on paper between practitioners in the Irish 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, 2005) At present the extent of use of Information Communication Technology (ICT) in the 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 (Hore and West, 2005b). Competition from international firms as a result of increased globalization has prompted a renewed focus on improving general performances within the construction industry,(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 Aouad 2000)

## 3-2 MIS and Construction Industry:

### I. The Current, Installed Data Information System:

The conventional computer-based data/information systems which many construction companies are currently using are interactive data/information systems that utilize decision rules and models, coupled with a comprehensive database. These systems include Decision Support System (DSS), Management Information System (MIS), and Data Base System (DBS), which provide the following support:

- Retrieve a single item of information.
- Provide a mechanism for ad hoc data analysis.
- Aggregate prespecified data.
- Estimate the consequences of proposed decisions.
- Propose decisions.
- Formulate strategies.

The first five are typical computer-based data/information functions. The last one, which requires judgement and creativity, can be done by an expert system. The expert system can supplement the computer-based data/information system by using a built-in associative memory with knowledge of business and inferential rules. While current computer-based data/information systems support quantitative, mathematical, and computational capability, computer-based data/information systems should also be developed to support qualitative analysis based on analogical reasoning (e.g., deduction), explanation capabilities for procedures, solutions, and closed-system assumptions. The problem domain is circumscribed and the system's functions are confined to boundaries. (Turban, E., Watkins, R., 1986)

### II. Knowledge-Based Expert Systems:

The Knowledge-Based Expert System (KBES), which is in the conceptualization stage of the development process, is a computer program that includes a knowledge base containing an expert's knowledge for a general purpose domain for construction project management research, and a reasoning mechanism for propagating inferences over the knowledge base.

The effective representation of domain knowledge is generally considered to be the keystone to the success of the KBES. The most important need for an expert system prototype development is the need for techniques to examine a problem and to develop its amorphous shape into something concrete enough so that a prototype system can be

created. Presented in Table 3-1 are the steps from initiation to implementation. (Freiling, Mike, et al, 1985)

**Table 3-1** Phases of Analysis and Project Document. (Freiling, Mike, et al, 1985)

| KNOWLEDGE DEFINITION PHASE | | |
|---|---|---|
| NUMBER | STEP | PROJECT DOCUMENT |
| 1 | Familiarization | Paper knowledge base |
| 2 | Organizing | Knowledge acquisition |
| 3 | Representation | Internal knowledge base format |
| PROTOTYPE IMPLEMENTATION PHASE | | |
| 4 | Acquiring knowledge | Knowledge base |
| 5 | Inference strategy design | Inference engine |
| 6 | Interface design | Interface |

In the nature of the construction industry, the advantages of the role of frame-based representation in reasoning are considerable: There are considerable advantages to a frame based representation. They are designed to function in much the same way construction experts think. This frame representation provides a concise structural representation of useful relations and contains a concise definition-by-specialization technique that is easy for most domain experts to use. Frame representations are particularly useful because the taxonomic relationships among frames enable descriptive information to be shared among multiple frames (via inheritance) and allows the internal structure of the frame to semantically integrate and maintain the constraints.

The KBES has the capacity to integrate frames and production rules into a single unified representation facility. The utility of such hybrid facilities is becoming increasingly evident with experience. One of the major advantages of this kind of hybrid facility is its ability to make the organizational and expressive power of object- oriented programming available to domain experts who are not programmers. The basic components of the KBES are discussed in order to highlight the role in the reasoning of a knowledge system. (Fikes, R., Kehler, T., 1985)

The KBES has many advanced capabilities. It can implement architecturally based system, is able to integrate structural knowledge frame systems and can interact with existing computer-based data/information systems:

- Incrementalism: to start small and build incremental prototypes that service a real need in the construction industry, until construction experts became available and descriptions of additional information's are obtained.
- Accessibility: to allow both construction expe1ts and the end users accessibility to a fully integrated and comprehensive system. This means that the organization of knowledge in the system has to correspond closely to the organization used by construction experts and the end users.
- User Participation: to allow the end users to participate in building the system. It is very necessary to demonstrate the prototype KBES early in order to decide if it's the best-fit solution.
- Select ability: to have the capability to set aside the KBES system or call up specific tasks and have the system operating in a working environment.

(Furguson, J.D., Siemens, R., 1985)

The summary of the features of formalization and several reasoning capabilities are shown in Figure 3-1

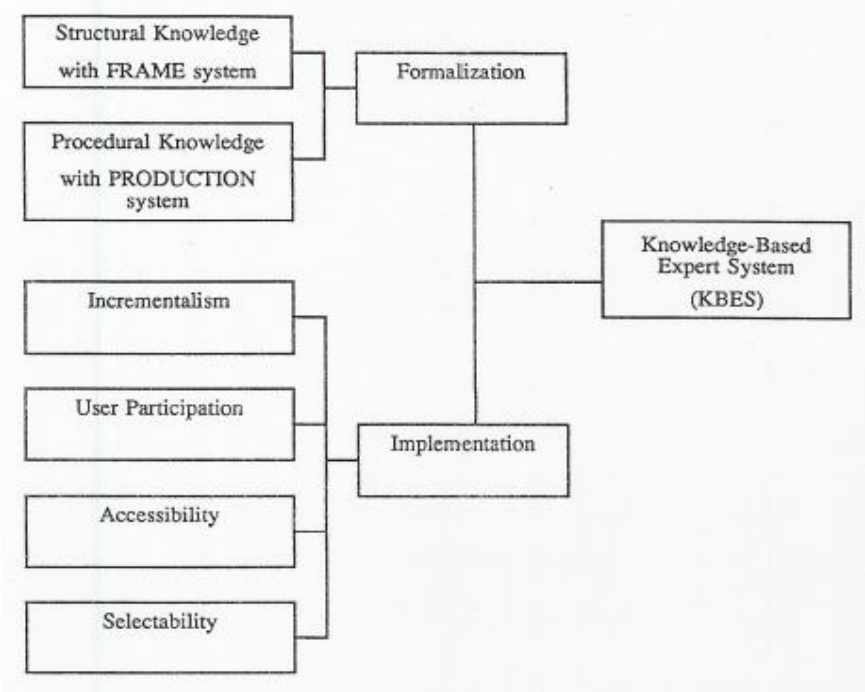


**Figure 3-1** the structure of the KBES (Furguson, J.D., Siemens, R.,)

## III. The Construction Information System:

A human expert frequently uses databases. It is reasonable to assume that a computerized expert would need to do the same. The KBES should be able to access the existing computer-based data/information system to obtain factual knowledge. The Construction Information System (CIS), which is an integration of the current computer- based data/information system and the KBES, is designed to complete this task. The proposed integration diagrammed in Figure 3-2 illustrates the implementation process.

The CIS may be envisioned as follows: The end user works with the conventional computer-based data/information system and follows the first five steps. When the KBES reaches the strategy formulation phase, it will be able to completely separate the database and assume the role of a human expert. The end user will be able to call up the system and access the expertise of the strategy formation.

The integration process of the CIS will require compatibility of hardware and software. If an existing expert system runs on a LISP-type machine, and the conventional data/information system on a microcomputer, there are technical problems, such as the need to use different programming languages. At the present time the development tools of computer-based data/information systems and KBES are completely independent. However, there are some indications that such tools can be combined. Some commercial tools already include a universal database and a natural language interface, which combine an expert system's shell with a database management system, graphics, spreadsheet, and communications package. (Scott Morton, M., 1984)

The dynamics of the integration process will present many management challenges. One relevant issue the CIS model faces is that construction managers have increasingly criticized computer professionals for their relative inability to deliver systems that meet the end user's sophisticated needs and that are on time and cost effective. However, there are several reasons why the CIS model will be capable of meeting these concerns. First, there is evidence that several computer-based data/information systems already are structured to the construction industry, and they are usually broader in scope, while the KBES is applied to a narrow domain; therefore, it logically follows that several small KBES may be needed to fully support one computer-based data/information system in order to meet the end user's real needs. Second, recent developments in software tools could make the development of the KBES economically feasible. The

development of this new system could exclusively serve current data/information systems and thus reduce the overall costs. (Reitman, W., 1982)

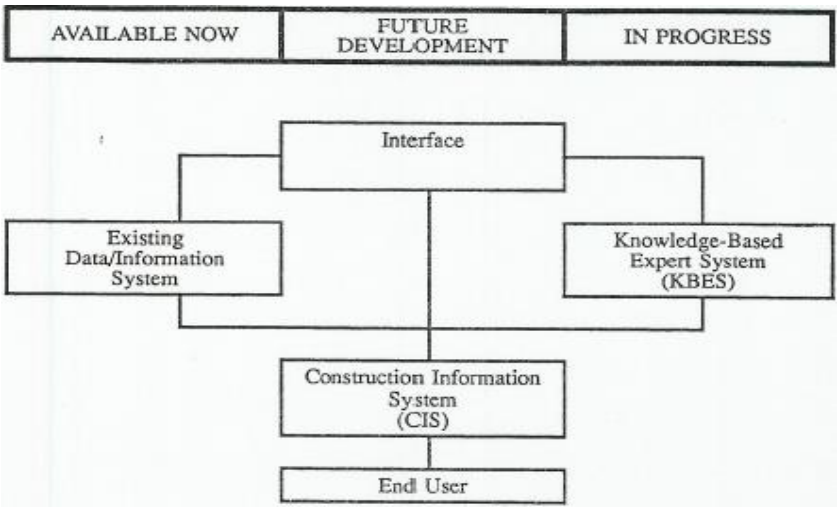


**Figure 3-2** The Conceptual Design of the CIS (Scott Morton, M., 1984).

## IV. Key Drivers for Change:

The nature of the construction industry is different to other industries, such as the manufacturing or retail sector, where processes and the working environment are well defined and controlled (Gann, 1996). The temporary nature and uniqueness of construction projects is reflected in one-off locations, one-off designs solutions and one- off project teams, which leads to a very fragmented communication platform (see Figure 3-3). This has led to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains (Love et al., 1999).

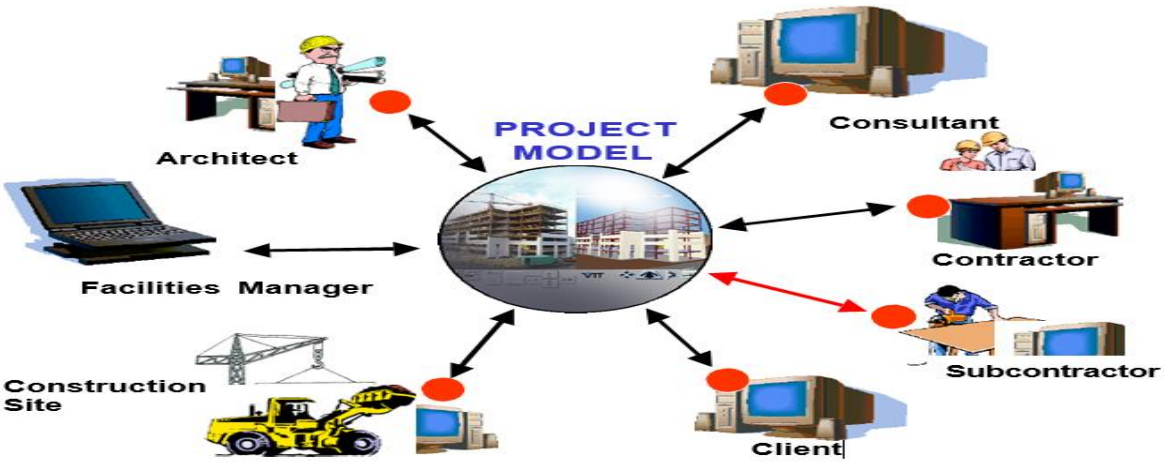


**Figure 3-3** Fragmented nature of the construction industry (Sarshar et al., 2000).

This, in turn, has created challenges for the application of ICTs in the Irish construction industry. It is now becoming accepted that the preferred communication model for managing information on a construction project should be based on a central project model, through which, all the information is disseminated (Figure 3-4 ).

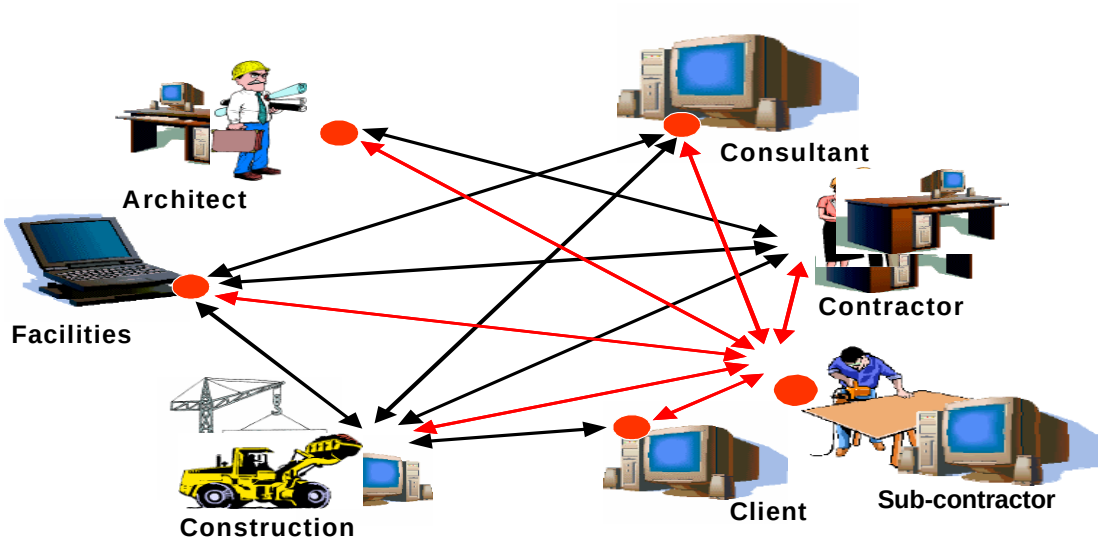


**Figure 3-4** preferred communication model for construction (Sarshar et al., 2000)

## V. Opportunities for Electronic Support in Construction:

Construction sectors in many countries around the world are increasingly recognizing the importance of ICT. ICT is improving the capability and efficiency of specific aspects within the construction process. It also has the potential to vastly improve communication throughout the construction process (see Figure 3-5) through electronic dissemination of information. (Sarshar et al., 2000).

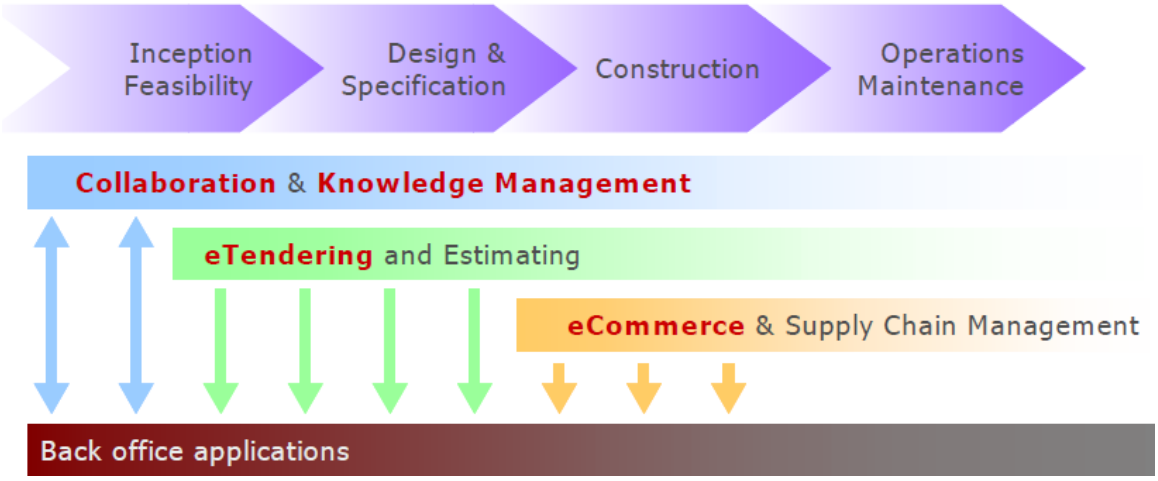


**Figure 3-5** Illustration of how ICT can support the construction process (Sarshar et al., 2000).

ICT should support the entire construction process from inception through to the operational maintenance of the building asset. The idea of a project model that supports improved co-ordination and management of information throughout the project life cycle is gained increased recognition. ICT is improving the capability and efficiency of specific aspects within the construction process. Figure 3-6 illustrates the application of available technologies throughout the project life cycle. (Sarshar et al., 2000).


**Figure 3-6** Project model for construction (Sarshar et al., 2000).

## 3-3 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 Microstation, ArchiCAD, MiniCAD, FastCAD, etc. These CAD programmes have replaced the traditional drawing board in the production of design information. 2D CAD systems have dramatically improved the drawing process. 3D modelling can enable designers to investigate the buildings internal spatial system and its relationship with the surrounding environment. Visualisation and animation systems, like 3D Studio, Graphisoft, Revitt and ArchiCAD, 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 Modelling (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 modelling technology techniques. Autodesk Architectural Desktop and Autodesk Building Systems are examples of software currently available. (Sun, M. and Howard, R. 2004)

## I. Building Engineering Applications:

Over the past two decades, a range of building engineering applications have been developed for energy analysis, HVAC design, structural analysis, lighting simulation, etc. The benefits of these applications are that they allow designers to evaluate alternative design solutions in order to achieve the optimum design. They also help to ensure that the design complies with building regulations. Software packages such as CADLink from Cymap and the HEVA Comp package both offer a comprehensive range of software options for energy, lighting and building services design.

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 programmes can assist in the quantity take-off in the production of bills of quantities. Examples of such software includes, Buildsoft, Masterbill, CATOPro etc. Modern cost estimation programs can be integrated with CAD programs and linked data for labour, 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. (Sun, M. and Howard, R. 2004)

## II. 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.

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).

Facilities Management (FM) is a relatively new phenomenon which emerged in the early 1980's. It reflects the wide recognition of the importance of building operations and maintenance and the impact they have on the life cycle cost of a building. The software available for FM has developed from a combination of CAD and database management systems. CAD is often used to provide data on departments and location of individuals, together with their services. Special routines enable blocking and stacking studies to be carried out to explore alternative layouts or to reflect on organizational change. The database is the most important part of FM software as it holds data on people and their services. (Sun, M. and Howard, R. 2004)

## III. Building Information Modeling (BIM):

BIM (Building Information Modeling) is based on the relevant information and data as a basis for building projects model, were established architectural models, real information through digital simulation of building information possessed. It has visualization, coordination, simulation, optimize and can plot of five characteristics. In recent years, there is the inevitable product of a new term in the construction industry, as well as the development of information technology in the construction industry. Full application of BIM technology, will generate construction immeasurable impact of scientific and technological progress, greatly improving the degree of integration of construction projects, a huge benefit for the development of the construction industry. With the widely application of BIM technology in the country, China's construction industry is bound to have a transformative development and leap, it will bring many changes and optimization ideas, work, work processes, etc. for the construction industry practitioners. American National Standard for BIM meaning made the following four

levels of interpretation: a one facility (building projects) digital representation of physical and functional characteristics; b. A shared knowledge resource; c a share on this... information infrastructure, provide a reliable basis for all decision-making facilities from the beginning of the whole concept of life-cycle process; at different stages of the project by the different stakeholders in the BIM insert, extract, update and modify the information to support and reflect its respective responsibilities of collaboration. (G.P. 2011)

- **BIM Workflow Process:**

From the beginning to the end of engineering projects, BIM provides engineering modeling, hardware support, and regulated modeling principle and criteria. Utilizing the visualization, synchronization, simulation and optimization aspects, BIM can revolutionize engineering project by creating relevant regulation, quality control process, and hazard preventing measurement. The working process has three stages (Figure 3-7)

Planning stage, which refers to confirming the BIM application and planning the application process based on the traditional engineering project proposal and plausibility report.

Organization stage, which refers to confirming the responsibilities of all parties related and defining the corporation process based on the different information requirement of BIM.

Construction stage, which refers to each participating personal creating the BIM application and information sharing process.

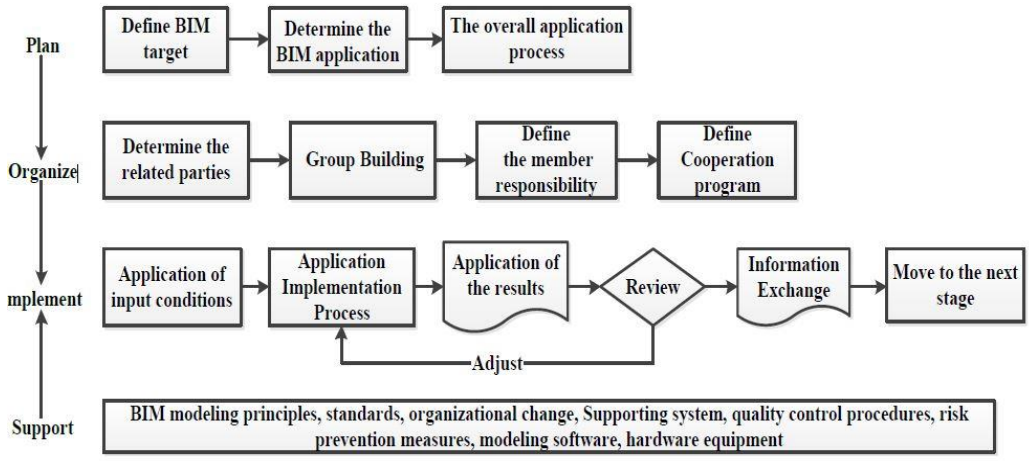


**Figure 3-7** BIM workflow in construction project life-cycle. (He Guanpei, Wang Yiqun, Ying Yuken 2005)

- **BIM Application in the Engineering Project:**

The BIM application team in the project is led by construction company, and covers all phases and parties of the project. The team is also responsible for hiring professional BIM consultants and operation according to the designed BIM application process.

BIM database is the core of the information management system in the engineering project, including all the data information in the full life-cycle. Through applying BIM modeling, we can complete the design, analysis, optimization, and simulation and information management during different stages of the project. At the same time, we can gradually update and perfect BIM modeling by adding relevant drawings and documents to ensure the comprehensiveness and continuity of engineering information.

- **Design Phase:**

The design phase usually has the most influence on the cost, benefit and architecture properties, while the design changes during construction phase cause the most cost waste. Thus, applying more advanced BIM technology to enhance design quality during this phase can effectively increase the influence on the design and construction cost, which means the sooner the application of BIM, the more insurance the project has.

Multi-specialties coordination design:

Architecture, structure, equipment and other expert engineers use BIM to construct their design models, which is the basic data source of a BIM database. Using a united design platform can realize the seamless connection of different engineering data, and enables personal to discuss their designs from the original idea to the specific charts and drawings in order to provide better design, faster document production and more effective team corporation.

Visualization design:

Models can be loaded into advanced design visualization tools (3ds Max, Maya) to analyze the visual effect, without having to build models again. Highly realistic renderings as well as special animation effect can help designers expand the visual environment of the design plan in order to realize more effective design testing and communication.

### Detail design:

The calculable information can be derived to assist in the engineering calculation. At the same time, the information in the models can be used to check the predicted budget, and realize synchronized budget prediction with the design process based on BIM modeling, in order to achieve real detailed design.

### Design coordination:

Using tools like Navis works in BIM modeling to conduct collision detection (hard collision and soft collision), Check the fault, leakage, touch and lack of the components designed by different professional design. Using the method of collision check report and 3D pipeline synthesis, it can prevents multiple digging, material waste and trash production in later construction. It can also solve the great on construction site coordination in advance by design coordination and effectively reduce the needed labor, material and time cost.

- **Construction Phase:**

Entering the construction phase, the BIM modeling can continue to support the optimization of construction plan, 5D construction simulation, quality surveillance and the enhancement of digital management during construction.

### Construction plan optimization:

Using the BIM modeling, personal can choose and optimize multiple construction plan, and come up with the best plan through quantity analysis .At the same time, the shared data platform reforms the communication route between design and construction party, and the construction can decide the plausibility of the design more conveniently. When hazards in the quality, safety and plausibility are found before the construction, effective measurement can be taken.

## 5D construction modeling:

During construction, 5D construction modeling can be realized by combining BIM modeling with schedule and cost information, which means using computers to accurately determine the sequence, duration time and relationship between different works in engineering project, in order to maximize the financial benefit with advanced management and the smallest amount of consumption. At the same time, the creation of 5D models enables the various participants (from architects, designers, contractors to owners) of a construction project to visualize the progress of construction activities and its related costs over time. This BIM-centric project management technique has potential to improve management and delivery of projects of any size or complexity.

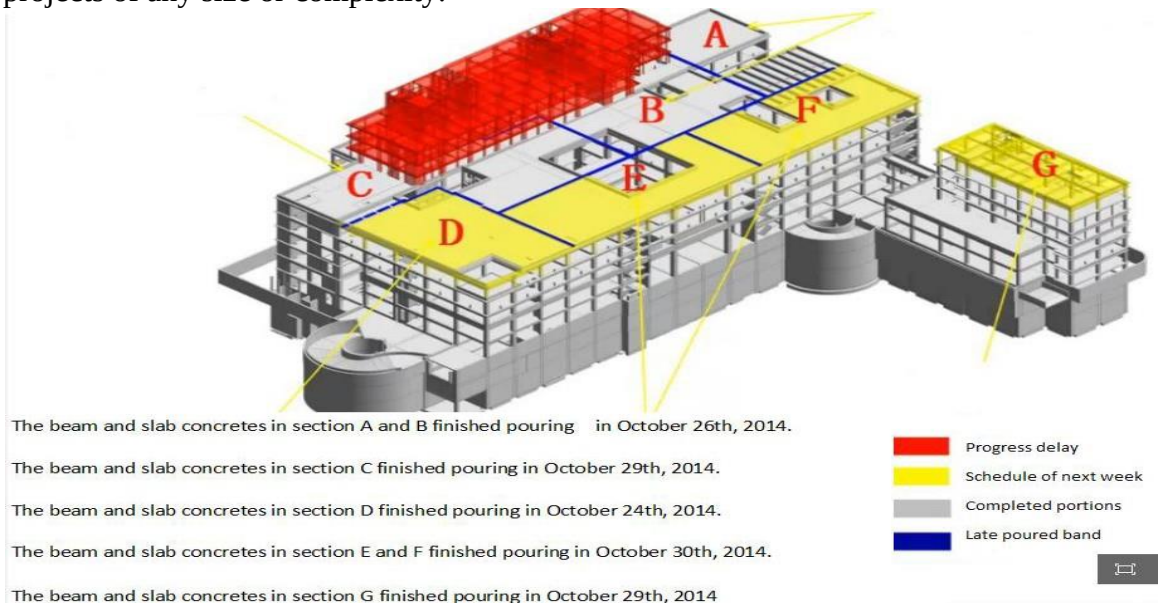


**Figure 3-8** 5D construction modeling (Lu Ning 2010)

## 3Construction safety and quality surveillance and report:

At the construction site, personal can combine BIM models with laser mapping technology, RFID radio frequency identification technology, smart phone transmission, digital camera probe and other advanced technology and tools to realize digital surveillance and better manage the construction site as well as supervise construction quality. This project used the digital camera probe and enables management personal to have more time on advanced control of the construction site as well as the strict control of essential parts and process of the construction. This not only enhanced work efficiency, but also reduced the need for management personals. Also, this mode enables discovering and solving quality

issues immediately, and the awareness of construction site through remote surveillance to effectively control engineering pace.

- **Operation Phase:**

After the construction is done, the finished BIM model, BIM application documents and device information can make sure that building management companies have enough information to realize true information delivery. During the operation phase, personals can predict the change in thermal load due to device adjustment in the data center by using BIM modeling. Through thermodynamic calculation and validation, they can make the adjustment plan for air condition system, and effectively reduce the energy consumption of the building and increase the utilization ratio while eliminating thermos hazard and enhancing the availability of the engine room. (Lu Ning. 2010)

# Chapter 4

# Chapter 4

# Research Methodology and Data Analysis

## 4-1 Data Collection:

Researcher deal in this section a description of the method and procedures followed by the implementation of this study, including a description of the society study and appointed, and the method of preparation tools, and actions taken to ensure its sincerity and substantiated, and the way it has followed for the application of statistical and processors under which the data were analyzed and the extraction results, as specifically, a description of the curriculum includes study section.

## I. Questionnaire :

- **The Study Population:**

Study population means the overall group of elements that the researcher is seeking to circulate them related to the result of the problem studied.

The study sample was randomly constructed from Sudan University for Science and Technology construction management students to a number of engineers in the engineering companies (construction). Where the researcher distributes a number (70) to identify the target of, and has to respond to a number (50) of data since returned questionnaires filled in all the required information, a rate of (71%).

To get an accurate results as much as possible researcher keen on the study sample surveyed in terms of the diversity of the following:

1. Individuals from various age groups.
2. Individuals, male and female.
3. Individuals from various educational qualifications.
4. Individuals from different grades.
5. Individuals from different years of practical experience.

The following is a description of the members of the study sample according to the above variables (the characteristics of the respondents) are divided on the tables and graphs.

- **Study Tool:**

The research tool is a tool used by a researcher to gather the necessary information on the phenomenon under study. Many of the tools used in the field of scientific research to obtain the information necessary for the study and the data. The researcher adopted the resolution as a key tool to collect information from the study sample, as for the identification of advantages including:

1. It can be applied to get information on the number of individuals.
2. Low cost and easy to application.
3. Questionnaire provide time for the transponder and give it a chance to think.
4. Respondents to the questionnaire feel free to express.

## II. Statistical Methods:

To achieve the objectives of the study and to verify the hypotheses, the following statistical methods has been used:

1. Graphic formats.
2. Frequency distribution of the answers.
3. Percentages.
4. Mediator.

For accurate results as much as possible, the use of statistical program which is a program analyze data in all areas, which indicates a shortcut to the Statistical Package for Social Sciences (Statistical Package for Social Sciences).

In this study, the study analysis division to two sections , first section which analyze description of personal data and statements in the form of numbers and percentages supported graphics charts for more understanding and clarification, while the second section of the study is to analyze the assumptions phrases to see if they are realized or not.

## 4-2 Data Analysis:

### I. General Information:

**Table 4-1** Distribution of the research sample by gender

| Phrase | Repetition | The ratio |
|---|---|---|
| Male | 39 | 78% |
| Female | 11 | 22% |
| **Total** | 50 | 100% |

From the table above it is clear that most of the study sample are male they have accounted for 78%, while the proportion of females stood at 22% and it shows that the male category are mostly in the research sample.

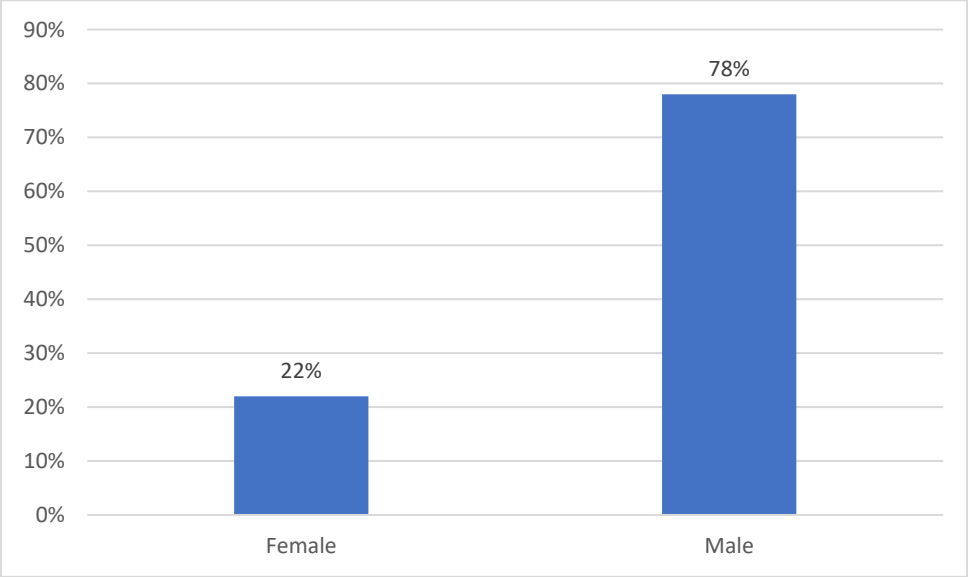


**Figure 4-1** Distribution of the research sample by gender

**Table 4-2** Distribution of the research sample by age

| Phrase | Repetition | The ratio |
|---|---|---|
| Less than 30 years | 28 | 56% |
| More than 30 and less than 40 Study | 16 | 32% |
| More than 40 and less than 50 years | 6 | 12% |
| **Total** | 50 | 100% |

From the table above it is clear that individuals who are under 30 years old accounted for 56% and individuals who are aged between 30-40 years old accounted for 32% Individuals between 40-50 years old accounted for 12% and this indicates that most of the study sample are young and younger than 30 years old.

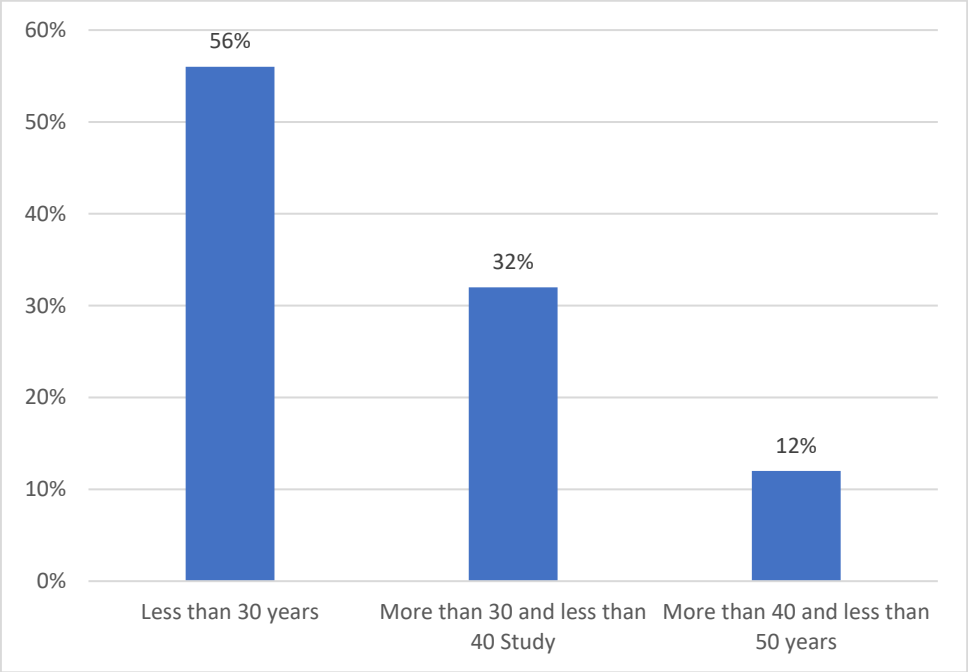


**Figure 4-2** Distribution of the research sample by age

**Table 4-3** Distribution of the research sample by level of education

| Phrase | Repetition | The ratio |
|---|---|---|
| Undergraduate degree | 30 | 60% |
| Higher Diploma | 0 | 0 |
| Master's degree | 15 | 30% |
| PH.D. | 5 | 10% |
| **Total** | 50 | 100% |

The table above shows that individuals who hold a BA accounted for 60% and individuals Higher Diploma proportion campaign 0% and retail campaign master's degree accounted for 40% and no members hold doctorate, and it shows that the campaign BA are the category most likely in the study sample.

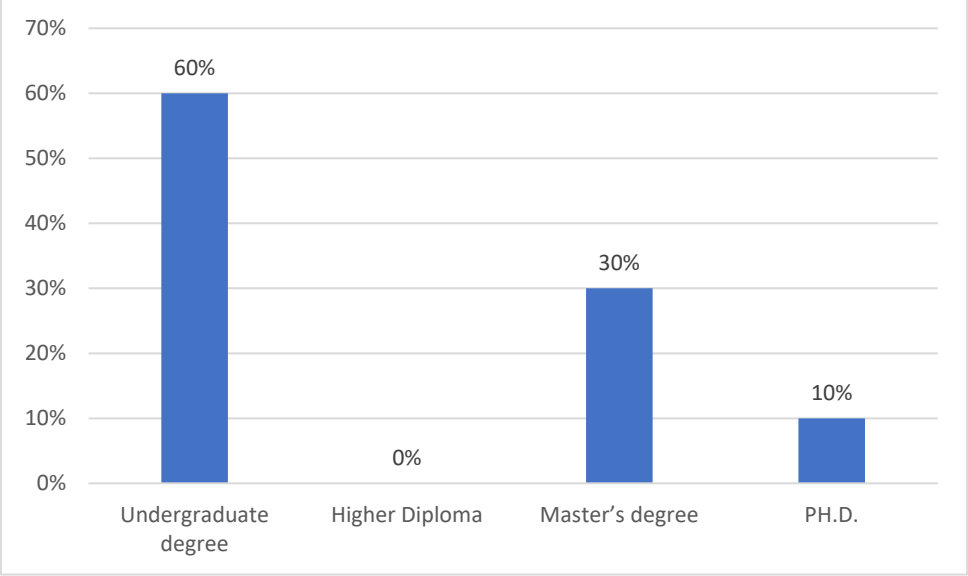


**Figure 4-3** Distribution of the research sample by level of education

**Table 4-4** Distribution of sample members by practical experience

| Phrase | Repetition | The ratio |
|---|---|---|
| Less than 5 years | 17 | 34% |
| More than 5 and less than 10 years | 11 | 22% |
| More than 10 and less than 15 years | 16 | 32% |
| More than 15 and less than 20 years | 6 | 12% |
| **Total** | 50 | 100% |

From the table above it is clear that individuals who have less experience than 5 years accounted for 34% and individuals who range from their years of experience between 5-10 years accounted for 22% and individuals between 10-15 years accounted for 32% and individuals between 15-20 years accounted for 12%, so It indicates that individuals who experience less than 5 years of age are the most likely group in the study sample.

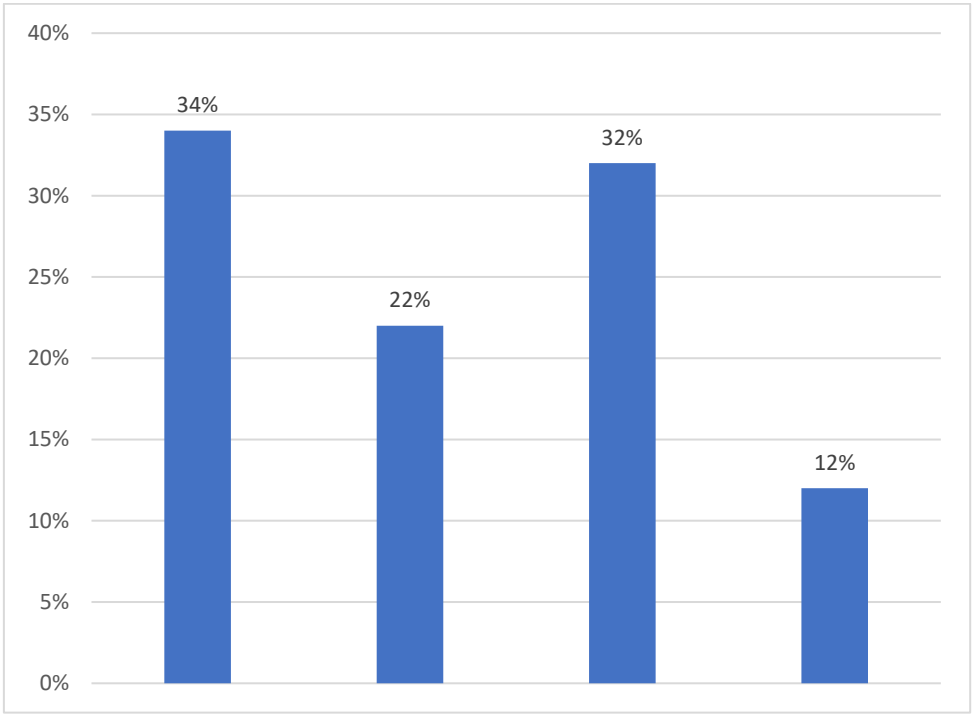


**Figure 4-4** Distribution of sample members by practical experience

## II. Information System:

**Table 4-5** Information System

| | Question | Yes | No | N/A |
|---|---|---|---|---|
| 2.1 | Has the responsibility for achieving objectives been assigned and documented? | 24 | 15 | 11 |
| | | **48%** | **30%** | **22%** |
| 2.2 | Does the information system provide management with necessary reports on the department's performance relative to established objectives, including relevant external and internal information? | 34 | 16 | 0 |
| | | **68%** | **32%** | **0%** |
| 2.3 | Have procedures been implemented in the department to verify the accuracy of data in management and monitoring reports? | 23 | 27 | 0 |
| | | **46%** | **54%** | **0%** |
| 2.4 | Is the information provided to the right people in sufficient detail and on time to enable them to carry out their responsibilities efficiently and effectively? | 34 | 16 | 0 |
| | | **68%** | **32%** | **0%** |
| 2.5 | Is the development or revision of information systems over financial reporting based on a strategic plan and interrelated with the university's overall information systems, and is it responsive to achieving the organization objective and activity-level objectives? | 24 | 21 | 5 |
| | | **48%** | **42%** | **10%** |
| 2.6 | Does management commit the appropriate human and financial resources to develop the necessary financial reporting information systems? | 24 | 15 | 11 |
| | | **48%** | **30%** | **22%** |
| | **total** | 163 | 110 | 27 |
| | | **54%** | **37%** | **9%** |

**Table 4-6** Information System Statistics

**Statistics**

| | | rate | Information System | fre |
|---|---|---|---|---|
| N | Valid | 18 | 18 | 18 |
| | Missing | 0 | 0 | 0 |
| Mean | | 2.00 | 3.500 | 16.6667 |
| Median | | 2.00 | 3.500 | 16.0000 |
| Std. Deviation | | .840 | 1.7573 | 10.75940 |
| Variance | | .706 | 3.088 | 115.765 |

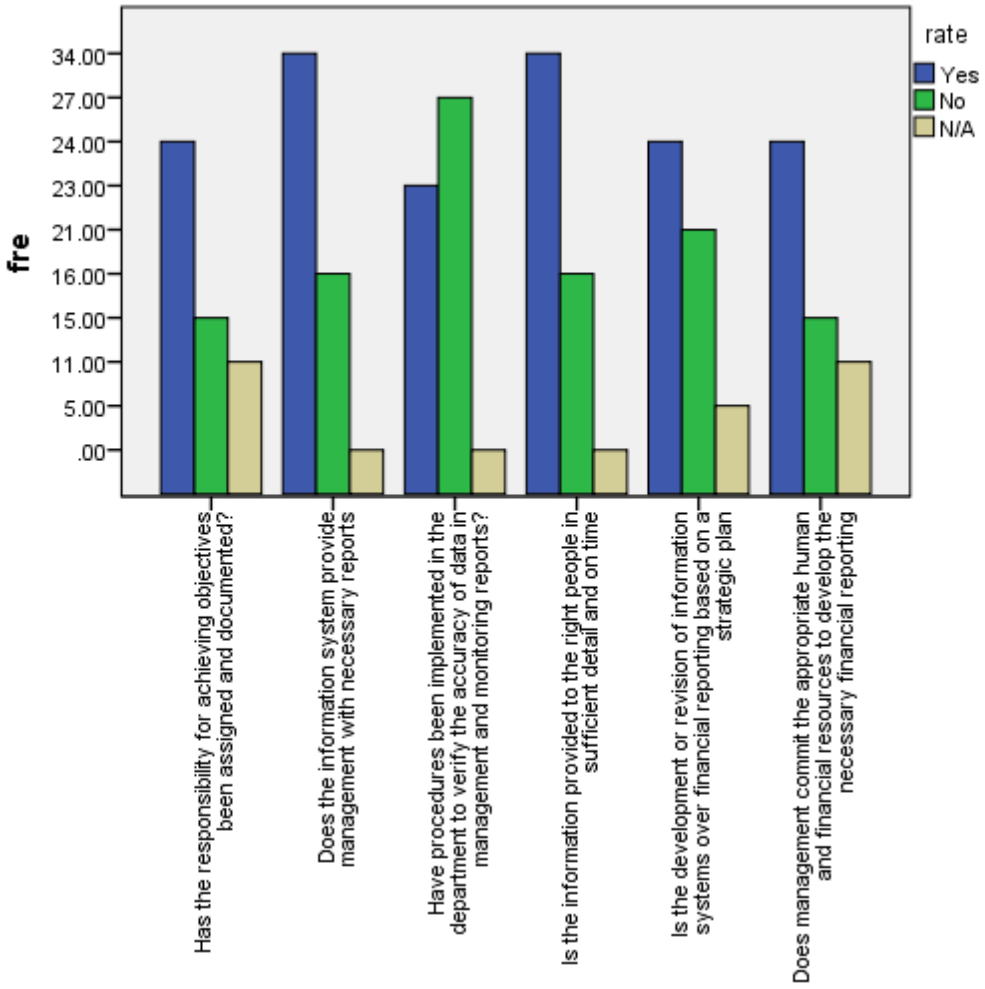


**Figure 4-5** Information System

The table 4-5 shows that the information is being recorded and summarized by the Information Systems and includes information relating to the economic industry Regulatory information obtained from external sources as well as internal information as approved most of the members of the research sample to questions from the questionnaire and reached individuals who chose the phrase ratio (Yes) 54% is a very high percentage compared with individuals who believe otherwise and chose the phrase (not) accounted for 37% individuals neutrals were 9%.

## III. Using Information in Your Everyday Practice at Work:

**Table 4-7** Using information in your everyday practice at work

| | **Using the following scale, rate the frequency with which you have used information from the following sources during the past year…** | **Never** | **1 or 2 times** | **3 or 4 times** | **4 times or more** |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| 3.1 | Scholarly documents. | 6 | 39 | 5 | 0 |
| | | **12%** | **78%** | **10%** | **0%** |
| 3.2 | Professional publications. | 6 | 39 | 5 | 0 |
| | | **12%** | **78%** | **10%** | **0%** |
| 3.3 | Evaluations of your organization | 13 | 0 | 22 | 15 |
| | | **26%** | **0%** | **44%** | **30%** |
| 3.4 | Internet Web sites | 0 | 8 | 16 | 22 |
| | | **0%** | **16%** | **32%** | **52%** |
| 3.5 | Multimedia materials, such as video, DVD and software | 7 | 28 | 10 | 5 |
| | | **14%** | **56%** | **20%** | **10%** |
| 3.6 | Mass media, such as television, radio, newspapers and magazines | 12 | 38 | 0 | 0 |
| | | **24%** | **76%** | **0%** | **0%** |
| 3.7 | In-service training or workshops | 5 | 29 | 11 | 5 |
| | | **10%** | **58%** | **22%** | **10%** |
| 3.8 | Professional conferences or presentations | 11 | 34 | 0 | 5 |
| | | **22%** | **68%** | **0%** | **10%** |
| 3.9 | Experts or resource people | 6 | 13 | 18 | 13 |
| | | **12%** | **26%** | **36%** | **26%** |
| | **Total** | 66 | 228 | 87 | 69 |
| | | **15%** | **51%** | **19%** | **15%** |

**Table 4-8** Using information in your everyday practice at work Statistics

**Statistics**

| | | rate | Using information | fre |
|---|---|---|---|---|
| N | Valid | 36 | 36 | 36 |
| | Missing | 0 | 0 | 0 |
| Mean | | 2.50 | 5.000 | 12.3889 |
| Median | | 2.50 | 5.000 | 9.0000 |
| Std. Deviation | | 1.134 | 2.6186 | 11.80624 |
| Variance | | 1.286 | 6.857 | 139.387 |

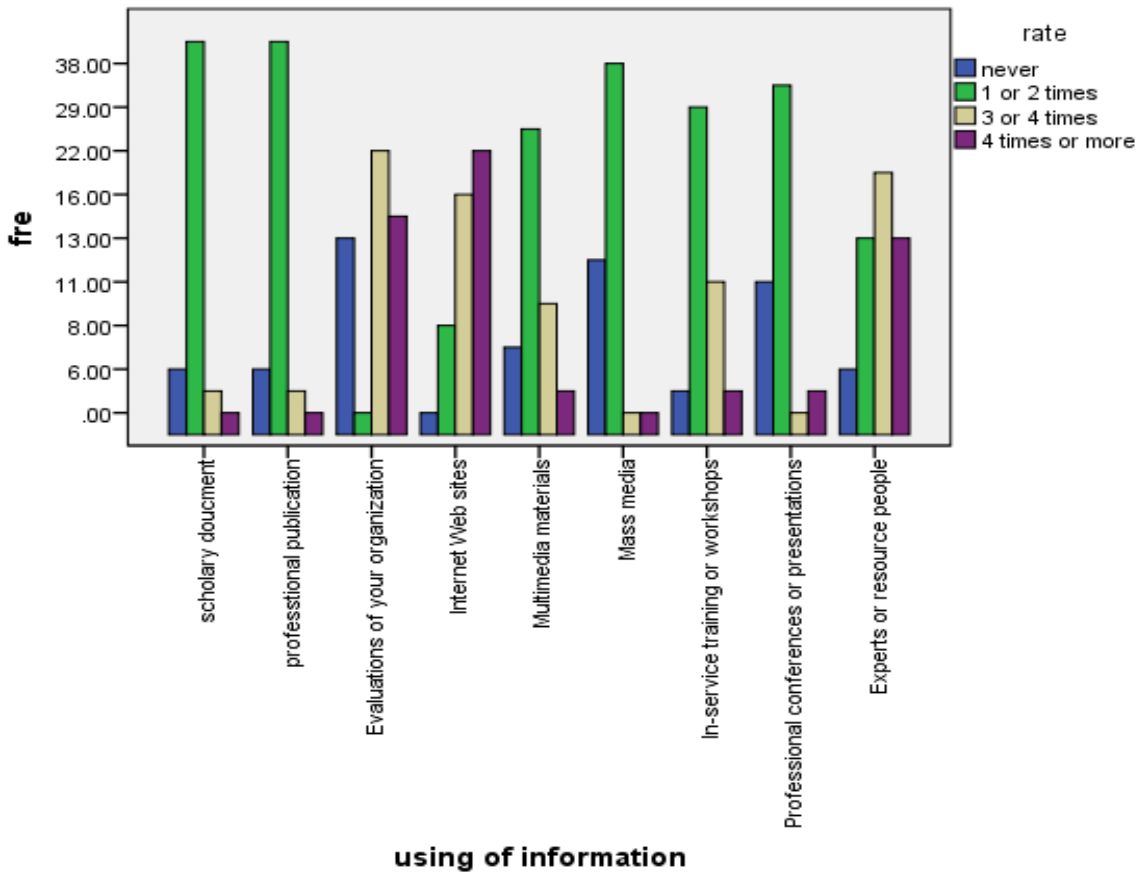


**Figure 4-6** Using information in your everyday practice at work

From the table 4-7 it is clear that the study sample were using many ways to document the information in the workplace, where individuals who do not use the means 15% accounted for a very small percentage compared to the individuals who use them once or twice which accounted for 51% of the individuals who use it 3 or 4 times the proportion of 19% and individuals who use more than four times the proportion of 15%.

## IV. Information Technology Skills:

**Table 4-9** information technology skills

| | Using the following scale, rate the frequency with what is your skills level for the following … | Not at all skilled | Not very skilled | Fairly skilled | Very skilled | EXPERT |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 4.1 | Writing Software (word .... etc.) | 0 | 6 | 21 | 23 | 0 |
| | | **0%** | **12%** | **42%** | **46%** | **0%** |
| 4.2 | Spreadsheets (Excel, etc.). | 0 | 12 | 16 | 17 | 5 |
| | | **0%** | **24%** | **32%** | **34%** | **10%** |
| 4.3 | Presentation Software (PowerPoint, etc.). | 5 | 2 | 26 | 17 | 0 |
| | | **10%** | **4%** | **52%** | **34%** | **0%** |
| 4.4 | Graphics Software (Photoshop, Flash, etc.). | 11 | 16 | 5 | 13 | 5 |
| | | **22%** | **32%** | **10%** | **26%** | **10%** |
| 4.5 | Using the internet to effectively and efficiently search for information. | 0 | 5 | 25 | 20 | 0 |
| | | **0%** | **10%** | **50%** | **40%** | **0%** |
| 4.6 | Evaluating the reliability and credibility of online sources of information. | 5 | 16 | 18 | 11 | 0 |
| | | **10%** | **32%** | **36%** | **22%** | **0%** |
| 4.7 | Understanding the ethical/legal issue surrounding the access to and use of digital information. | 16 | 16 | 5 | 13 | 0 |
| | | **32%** | **32%** | **10%** | **26%** | **0%** |
| | **total** | 37 | 73 | 116 | 114 | 10 |
| | | **11%** | **21%** | **33%** | **33%** | **3%** |

**Table 4-10** information technology skills Statistics

**Statistics**

| | | rate | information technology skills | fre |
|---|---|---|---|---|
| N | Valid | 35 | 35 | 35 |
| | Missing | 0 | 0 | 0 |
| Mean | | 3.00 | 4.000 | 10.0000 |
| Median | | 3.00 | 4.000 | 11.0000 |
| Std. Deviation | | 1.435 | 2.0292 | 8.21047 |
| Variance | | 2.059 | 4.118 | 67.412 |

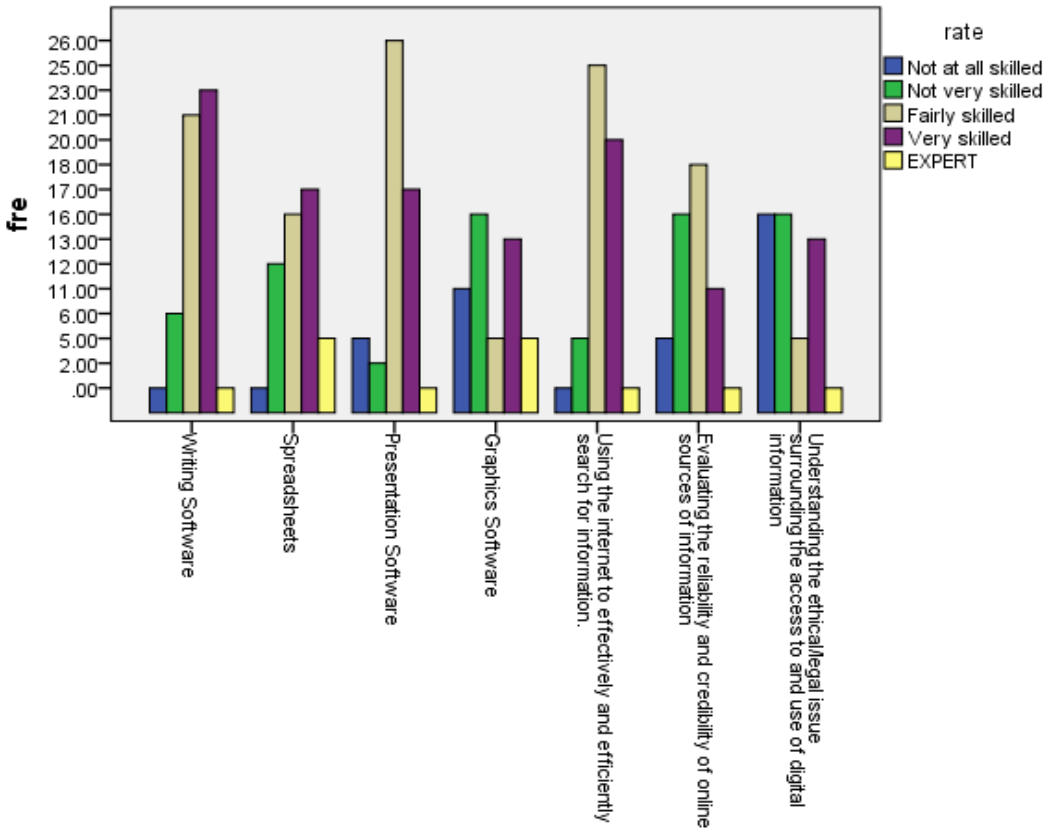


**Figure 4-7** information technology skills

The above table shows that the degree of use of the study sample technical means very different, where the proportion of Not at all skilled hit 11%, while the individuals who chose Not very skilled 21% Individuals who chose Fairly skilled accounted for 33% and individuals who have chosen words very skilled 33% and individuals who have chosen expert account for 3%. This indicates that most of the staff familiar with the ways technology and some other are not.

## V. Organizational Factors:

**Table 4-11** Organizational factors

| | **Using the following scale, rate the extent to which you agree that your use of management information system is influenced by the following organizational factors…** | **Strongly agree** | **disagree** | **Neutral** | **agree** | **Strongly disagree** |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 5.1 | A supportive environment | 22 | 0 | 5 | 23 | 0 |
| | | **44%** | **0%** | **10%** | **46%** | **0%** |
| 5.2 | Human resources, such as the availability of qualified staff | 23 | 0 | 16 | 11 | 0 |
| | | **46%** | **0%** | **32%** | **22%** | **0%** |
| 5.3 | Opportunities to challenge established habits and Traditions | 11 | 5 | 16 | 18 | 0 |
| | | **22%** | **10%** | **32%** | **36%** | **0%** |
| 5.4 | Available facilities and technology | 27 | 5 | 6 | 12 | 0 |
| | | **54%** | **10%** | **12%** | **24%** | **0%** |
| 5.5 | Incentives, such as remuneration, honoraria, lessening of the work-load, etc. | 17 | 16 | 17 | 0 | 0 |
| | | **34%** | **32%** | **34%** | **0%** | **0%** |
| | **total** | 100 | 26 | 60 | 64 | 0 |
| | | **40%** | **10%** | **24%** | **26%** | **0%** |

**Table 4-12** Organizational factors Statistics

**Statistics**

| | | rate | Organizational factors | fre |
|---|---|---|---|---|
| N | Valid | 25 | 25 | 25 |
| | Missing | 0 | 0 | 0 |
| Mean | | 3.00 | 3.000 | 10.0000 |
| Median | | 3.00 | 3.000 | 11.0000 |
| Std. Deviation | | 1.443 | 1.4434 | 8.98610 |
| Variance | | 2.083 | 2.083 | 80.750 |

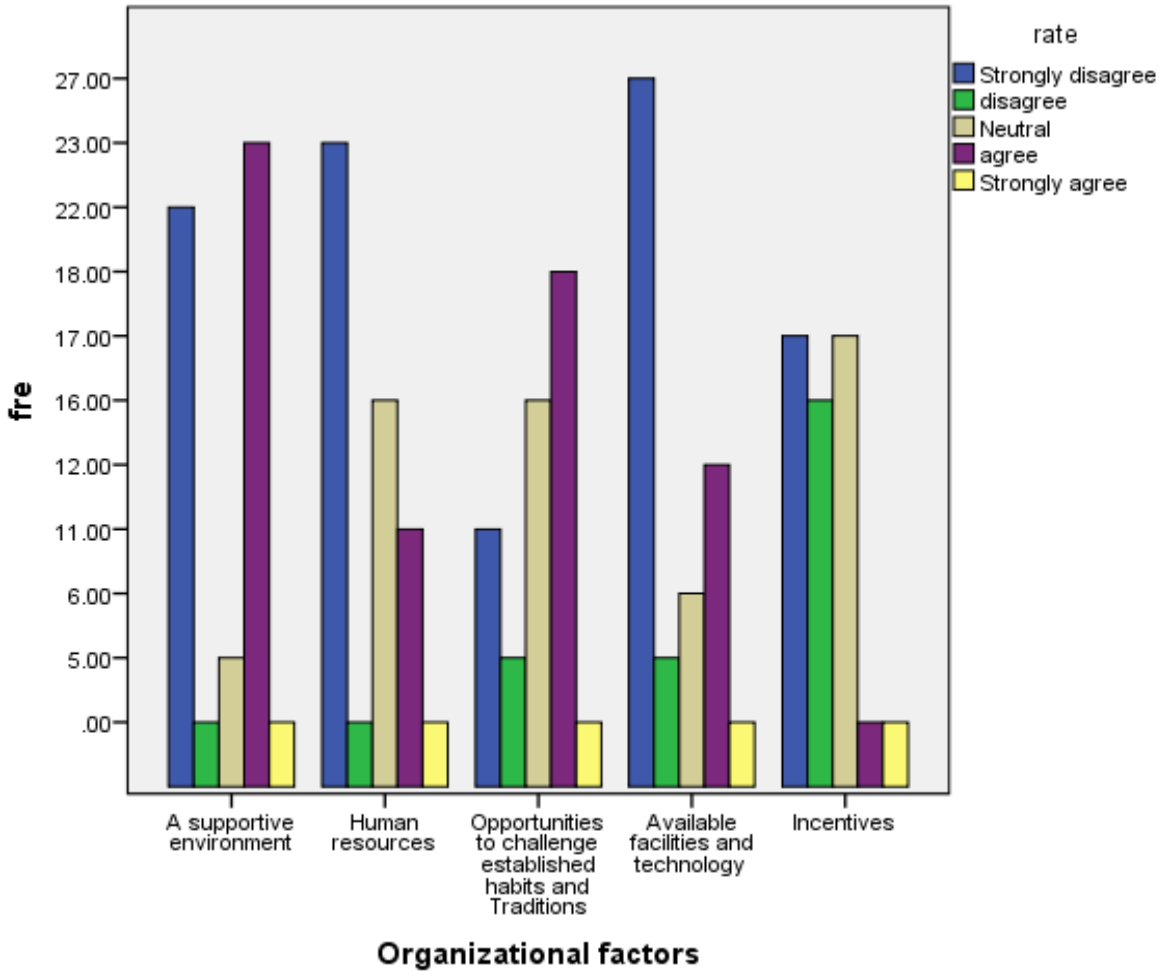


**Figure 4-8** Organizational factors

The above table shows that most of the study sample Affected by regulatory factors in their use of management information system, individuals who chose the phrase Strongly agree 40% and individuals who chose the phrase Agree 10% and when to bring them together into percentage (50%), a very high ratio, while individuals who chose neutral accounted for 24% and individuals who are not influenced by accompanying environmental factors chose the words do not agree accounted for 26% and there is no individual chose the phrase strongly disagree.

## VI. Strategic Management & MIS Implementation:

**Table 4-13** Strategic Management & MIS Implementation

| | **Using the following scale, rate the extent to which your organization strategy and implementation for MIS…** | **Yes, totally** | **Largely** | **Partially** | **To small extent** | **Not applicable** |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 6.1 | Is your organization meeting its own expectations as regards managing its own information? | 2 | 10 | 23 | 10 | 5 |
| | | **4%** | **20%** | **46%** | **2%** | **10%** |
| 6.2 | Does your organization have a Knowledge and Information Management (KIM) strategy? | 1 | 1 | 22 | 10 | 16 |
| | | **2%** | **2%** | **44%** | **20%** | **32%** |
| 6.3 | Do managers understand why and how MIS is critical to the organization? | 7 | 12 | 15 | 11 | 5 |
| | | **14%** | **24%** | **30%** | **22%** | **10%** |
| 6.4 | Does the organization document how each information asset will be used over time? | 13 | 5 | 22 | 5 | 5 |
| | | **26%** | **10%** | **44%** | **10%** | **10%** |
| 6.5 | Have costs and resource needs for MIS been determined? | 12 | 12 | 0 | 11 | 15 |
| | | **24%** | **24%** | **0%** | **22%** | **30%** |
| 6.6 | Does the organization know what information it needs to create and capture in the first place? | 7 | 11 | 22 | 5 | 5 |
| | | **14%** | **22%** | **44%** | **10%** | **10%** |
| 6.7 | Is the organization confident that it has the right processes and IT infrastructure to keep information it creates as long as it is needed? | 8 | 0 | 15 | 22 | 5 |
| | | **16%** | **0%** | **30%** | **44%** | **10%** |
| 6.8 | Do all business areas have guidance on what information should be kept and where? | 3 | 10 | 27 | 5 | 5 |
| | | **6%** | **20%** | **54%** | **10%** | **10%** |
| 6.9 | Is key and critical information always easy to find when it is needed? | 12 | 0 | 28 | 5 | 5 |
| | | **24%** | **0%** | **56%** | **10%** | **10%** |
| 6.10 | Do people have the right skills to use information management systems? | 1 | 7 | 36 | 6 | 0 |
| | | **2%** | **14%** | **72%** | **12%** | **0%** |
| 6.11 | Is Knowledge and Information Management included as part of the change management strategy? | 12 | 16 | 22 | 0 | 0 |
| | | **24%** | **32%** | **44%** | **0%** | **0%** |
| 6.12 | Does the organization have a records management policy? | 17 | 6 | 15 | 6 | 6 |
| | | **34%** | **12%** | **30%** | **12%** | **12%** |
| 6.13 | Does the policy include information management? | 12 | 1 | 15 | 11 | 11 |
| | | **24%** | **2%** | **30%** | **22%** | **22%** |
| 6.14 | Are information management policies and guidance easily accessible to staff at all levels of the organization? | 18 | 0 | 26 | 1 | 5 |
| | | **36%** | **0%** | **52%** | **2%** | **10%** |
| 6.15 | Does the organization have a formal mechanism for ensuring knowledge capture and knowledge transfer? | 1 | 10 | 28 | 11 | 0 |
| | | **2%** | **20%** | **56%** | **22%** | **0%** |
| | **total** | 126 | 101 | 316 | 119 | 88 |
| | | **17%** | **13%** | **42%** | **16%** | **12%** |

**Table 4-14** Strategic Management & MIS Implementation Statistics

**Statistics**

| | | rate | Strategic Management & MIS Implementation | fre |
|---|---|---|---|---|
| N | Valid | 75 | 75 | 75 |
| | Missing | 0 | 0 | 0 |
| Mean | | 3.00 | 8.000 | 10.0000 |
| Median | | 3.00 | 8.000 | 10.0000 |
| Std. Deviation | | 1.424 | 4.3496 | 8.15889 |
| Variance | | 2.027 | 18.919 | 66.568 |

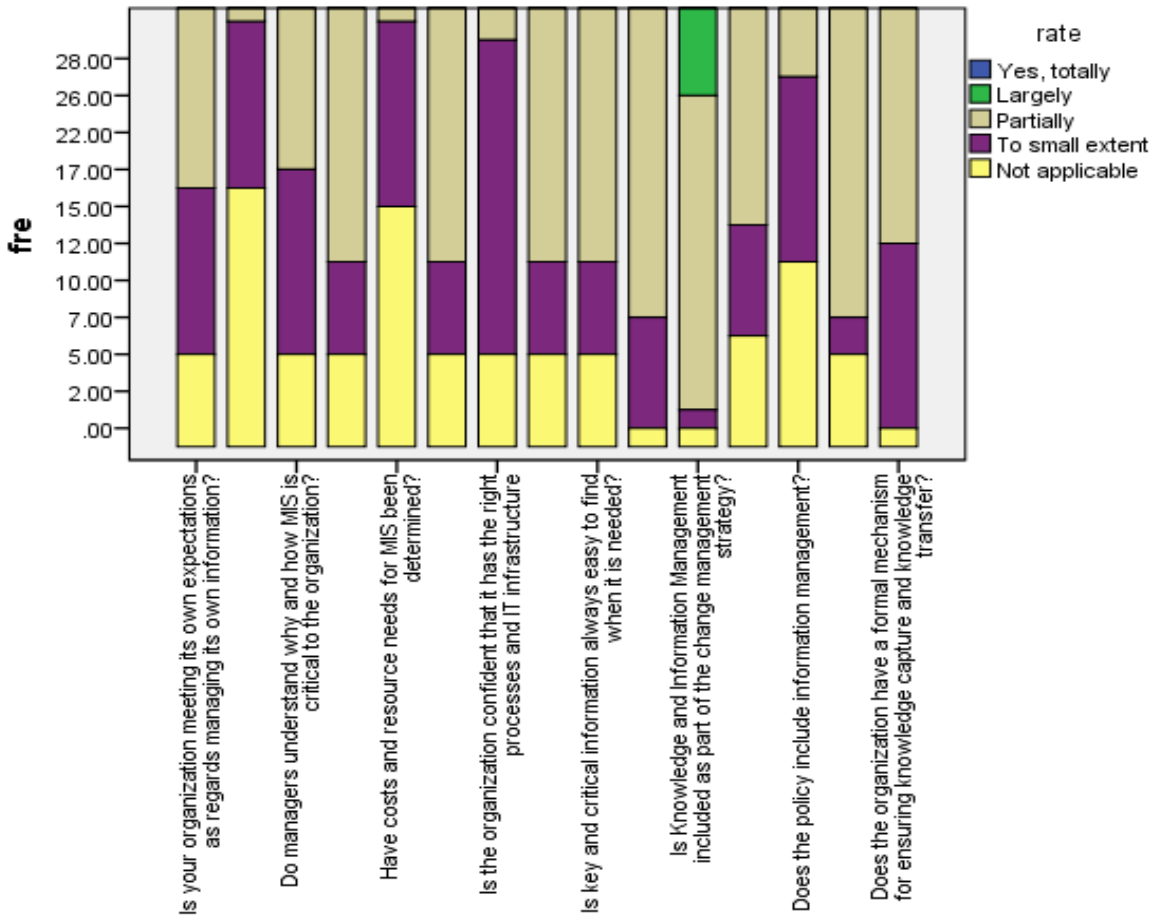


**Figure 4-9** Strategic Management & MIS Implementation

Seen from the above table that organizations use several strategies in the management information system where the percentage of persons who chose the phrase Yes definitely 17% and individuals who have chosen Largely is a percentage of 13% and individuals who have chosen the term Partially 42% and individuals who have chosen words To small extent proportion of 16% and individuals who have chosen the term is Not applicable percentage of 12%.

## VII. Your Opinion About Management Information System:

**Table 4-15** the opinions about management information system

| **Using the following scale, rate the extent to which you personally agree that management information system…** | | **Strongly disagree** 1 | **disagree** 2 | **Neutral** 3 | **agree** 4 | **Strongly agree** 5 |
|---|---|---|---|---|---|---|
| 7.1 | Is easy to find | 6 | 10 | 21 | 7 | 6 |
| | | **12%** | **20%** | **42%** | **14%** | **12%** |
| 7.2 | Is easy to understand | 0 | 10 | 6 | 34 | 0 |
| | | **0%** | **20%** | **12%** | **68%** | **0%** |
| 7.3 | Offers timely information | 5 | 10 | 5 | 19 | 11 |
| | | **10%** | **20%** | **10%** | **38%** | **22%** |
| 7.4 | Is reliable and trustworthy | 0 | 10 | 5 | 13 | 22 |
| | | **0%** | **20%** | **10%** | **26%** | **44%** |
| 7.5 | Is useful to guide or improve your professional practice | 0 | 5 | 6 | 12 | 27 |
| | | **0%** | **10%** | **12%** | **24%** | **54%** |
| 7.6 | Is easy to transfer into your practice | 0 | 10 | 6 | 27 | 17 |
| | | **0%** | **20%** | **12%** | **34%** | **34%** |
| | **Total** | 11 | 55 | 49 | 102 | 83 |
| | | **4%** | **18%** | **16%** | **34%** | **28%** |

**Table 4-16** the opinions about management information system Statistics

**Statistics**

| | | rate | Strategic Management & MIS Implementation | fre |
|---|---|---|---|---|
| N | Valid | 30 | 30 | 30 |
| | Missing | 0 | 0 | 0 |
| Mean | | 3.00 | 3.500 | 10.3333 |
| Median | | 3.00 | 3.500 | 8.5000 |
| Std. Deviation | | 1.438 | 1.7370 | 8.80569 |
| Variance | | 2.069 | 3.017 | 77.540 |

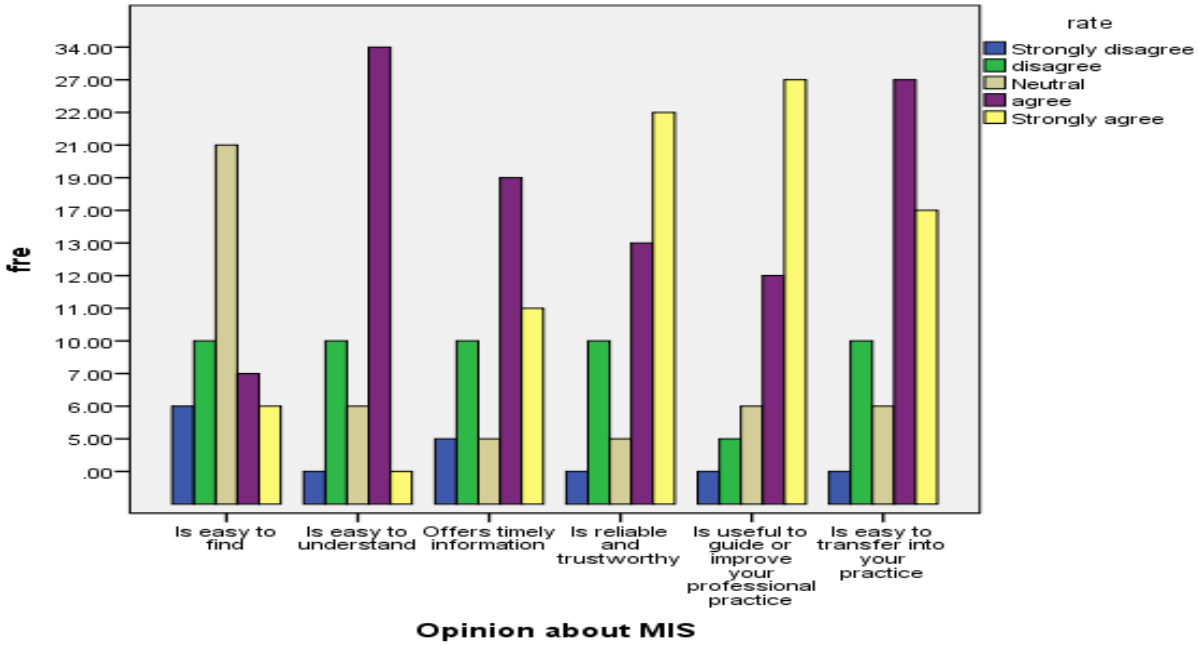


**Figure 4-10** the opinions about management information system

From the table above it is clear that most of the research sample individuals agree to all questions relating to administrative information system for organizations to have a reaching individuals who chose the phrase Strongly agree (28%) and individuals who chose the phrase agree accounted for (34%) and when to bring them together into percentage (62%) which is very high percentage, and individuals of (16%) chose neutral, and individuals who believe otherwise and chose the words do not agree accounted for (18%) and individuals who chose the phrase strongly disagree accounted for (4%) and when to bring them together into (22%), which is very weak percentage .

## 4-3 Hypothesis Test:

- Lack of qualified information technology staff leading to weak implementation of the management information system. **(reject )**
- Facilities and information technology for the MIS implementation are not fully available. **( accept )**
- Not include the cost of implementing the MIS in the budget of the institution, which effects on the meeting the requirements of operation system. **( accept )**
- Organizational factors affect the effectiveness of MIS. **( accept )**
- It is difficult to understand and implementation management information system and it is difficult to understand how the MIS works. **(reject )**

# Chapter 5

# CHAPTER 5

# Conclusions and Recommendations

## 5-1 Conclusion:

The primary focus of this study was to determine surrounding problematic and success key issues regarding MIS implementation. Each implementation stage was presented in order to understand the MIS implementation process together with describing the activities in each stage. The most important learning from this research is that the description of problematic issues which was categorised into five main issues regarding implementation of new MIS within the organisation was presented. Moreover, key issues for successful MIS implementation which refer to the success factors to ensure the achieve of MIS implementation were identified. In addition, effects and consequences of MIS implementation were described. Though there have been certain limitations in the study, the following conclusions drawn from the study could provide some insight to the managers to improve the management information system for construction industry.

- The sources of information used for employees to be a large degree of Internet sites and then multimedia and a lesser degree of expert peoples in the field.
- There are enough skills with respect to information technology, especially in the use of the Internet, but there is a lack of understanding of the ethical and legal terms for access and use digital information. And individuals have the appropriate application of management information system skills.
- MIS is influenced by regulatory factors and is largely in the motivation, the availability of qualified staff, facilities and the availability of technology.
- The organizations have a lack of implementing the Strategy of knowledge and information management, and also there is a weakness in the information technology in order to maintain the information for reference when needed.
- The organizations documentation for the valuable information that can be used with the passage of time, and there is a good knowledge of the what type of information they need in the first place, but this documentation is often documented paper, not digital.
- Management Information System is an easy system to understand it, as it provides information in a timely and reliable and is useful to guide and improve professional practice.

## 5-2 Recommendations:

- The implementation of management information system requires the provision of appropriate technology for the system in the organization, so, if possible, the organizations must work to provide this technology to use the system.
- Training and qualification the staff in relation to the skills of information technology is important to know how to deal with the management information system and use it more successful and effective.
- The cost of implementation management information system must be determined accurately within the organization's budget to provide the necessary requirements for the system implementation.
- Include the objectives of the organization and the work plan and performance reports and financial reporting in the management information system and work to develop the information system on an ongoing basis.
- Documentation for all the information and information that can be utilized with the passage of time in digital document on the management information system in order to maintain the information for reference whenever there was need for them.

## 5-3 Recommendation for Future Studies:

- Questions in this questionnaire was subject to the understanding and knowledge of the respondents of the MIS Therefore, in the case of lack of respondent’s knowledge of the Management Information System means and how its work, the answers were often be random.
- The dependence in this research was the questionnaire of the engineers who works in the construction sector, and has not been a case study of organization applied the management information system, so future studies can do a case study of organization applied the management information system to find out the advantages and disadvantages and difficulties encountered in the implementation of the system.
- In this questionnaire it is not studding the impact of communication on the management information system and how to build a communication system through the Management Information System.

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# The Appendix

## I. The Questionnaire

**Sudan University of Science and Technology**

**Postgraduate Collage**

**'Application of Management Information System in Construction projects in Sudan'**

**Supervised by Assistant Professor**
**SALAHELDIN AJBANI**

**Prepared by**
**HASSAN ABDALLAH HASSAN**

### About the research:

Management Information System is a compact system between the machine and the user to provide information to support management processes and functions in the decision-making organization. The system uses computerized and manual procedures, such as models for analysis, planning, control and decision-making in addition to the database.

### Note:

All information you provide will be kept strictly confidential and under no circumstances will your individual responses be released to your administration.

Please remember that your participation is entirely voluntary and you are free to discontinue at any time. However, your professional experiences and opinions are crucial to helping us understand how management information system is used in practice. We would greatly appreciate your taking time to complete this questionnaire.

## SECTION 1- General information

1.1 Are you male or female?

| Male | Female |
|---|---|
| O | O |

1.2 How old are you?

| Less than 30 years | More than 30 and less than 40 Study | More than 40 and less than 50 years |
|---|---|---|
| O | O | O |

1.3 The highest degree obtained

| | |
|---|---|
| **Undergraduate degree** | O |
| **Higher Diploma** | O |
| **Master's degree** | O |
| **PH.D.** | O |
| **Other (Please specify):** ..... | O |

1.4 Professional Experience

| | |
|---|---|
| **Less than 5 years** | O |
| **More than 5 and less than 10 years** | O |
| **More than 10 and less than 15 years** | O |
| **More than 15 and less than 20 years** | O |
| **Job description in the company:** ..... | |

## SECTION 2 – Information System

**INFORMATION:**
Information is recorded, processed, summarized, and reported by information systems. Relevant information includes industry, economic, and regulatory information obtained from external sources, as well as internally generated information.

| | Question | Yes | No | N/A |
|---|---|---|---|---|
| 2.1 | Has the responsibility for achieving objectives been assigned and documented? | O | O | O |
| 2.2 | Does the information system provide management with necessary reports on the department's performance relative to established objectives, including relevant external and internal information? | O | O | O |
| 2.3 | Have procedures been implemented in the department to verify the accuracy of data in management and monitoring reports? | O | O | O |
| 2.4 | Is the information provided to the right people in sufficient detail and on time to enable them to carry out their responsibilities efficiently and effectively? | O | O | O |
| 2.5 | Is the development or revision of information systems over financial reporting based on a strategic plan and interrelated with the university's overall information systems, and is it responsive to achieving the organization objective and activity-level objectives? | O | O | O |
| 2.6 | Does management commit the appropriate human and financial resources to develop the necessary financial reporting information systems? | O | O | O |

## SECTION 3 – Using information in your everyday practice at work

In this section we want to document the type of information you use in your everyday practice at work.

| | **Using the following scale, rate the frequency with which you have used information from the following sources during the past year…** | **Never** | **1 or 2 times** | **3 or 4 times** | **4 times or more** |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| 3.1 | Scholarly documents. | O | O | O | O |
| 3.2 | Professional publications. | O | O | O | O |
| 3.3 | Evaluations of your organization | O | O | O | O |
| 3.4 | Internet Web sites | O | O | O | O |
| 3.5 | Multimedia materials, such as video, DVD and software | O | O | O | O |
| 3.6 | Mass media, such as television, radio, newspapers and magazines | O | O | O | O |
| 3.7 | In-service training or workshops | O | O | O | O |
| 3.8 | Professional conferences or presentations | O | O | O | O |
| 3.9 | Experts or resource people | O | O | O | O |

- **Please list other sources of information you use in your everyday practice at work:**

_____

_____

_____

_____

## SECTION 4 – information technology skills

In this section we want to document what for your information technology skills.

| | **Using the following scale, rate the frequency with what is your skills level for the following ...** | **Not at all skilled** | **Not very skilled** | **Fairly skilled** | **Very skilled** | **EXPERT** |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 4.1 | Writing Software (word .... etc.) | O | O | O | O | O |
| 4.2 | Spreadsheets (Excel, etc.). | O | O | O | O | O |
| 4.3 | Presentation Software (PowerPoint, etc.). | O | O | O | O | O |
| 4.4 | Graphics Software (Photoshop, Flash, etc.). | O | O | O | O | O |
| 4.5 | Using the internet to effectively and efficiently search for information. | O | O | O | O | O |
| 4.6 | Evaluating the reliability and credibility of online sources of information. | O | O | O | O | O |
| 4.7 | Understanding the ethical/legal issue surrounding the access to and use of digital information. | O | O | O | O | O |

## SECTION 5 – Organizational factors

By "organizational factors" means elements that have to be contended with in everyday life and that may affect professional activities including organizational culture such as established habits, traditions and values and physical and human resources.

| **Using the following scale, rate the extent to which you agree that your use of management information system is influenced by the following organizational factors…** | **Strongly disagree** | **disagree** | **Neutral** | **agree** | **Strongly agree** |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 5.1 A supportive environment | O | O | O | O | O |
| 5.2 Human resources, such as the availability of qualified staff | O | O | O | O | O |
| 5.3 Opportunities to challenge established habits and Traditions | O | O | O | O | O |
| 5.4 Available facilities and technology | O | O | O | O | O |
| 5.5 Incentives, such as remuneration, honoraria, lessening of the work-load, etc. | O | O | O | O | O |

- **Please list any other organizational factors that may influence your use of management information system:**

## SECTION 6 – Strategic Management & MIS Implementation

| Using the following scale, rate the extent to which your organization strategy and implementation for MIS… | | Yes, totally | Largely | Partially | To small extent | Not applicable |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 6.1 | Is your organization meeting its own expectations as regards managing its own information? | O | O | O | O | O |
| 6.2 | Does your organization have a Knowledge and Information Management (KIM) strategy? | O | O | O | O | O |
| 6.3 | Do managers understand why and how MIS is critical to the organization? | O | O | O | O | O |
| 6.4 | Does the organization document how each information asset will be used over time? | O | O | O | O | O |
| 6.5 | Have costs and resource needs for MIS been determined? | O | O | O | O | O |
| 6.6 | Does the organization know what information it needs to create and capture in the first place? | O | O | O | O | O |
| 6.7 | Is the organization confident that it has the right processes and IT infrastructure to keep information it creates as long as it is needed? | O | O | O | O | O |
| 6.8 | Do all business areas have guidance on what information should be kept and where? | O | O | O | O | O |
| 6.9 | Is key and critical information always easy to find when it is needed? | O | O | O | O | O |
| 6.10 | Do people have the right skills to use information management systems? | O | O | O | O | O |
| 6.11 | Is Knowledge and Information Management included as part of the change management strategy? | O | O | O | O | O |
| 6.12 | Does the organization have a records management policy? | O | O | O | O | O |
| 6.13 | Does the policy include information management? | O | O | O | O | O |
| 6.14 | Are information management policies and guidance easily accessible to staff at all levels of the organization? | O | O | O | O | O |
| 6.15 | Does the organization have a formal mechanism for ensuring knowledge capture and knowledge transfer? | O | O | O | O | O |

## SECTION 7 – Your opinion about management information system

In this section we want to document your opinion about management information system.

| | **Using the following scale, rate the extent to which you personally agree that management information system…** | **Strongly disagree** | **agree** | **Neutral** | **agree** | **Strongly agree** |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 7.1 | Is easy to find | O | O | O | O | O |
| 7.2 | Is easy to understand | O | O | O | O | O |
| 7.3 | Offers timely information | O | O | O | O | O |
| 7.4 | Is reliable and trustworthy | O | O | O | O | O |
| 7.5 | Is useful to guide or improve your professional practice | O | O | O | O | O |
| 7.6 | Is easy to transfer into your practice | O | O | O | O | O |

- **Please add any other opinions about management information system:**

- **Please comment here on the relevance of this questionnaire to your reality.**

**Thank you for your time and participation!**

## II. Statistic Table:

| Probability Value | Kay value | Degree of freedom | standard deviation | mean | Phrases |
|---|---|---|---|---|---|
| 0 | 15.680[a] | 1 | 0.418 | 1.78 | 1.1 |
| 0.001 | 14.560[b] | 2 | 0.705 | 1.56 | 1.2 |
| 0.157 | 2.000a | 1 | 0.99 | 1.8 | 1.3 |
| 0.104 | 6.160[c] | 3 | 1.055 | 2.22 | 1.4 |
| 0.07 | 5.320[b] | 2 | 0.803 | 1.74 | 2.1 |
| 0.011 | 6.480[a] | 1 | 0.471 | 1.32 | 2.2 |
| 0.572 | .320[a] | 1 | 0.503 | 1.54 | 2.3 |
| 0.011 | 6.480[a] | 1 | 0.471 | 1.32 | 2.4 |
| 0.002 | 12.520[b] | 2 | 0.667 | 1.62 | 2.5 |
| 0.07 | 5.320[b] | 2 | 0.803 | 1.74 | 2.6 |
| 0 | 44.920[b] | 2 | 0.473 | 1.98 | 3.1 |
| 0 | 44.920[b] | 2 | 0.473 | 1.98 | 3.2 |
| 0.262 | 2.680[b] | 2 | 0.755 | 3.04 | 3.3 |
| 0.008 | 9.760[b] | 2 | 0.749 | 3.36 | 3.4 |
| 0 | 26.640[c] | 3 | 0.828 | 2.26 | 3.5 |
| 0 | 13.520[a] | 1 | 0.431 | 1.76 | 3.6 |
| 0 | 30.960[c] | 3 | 0.794 | 2.32 | 3.7 |
| 0 | 28.120[b] | 2 | 0.795 | 1.98 | 3.8 |
| 0.12 | 5.840[c] | 3 | 0.981 | 2.76 | 3.9 |
| 0.006 | 10.360[b] | 2 | 0.688 | 3.34 | 4.1 |
| 0.068 | 7.120[c] | 3 | 0.953 | 3.3 | 4.2 |
| 0 | 29.520[c] | 3 | 0.886 | 3.1 | 4.3 |
| 0.048 | 9.600[d] | 4 | 1.344 | 2.7 | 4.4 |
| 0.002 | 13.000[b] | 2 | 0.647 | 3.3 | 4.5 |
| 0.044 | 8.080[c] | 3 | 0.931 | 2.7 | 4.6 |
| 0.09 | 6.480[c] | 3 | 1.182 | 2.3 | 4.7 |

| Probability Value | Kay value | Degree of freedom | standard deviation | mean | Phrases |
|---|---|---|---|---|---|
| 0.002 | 12.280[b] | 2 | 1.444 | 2.58 | 5.1 |
| 0.113 | 4.360[b] | 2 | 1.266 | 2.3 | 5.2 |
| 0.044 | 8.080[c] | 3 | 1.155 | 2.82 | 5.3 |
| 0 | 24.720[c] | 3 | 1.284 | 2.06 | 5.4 |
| 0.98 | .040[b] | 2 | 1.272 | 2.66 | 5.5 |
| 0 | 25.800[d] | 4 | 0.982 | 3.12 | 6.1 |
| 0 | 34.200[d] | 4 | 0.996 | 3.78 | 6.2 |
| 0.171 | 6.400[d] | 4 | 1.199 | 2.9 | 6.3 |
| 0 | 22.800[d] | 4 | 1.253 | 2.68 | 6.4 |
| 0.868 | .720[c] | 3 | 1.52 | 3.34 | 6.5 |
| 0 | 20.400[d] | 4 | 1.125 | 2.8 | 6.6 |
| 0.003 | 13.840[c] | 3 | 1.186 | 3.32 | 6.7 |
| 0 | 38.800[d] | 4 | 0.979 | 2.98 | 6.8 |
| 0 | 28.240[c] | 3 | 1.207 | 2.82 | 6.9 |
| 0 | 60.560[c] | 3 | 0.586 | 2.94 | 6.10 |
| 0.219 | 3.040[b] | 2 | 0.808 | 2.2 | 6.11 |
| 0.016 | 12.200[d] | 4 | 1.387 | 2.56 | 6.12 |
| 0.024 | 11.200[d] | 4 | 1.448 | 3.16 | 6.13 |
| 0 | 32.080[c] | 3 | 1.282 | 2.5 | 6.14 |
| 0 | 30.480[c] | 3 | 0.714 | 2.98 | 6.15 |
| 0.003 | 16.200[d] | 4 | 1.15 | 2.94 | 7.1 |
| 0 | 27.520[b] | 2 | 0.814 | 3.48 | 7.2 |
| 0.01 | 13.200[d] | 4 | 1.311 | 3.42 | 7.3 |
| 0.007 | 12.240[c] | 3 | 1.168 | 3.94 | 7.4 |
| 0 | 24.720[c] | 3 | 1.016 | 4.22 | 7.5 |
| 0.068 | 7.120[c] | 3 | 1.119 | 3.82 | 7.6 |