EVALUATING THE KNOWLEDGE MANAGEMENT PRACTICES OF CONSTRUCTION FIRMS IN PAKISTAN

A thesis submitted in partial fulfillment of
the requirements for the degree of

**Masters of Science
in
Construction Engineering and Management**

by

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July, 2014

This is to certify that the
thesis titled

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Prof. Dr. Muhammad Babar Khan
Supervisor,
Department of Construction Engineering and Management,
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DEDICATED
TO
MY BELOVED FATHER

(Prof. Muhammad Farooq Qazi)

ACKNOWLEDGEMENTS

ABSTRACT

Knowledge management is considered as a tool to develop performance with many academic and experts including improved processes, better time management, decision making, project delivery methods, quality and cost management etc. Unfortunately, knowledge management implementation is retarded because of various conflicting assumptions of knowledge management and different tools considered by users. Due to these contradicting understandings of knowledge management and a lack of awareness about information management, confusion within industry was further increased. Past stories on knowledge management are occupied with the differences between knowledge, information and data. Now it has been accepted that companies required a mixture of all these. Knowledge management is basically the knowledge identification and optimization of knowledge which is carried out to create value, enhance efficiency and achieve benefits.

In Pakistan, the studies on Knowledge Management in construction sector are not very common. This thesis highlights perceptions of Pakistani construction industry with regard of Knowledge management. The main objective was to find out the effectiveness, strategies, tools/ techniques and emerging issues with regard of knowledge management in Pakistani construction industry. The methodology was two dimensional. This was based upon a general questionnaire survey and a case study of a client organization. In first dimension of the research work, the questionnaire was designed based upon research variables for to get general perception of Knowledge management including awareness/commitment, strategies and tools/ technique. The questionnaire survey was carried out among different Stakeholders of Pakistani construction industry which include designers/engineers, contractors/sub-contractor and consultants/facility owners. The data, which was collected from participants, was analyzed by executing different statistical tests to make conclusions. In second dimension of the research work, one client organization was targeted to evaluate the emerging issues of knowledge management in Pakistani construction industry. For general data collection, separate questionnaire was developed which was distributed among the employees of case study organization while main case study was based upon interviews of senior management staff.

Results of general questionnaire indicated that there is good awareness about managing knowledge among the construction industry stakeholders. Respondents have perceptions that knowledge management is not just record keeping but a complete system of capturing, storing, codifying and reuse of knowledge at right time. It reduces delivery

time and improves quality of works. People fear to share knowledge is fond big hindrance for effective implementation of knowledge management system. To remove fear factor, a cultural change is required to improve local understating about knowledge management. For managing knowledge E-mail was considered most effective tool which is quickly replacing the old system of information delivery. Departmental managers are considered ultimate responsible of knowledge management in Pakistani construction industry.

Contents

List of Abbreviation

ACR	Annual Credibility Report
KM	Knowledge Management
SMEs	Small to medium-sized enterprise
CIRIA	Construction Industry Research and Information Association's
PII	Partners in Innovation
PEC	Pakistan Engineering Council
CPD	Continuing Professional Development

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INTRODUCTION

1.1 Background

"Knowledge is now regarded as management asset within the construction organizations, since it facilitate the organizations to improve their competitive advantage (Kant and Singh, 2011 and Kasimu et al., 2012)". Many studies have been conducted on Knowledge Management within developed countries. However, in Pakistan, KM is not very much familiar in our construction industry. "Laudon and Laudon, (2003) stated that knowledge is progressively considered as a survival tool in a dynamic and competitive environment". "Malone, (2004) added that knowledge has now turned into a precious property and KM continues to be broadly practiced by many organizations as one of the most promising approaches for the organization to be becoming successful within the information age". "However, many researchers and scholars has now recognized KM as one of the prerequisites to turn a construction organization into a centre of excellence for the development of infrastructure projects and innovated with high moral values in order to meet the national and international needs (Abdul-Rahman and Wang 2010; Alashwal, et al. 2011; Chou and Yang 2012)".

Knowledge Management is carried out to ensure safe storage of experience and data in a manner that it should be easily accessible for right hands. "According to Davenport et al., (1998) KM is a procedure for collection, distribution and efficient utilization of the knowledge resource". "Disterer (2003) added that KM is the creation, acquisition, capture, discussing and use of knowledge in almost any forms to improve the organization performance". "O'Dell and Grayson, (1998) argued that KM is an approach employed by organizations to ensure that knowledge reach the right people at the proper time, and that those people share and use the knowledge to improve the organizational performance".

"The professionals when completing a task, they move to a different project in the same organization or a different organization or sometimes they proceed to another project, resign, or retire. Therefore, the new knowledge and experiences acquired by the professionals are lost after completing the projects, and if the organization did not recorded, captured is not stored within the repository to be shared for reuse in the subsequent projects

(Kazi and Koivuniemi, 2006 Fong and Wong et al., 2005)". "This is because the tacit knowledge and experiences are in the minds of engineers and experts that are actively participated in the construction projects. However, researchers and scholars intensified that capturing the tacit knowledge of experts and engineers that take part in the project development for re-using in future projects is vital for the improvement of the organizational performances (Tserng and Lin 2005 Koskinen et al. 2003 Woo et al, 2004 and Jeeger and Kant, 2013)".

In developing countries like Pakistan, there is no proper way of managing Knowledge generated during various phases of the construction project. However, in few shapes, construction firms are working to safe guard there record in the form of SOPs, letters, reports, K-drives and standard forms. This study has tried to evaluate the current practices which are being followed to maintain knowledge of construction firms in Pakistan. It has also identified various techniques which are currently being used in Pakistani construction firms and emerging issues to construction firms with respect to KM.

1.2   Reasons for Selection of the Topic:

The following were the reasons for the selection of this topic:

a) This research work was to create awareness among the stakeholders like designers/ engineers, contractors/sub-contractor, academia, developers, construction and project managers, and facility owners about various aspects of good knowledge management.

b) This research was to identify the methods which increase the chances of conducting successful knowledge management in construction firms.

c) This was also to explore perceptions of knowledge management in Pakistani construction firms.

1.3   Research Objectives:

The objectives for this research study work were:

i.   To assess general awareness and commitment of Pakistani construction industries for managing Knowledge.

ii.   Introduction to various strategies being used for Knowledge Management in Pakistani construction Industry.

iii.   Introduction to tools and techniques for Knowledge Management which are being used in Pakistani construction Industry

iv. To identify the emerging issues associated with Knowledge Management in the Pakistani construction organizations.

1.4 Relevance to National Needs:

Our national construction industry lacks proper KM practices. This study is providing some useful insights into the current practices of KM which will gain interest of construction companies to invest in the field of KM. It will enhance local understanding about KM and will improve project delivery techniques with continual process improvement. Further, good perception will reduce the loss of precious information gained with the passage of time.

1.5 Advantages of the Research work:

This research work would help:

a. To enhance the capability of our design, consultancy and construction firms to manage their record both tacit and explicit, in a ways to get real benefits by utilizing the knowledge of wining decision, made in past.

b. To create the better understanding of managing knowledge and attracting mind set of big players for investment in this filed in the shape of both time and monitory resources.

c. To provide current perceptions of knowledge management in Pakistani construction firms.

d. To identify multiple techniques for creation, verification, easy search and implementation of knowledge generated during past experiences.

1.6 Areas of Application, Scope and Limitation of this Research Study:

This thesis is providing better perception of importance of Knowledge Management in CE construction firms. It is enhancing capability of construction firms to capture experience of their employees for continual improvement of all processes of construction, even if employees leave company after serving a lengthy time period. This thesis covers the interests of Pakistani construction firms in particular and international construction firms in general.

1.7   Thesis Organization

Thesis is structured in seven chapters with chapter one includes an introduction to the research work, chapter 2 includes literature review, chapter 3 includes methodology used in this research study, chapter 4 includes analysis and results based upon main questionnaire, chapter 5 includes Case Study, 6th chapter presents findings, and final 7th chapter summarizes discussion and conclusions.

1.8   Summary

This chapter has introduced the topic of this study, the overall research work and the current state of the KM in Pakistan being a new concept. The motivations for the selection of this topic as how this would help to understand the processes of KM for more accurate and consistent information flow during different phases of a facility, research objectives, relevance to the national needs, advantages, scope and limitations of this research work. A thorough understanding of the research topic would come after the detailed literature review which is coming in the next chapter.

LITERATURE REVIEW

2.1. Background

Knowledge management (KM) has got much attention after the publication of "Nonaka and Takeuchi's (1995 "text The Knowledge-Creating Company)". "Knowledge management has been traded as a tool to improve performance with many academic and experts advocating the business benefits of KM including improved quality, shorter design and production times, customer and staff satisfaction, market leadership, etc. (O'Dell et al. 2000; Mertins et al. 2001)". Struggles have been made to engage KM which are equally degraded because of contradictory definition of knowledge management. These hurdles further added confusion with conflicting awareness of knowledge management and information management systems.

Early literature on knowledge management was lacking concentration upon differences distinctions between knowledge, information and data. However, currently it has been accepted that user need a deep mixture of all these. It is also feel equally important to differentiate between knowledge and information management instead of considering them as same. "Webb (1998) defines knowledge management as the identification, optimization, and active management of intellectual assets to create value, increase productivity and gain and sustain competitive advantage."

2.2. Knowledge management:

"According to Davenport et al., (1998) KM is a process for collection, distribution and efficient utilization of the knowledge resource". "Disterer (2003) added that KM is the creation, capture, discussing and use of knowledge in almost any forms to improve the organizational performance". "O'Dell and Grayson, (1998) argued that KM is an approach employed by firms to ensure that knowledge reach the right people at right time, and that those people ensure to share and reuse the knowledge to improve the organizational performance". "Bhatt (2001) stated that KM is a procedure for knowledge creation, validation, exhibition, distribution and application". However, "Bounfour, (2003) asserted

that KM is a method, infrastructures and managing tools, made to create, share and leverage information and knowledge within and around organizations". "Even if the above ideas of researchers vary within their explanation of KM, there appears to become an agreement to deal with KM as a process permitting use of knowledge as a key factor to produce and add value (Kasimu et al., 2013 and Makama, 2012)". From the awareness and elucidation of the above-mentioned researchers knowledge management is a process of various activities which includes creation, capture, store, share, reuse and updating of knowledge in an organization. Figure 2.1 shows the process of knowledge management as shown below.
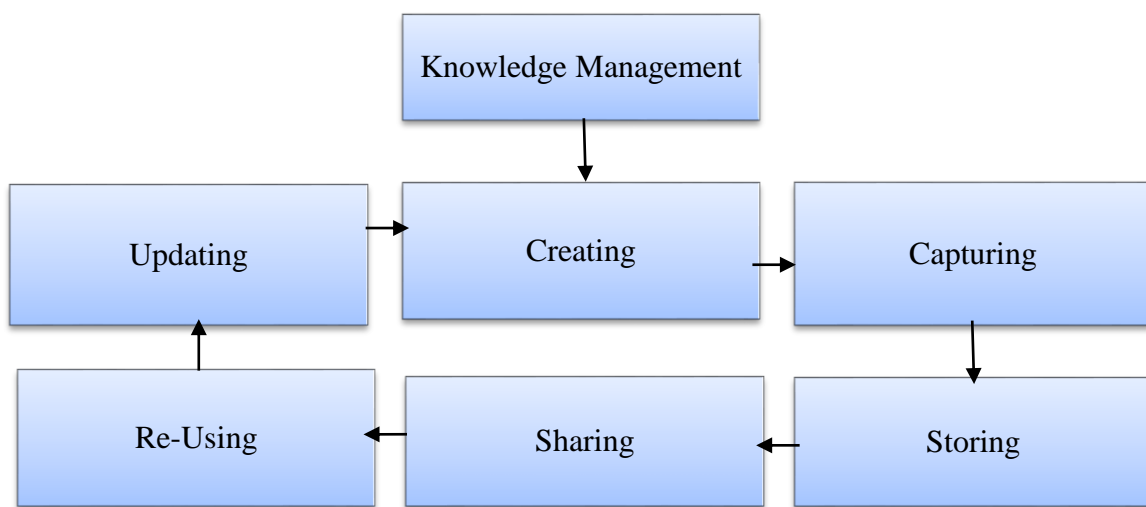
Figure 2. 1: Knowledge Management Framework

2.3. Meaning and various types of knowledge

For effective management of knowledge one should have correct understanding of meanings of knowledge. "If we consider knowledge as an interchangeable with information, then the emphasis tends to be on the management of information systems as a substitution for knowledge management (Blumentritt and Johnston, 1999)". From the above explanation it can be concluded that knowledge is not just information. "Nonaka and Takeuchi (1995) said that knowledge can be defined as a human process of vindicating personal belief toward the "truth" (i.e. a defensible true belief)". "Knowledge has also been defined as 'know-how know-why, and know-who', or an intangible economic resource from which future revenues will be derived (Rennie, 1999)". "Attempts to distinguish between data, information and knowledge have also geared towards the

understanding of the latter (Webb, 1998)". Viewing knowledge on the basis of it context, it background and ultimate use is very important. It proves that knowledge is an important part of a project oriented execution system. Absence of this part indicates a failure when completing a project. If this failure continues for a long period of time then it may lead to failure of the whole system. "Knowledge is constructed from data, which is first converted into information (i.e. related associations and patterns). After this information becomes knowledge, when it enters the system and when it is validated (collectively and individually) as a valid, significant and useful piece of knowledge to be implemented in the system (Blumentritt and Johnston, 1999)".
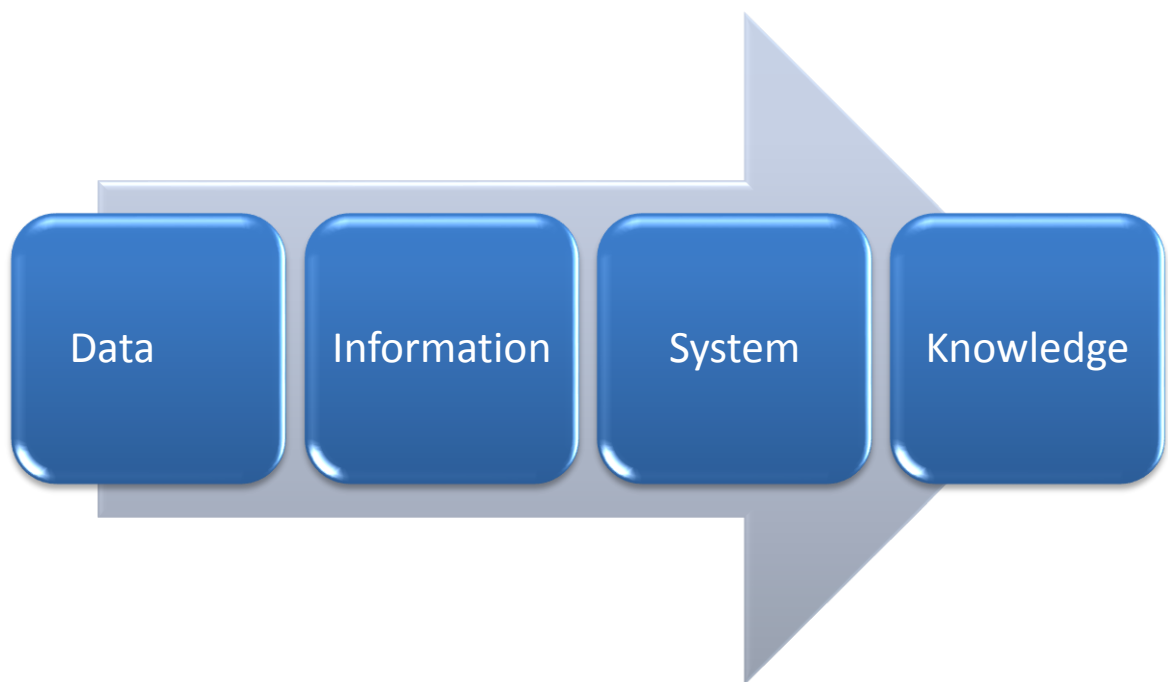
Figure 2. 2 : Knowledge Management Framework

The exact identification of knowledge to be managed is closely associated with he meaning of knowledge. "Various classifications of knowledge include: explicit and tacit knowledge; foreground and background knowledge; classifications with respect to the role of knowledge for business importance (e.g. business environments knowledge), or with respect to the performance roles within an organization (e.g. knowledge for control activities) (Siemieniuch and Sinclair, 1999)". More awareness about these types of knowledge makes it more convenient to manage knowledge. Tacit knowledge, which lubricates the gears of company's performances, is very difficult to be documented because it is in peoples' mind. Likewise, forefront knowledge (Include the organizations standard operating procedures, process diagrams etc.) relies on previous knowledge (comprehensive knowledge) in order to make it operational.

- *Explicit knowledge*

  It can be stored on paper or soft form using IT devices and networks. Specifically, for construction sector it includes daily progress reports, SOPs, minutes of meetings etc. "Explicit knowledge thus lends itself to an IT-centric strategy (Zack 1999; Tiwana 2000)".

- *Tacit knowledge*

  Tacit knowledge is saved in worker's mind and is gained with practical work. Documenting it is not an easy job. In construction field, it includes the common understanding of experienced professionals on the basis of their past experiences. Mostly it is shared using social interaction such as communities of practice, meetings, table talks and site visits etc.

2.4. Stratigies for Knowledge management

Knowledge management belongs to finding the all kind of relevant knowledge which remains available all the time. As a knowledge management implementer, an organization gets the ability to learn from its experiences and avoid repeating same mistakes. It helps to make organizations an innovator.

"O'Leary (2001) argued that Knowledge Management initiatives can help attract and look after top talent, as 'maximizing access to knowledge across the organization' can accelerate the learning experience of new employees, build more knowledge and increase organizational capability". Knowledge Management can lead modernism which acts like a magnet for new clients and retain important clients, and ultimately increase efficiency and economy. "Demarest (1997) noted that firms without knowledge management systems will be effectively unable to achieve the re-use levels required by the business model implicit in the markets they enter, and will lose market share to those firms who do practice knowledge management".

There are two major strategies for implementation of Knowledge Management system which includes codification and personalization.

- *Codification strategy*

  It focuses the capturing of explicit knowledge which is carried out using multiple Information Technology tools i.e. such as artificial intelligence, E-mails, Intranet Facilities, Video conferencing, social networking, development of data basis and data mining tools.

- *Personalization Strategy*

It encircles the capturing of tacit knowledge with the help of tools whci are non-IT and required social inter action such as" knowledge sharing networks (Dyer and Nobeoka, 2000)", "communities of practice (Wenger et al., 2000)", meetings with seniors, site visits etc.

In first strategy type IT is main requirement while in the second type of strategy IT provides only communication as add on. "Incentives and reward schemes may be necessary to encourage knowledge sharing and has been identified as one of the critical success factors for KM (Hall et al., 2000)".

There are many types of incentives/ rewards which include both tangible and intangible. However, a main problem in applying Knowledge Management system is to precisely identify the relevant benefits with regard of the context.

"Dent and Montague (2004) has suggested that it may be more appropriate to scrutinize, review and celebrate success rather than develop specific KM measurement". Researchers anticipate a requirement for more comprehensive actions when Knowledge Management improves with the passage of time in a setup. "A major challenge for those with responsibility for KM is therefore to make a strong business case and to convince senior management and other employees about its the potential benefits (Davenport et al., 1997)".

2.5.   Organizational Implications

Now a day, the construction industries are leaned to examine their performance critically. "The Latham and Egan Reports (Latham, 1994; Egan, 1998) have highlighted that plight of the UK construction industry, bad opinion of the customer, less profitability and over dozing are some of the drawbacks which are effecting the implementation of KM". The industry is snowed under with solving short-term issues. Previously, economical bench marks were seen as the key performance indicators. However, now it seems to be a change of culture. Senior construction players are becoming more aware of the principal of management and holistic approach philosophy as the use of Key Performance Indicators (KPIs) is increasing day by day.

It is being advocated that Knowledge Management supports the process of KPIs. "It forms an essential part of Kaplan and Norton's Balanced Scorecard (Kaplan and Norton, 1996) 'Internal Business' viewpoint, as well as the 'Learning and Growth' viewpoint".

- *Organizational strategy need*

"Organizational strategies provide a framework for decision making (Boseman and Phatak, 1989)". Knowledge is carried out in haphazard way without boundaries in the absence of such a strategy. Construction companies are working for knowledge management partially. As a result of these, they gained multiple experiences in particular Areas of work. Knowledge management is currently new for construction industry and it will comprehensive talk to exactly understand that weather it is considered as a just fashion or it actually benefits the organization and become permanent asset. It is very effective benefit to the company which cannot be directly calculated in monitory terms and can help in improving competitive advantage. Some companies are interested in KM and some have hired separate knowledge managers however, others take KM as just a use of Internet.

Innovations in construction sector are now being affected by the effective implementation of knowledge management systems. An organizational plan of KM will allow a complete framework that will be allow organizations to function, prepare schedule, and endorse a suitable program.

- *Strategy development*

"A strategy finalizes the major plans which are to be undertaken and then accordingly allocates resources (Cannon, 1968)". "Aaker (1984) also suggested assigning people or groups of people the responsibility for analyzing new issues, such as KM and developing responsive strategies". Planning for implementation of Knowledge Management system in an organization established clear goals with the methods to achieve them in a time schedule. For a construction organization there are multiple considerations which include but not limited to, identifying those areas of any process that provide maximum benefits, the scope of a problem which is to be identified, what standard will be used (IT or non- IT), evaluation criteria etc.

Another good way of strategy development is to get some help from those who have already developed and implemented KM strategy in their organization.

- *Current working practices and organizational structure*

The construction companies have a very bad record of facilitating the workers and their families which make sharing of knowledge more difficult. It is acknowledged that tacit knowledge is personal property instead of the organizational. Organizational structures and multi-functional teams increase difficulty of knowledge sharing. Any job that requires more resources should be questioned. Knowledge Management should become a compulsory part of the daily routine work for its successful implementation.

- *Cultural and other barriers*

It is observed that construction organizations usually don't appreciate the tradition of sharing knowledge. "Wates Group, a medium sized UK building company, stated it took four and a half years before staff accepted the concept of sharing knowledg (CPN, 2000)". The first focus should be upon change of culture if we want to implement and get benefits from KM. Every organization has its own culture and it depends upon their structure that what measures will be more effective for changing the culture in the favor of KM. In addition, many other barriers are required to be removed for applying KM at a level of enterprise with a successful manor. These include:

- *Time Lacking*

Knowledge sharing demands additional efforts. These efforts may be reduced by good work practices and the implementation of better knowledge sharing techniques. There are always compressed deadlines for construction projects.

- *Importance to solving big problems*

KM processes are multifaceted. This is very easy to imagine the environment of sharing knowledge among the team members of a project on required basis in different stages of the construction. However, practically, initially, it is good to implement KM on small projects which have minimum no of stake holders rather than implementing it on large and complex project, in start.

- *Knowledge Conversion*

Capturing Knowledge on projects that belong to across the organizational limits is one of the big problems. The industry contains multi-disciplinary teams which have rich experience of doing specific tasks. The real problem is to convert their tacit knowledge to explicit knowledge for the advantage of organization, which is not very simple to execute within a reasonable time scale and financial limits.

- *Medium and small size enterprise*

The Pakistani construction industry contains a large number of small and medium-sized enterprises. They have no interest in KM and in more cases they either do not see the requirement or much resource to implement KM system. In addition, it is always less desirable for small organizations to spend monitory and time resources for the sake of knowledge capturing as usually they are more low scope profit oriented.

- *Multi-Functional Teams*

In construction projects project team members belongs to multi functional categories. With such kind of teams knowledge management is not simple. The employer of individual team member dictates specific agenda which he/she has to follow. It is because of that, the

real benefits of KM remains up to some particulars instead of those all employees which were involve.

2.6. Management of knowledge in construction firms

Practical impact of knowledge management at industry level has been discussed by many researches in past. "For instance Kamara et al., (2002) outline the main significant influence of KM in the construction organization as a result of the need for innovation, improved organizational performance". "In addition, Carrillo et al., (2004) conducted a research in the UK engineering and construction firms, and discovered the reasons for KM practices in the construction organization as the necessity to inspire continuous improvement, in order to share valuable tacit knowledge, to disseminate best practices, to respond to clients rapidly, to reduce construction rework, and to develop new products and services respectively". Forgoing above, keeping in view the environment of construction and its projects in the domain of exclusivity and short-term in nature, which contains workers from the diverse or multi-functionality team, they should be intermingled together to achieve the main objectives.

The construction experts when finishing a job, they either switch to another task which is executing under the same project or go to another project which is executing under the supervision of the same firm , may resign, or leave the organization/retire. "The new knowledge/experiences gained by the experts are gone after completing the projects, and if the organization did not recorded, captured is not stored within the repository to be shared for reuse in the subsequent projects (Kazi and Koivuniemi, 2006 Fong and Wong et al., 2005)". Therefore, the expertise captured are remained in the form of tacit knowledge in the mind/ head of those workers which were actively involved in successful execution of these projects. "However, researchers and scholars intensified that capturing the tacit knowledge of experts and engineers that take part in the project development for re-using in future projects is vital for the improvement of the organizational performances (Tserng and Lin 2005 Koskinen et al. 2003 Woo et al, 2004 and Jeeger and Kant, 2013)".

It is growing fact that construction industry is very competitive. This fact that the construction industry is very competitive makes knowledge management very attractive for construction firms. Many processes are demanding from employees to explore the knowledge and shared it at least for one time. Many research projects at university level require full support from the construction industry. These projects are launched to get a bird eye view of the state of KM within the United Kingdom.

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"(Robinson et al. 2001), in a survey of United Kingdom engineering and construction firms, was able to identify the main drivers for knowledge management in construction which includes need to encourage continuous improvement (92.5%), to share valuable tacit knowledge (88.7%), to disseminate best practices (86.8%), to respond to customers quickly (84.9%), to reduce rework (77.4%) and to develop new products and services (58.5%)"

"Another survey of engineering design and construction organizations revealed that about 40% already have a KM strategy and another 41% plan to have a strategy within a year (Carrillo et al. 2004)". "Studies show that the most publicized knowledge management initiative is the post project evaluation (Orange et al. 2000)". "(Kamara et al. 2003) also describe the reliance of people to transfer project knowledge and the use of contractual arrangement such as partnering to share knowledge".

Interest which is increasing day by day in KM has escorted to an excitement to evaluate the working of other professional in same field which ultimately scales the efforts of organization. In UK, this can be executed informally for a research project and it is allowed. In USA there is a special forum for such activities which known as the APQC. However, it is disappointing that involvement of construction companies is not very attractive.

2.7.   Misconceptions of Knowledge Management

There are multiple misconceptions with regard of knowledge management in construction sector particularly in term of definition of information, data and knowledge. However, two major misconceptions are the common understanding that lessons learned and project extranets are knowledge management systems itself. The firms are leaned to execute lessons learned sessions after completing a project. Which contribute to sharing of knowledge. Lesson learned are not the complete KM System but a single process which is carried out to capture and share knowledge. "This add to knowledge captures but they are not conducted frequently in a proper manner and have many other shortfalls including the absence of all stakeholders, incomplete record of LL, and temporary distribution of the findings, if at all (Orange et al. 2000)". "This means that lessons learned are not leveraged as well, as they may be (Kamara et al. 2003)". Some time it is misunderstood that the extranet/ intranets are KM system itself while actually these are just add-ons to provide ease in communication of both data and information.

2.8. Challenges for knowledge management in construction firms

"Carrillo et al. (2004) outlined the main challenges faced in applying KM in construction companies which are as follows;

- Lack of sufficient time
- Organizational culture
- Insufficient standard work processes
- Inadequate funding"

All of the above, insufficient time considered most important challenge for the organizations particularly when the companies are expecting from the employees to execute KM activities in addition to their other responsibilities. "Many authors have recognized culture as a significant barrier to knowledge sharing practices (Ruggles 1998 McDermott and O'Dell 2001 Moore and Dainty., 2001)". "Dainty et al, (2004) stated that the task for KM is to inspire people to make a decision to voluntarily share tacit knowledge among the colleague within the organization. Even though the organizational culture continues to be blamed for that problem when it comes to vertical silos in organizations which result in a lack of knowledge of the items and others did, a culture of internal competition which undermines efforts to share knowledge, knowledge hoarding, etc". Fewer profit margins in construction companies have also discouraged the investment in knowledge management from big stakeholders. Now the construction industry has recognized the fact that the KM is not just executed with the help of IT because it ignored the second most important part of knowledge.
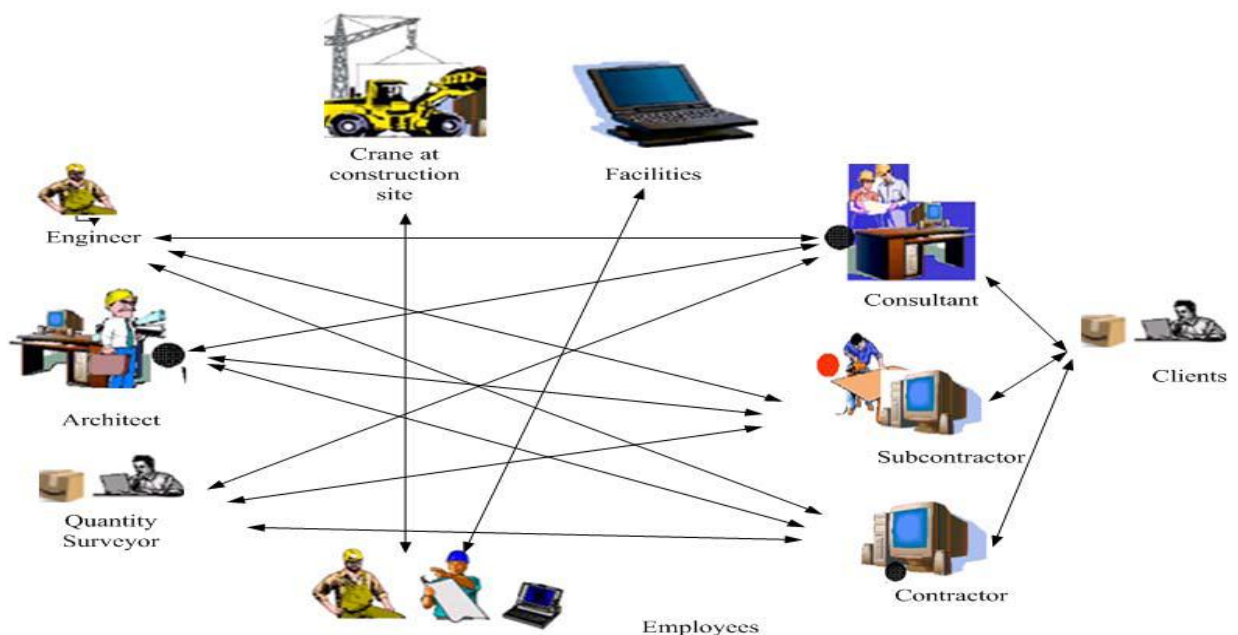
Figure 2. 3 : KM being carried out in construction

2.9. Benefits of knowledge management in construction

"Robinson et al., (2004) outlined that KM has been empirically established to improve the performance of the construction industry in terms of the quality, time, speed, reliability and reducing production costs". "The benefits of knowledge management have been supported by many studies, as a main competence that produces permanent competitive benefit (Skryme and Amidon, 1997; Davenport et al., 1998; McCampbell et al, 1999; Soliman and Spooner, 2000)". Many studies verified that the major benefits of the KM implementation are:

- Better decision making
- Better efficiency of manpower and operations
- Better innovation
- More flexibility to adopt changes
- Decreasing process time cycle
- Better management learning

"Moh, d Zin and Egbu., (2010) stated that due to this success, many calls were made by the construction industry leader and academics for the adoption of KM in the construction industry".
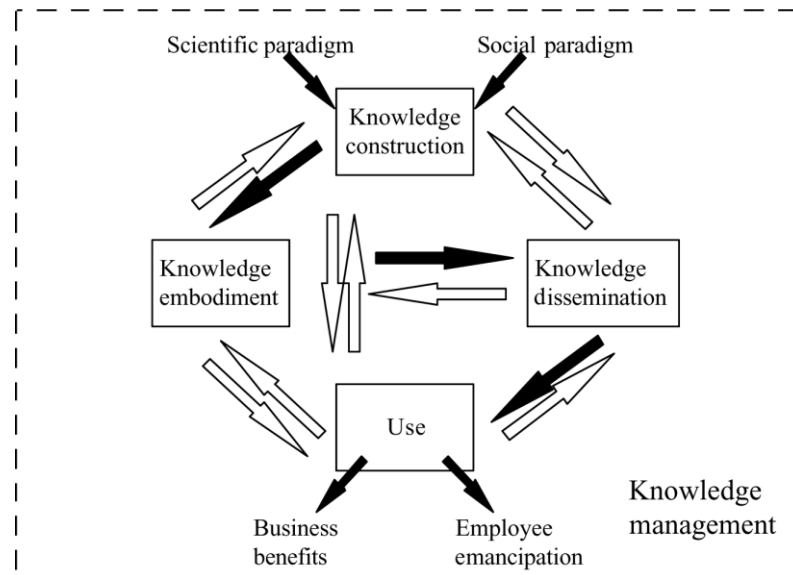
Source: McAdam and McCreedy, 1999

Figure 2. 4 : Extracting benefits from knowledge management

"Anumba et al., (2005) added that the implementation of KM strategy can lead to the agreement of several benefits to organizations". "Some of the key benefits of KM to the

construction were highlighted below by the following researchers (Anumba et al., 2005; Egbu, 2005; Al-Ghassani et al., 2004; Carrillo et al., 2004 and Robinson et al., 2005) such as:

- Innovation
- Improved performance
- Improved construction project delivery
- Facilitate the transfer of KM across a variety of project interface
- Improved support for teams of knowledge workers
- Retain the tacit knowledge
- Increased value
- Construction organizations can be more responsive and better able to respond to organization changes
- Risk minimization"

"Extraordinary benefits from knowledge project involves money saved or earned O' Dell and Grayson, 1998; McCampbell, et al., (1999). Beckman, (1997) added that, the majority of the benefits of KM are intangible and difficult to quantify". "In view of the fact that traditional financial measure such as return on asset (ROA) or return on equity (ROE) cannot adequately evaluate the intangible aspects of organizational assets, such as knowledge or knowledge workers, several innovative approaches emerged. Intellectual capital is one of the measures that receiving attention from academia and practice (Davenport and Prusak, 1998)".

2.10. Knowledge management in Pakistani construction firms

Pakistan is one of the under developing countries which have enough potential to execute the fast growing progress plan within available resources. It is located in south Asia and has common International boundaries with China, India, Afghanistan and Iran. People are hard working and energetic with very attractive percentage of young blood. "Almost 50% of the 84 million people are aged between 18 and 35 years old, while 20%, or 17 million people, are under the age of 26 (http://tribune.com.pk/story/525778/pakistans-youth-bulge/)".

Although, the War on Terror has damaged the progress regime of this country shoddily however this country has still enough ground for construction investors at both national as

well as international level. This country is full of natural resources (Construction raw Materials) and inexpensive manpower. The government has special interest for international investors and provides fool proof security to encourage development sector.

In 2012-13, GDP share of construction industry in Pakistan was increased up to 5.2% while in 2011-12 it was 3.2%. After 2005 earthquake, in which mass human casualties were occurred and country infrastructure was heavily affected, number of international companies attracted towards this. According to PEC currently, there are more than 15000 large, medium and small size local construction companies which are working in Pakistan. Detail is as under;

CATOGORY	NO. OF FIRMS
CA	150
CB	150
C1	1000
C2	1400
C3	4500
C4	7000
C5	80
C6	850

Knowledge Management is not very familiar in Pakistani construction firms. Even large construction firms are not fully aware of the benefits and implications of KM. There was dire need to conduct research work on KM to highlight current practices, which are being followed in Pakistani construction firms, to analyze the present situation with regard to KM. Most of the firms are limited to manage explicit knowledge only and there is no specific procedure to manage tacit Knowledge. It is presumed that Knowledge management is limited to standard procedures, format, templates and miscellaneous office record i.e. letters, drawings, progress reports and Minute sheets etc.

2.11. Summary

In this chapter a detailed literature review has been carried out in which meaning and types of knowledge management was highlighted, the KM strategy was discussed, organizational implications of KM were explained in details, KM in construction firms was discussed, misconceptions in KM were highlighted, benefits after implementing successful KM were also discussed. At the end of the chapter the status of KM in Pakistan was also discussed.

RESEARCH DESIGN AND METHODOLOGY

3.1   Introduction

For this research work, the design and methodology adopted, has been presented and discussed in this chapter. "Research strategy reflects how the researcher is going to carry out its study to achieve and to answer the research objectives(Saunders, Lewis et al. 2007)".This study was carried out to evaluate the general perception of Pakistani construction firms for managing their knowledge. The survey was conducted and data was collected for this research through a questionnaire. In addition to the questionnaire survey, case study was conducted in a client organization. Figure 3.1 shows the schematic layout of the research study.

At first a preliminary study to the topic was conducted, a detailed literature review was carried out and previous thesis/ research papers were consulted. After this, already developed questionnaire with regard of Knowledge Management were studied and examined. At the end of this review, the specifics of the research survey, case study survey and interview questions were developed.

The sample for this research study was taken from the population of construction industry in Pakistan. Stakeholders of the construction industry including Engineers / Consultants, General / Specialty Contractors and Developers / Facility owners were included in this survey. For the design of online questionnaire survey form Google documents application was used. The questionnaire was sent via email and facebook to Engineers/ Consultants, Contractors and Developers/ Facility Owners.

The emails were acquired from the following sources
1. PEC's (Pakistan Engineering Council) website
2. Personal / professional contacts and relations

Participation to the survey was voluntary and completely confidential. The only incentive was to receive the summary of the findings of the survey. The recorded answers were kept confidential and used for statistical analysis purposes only.
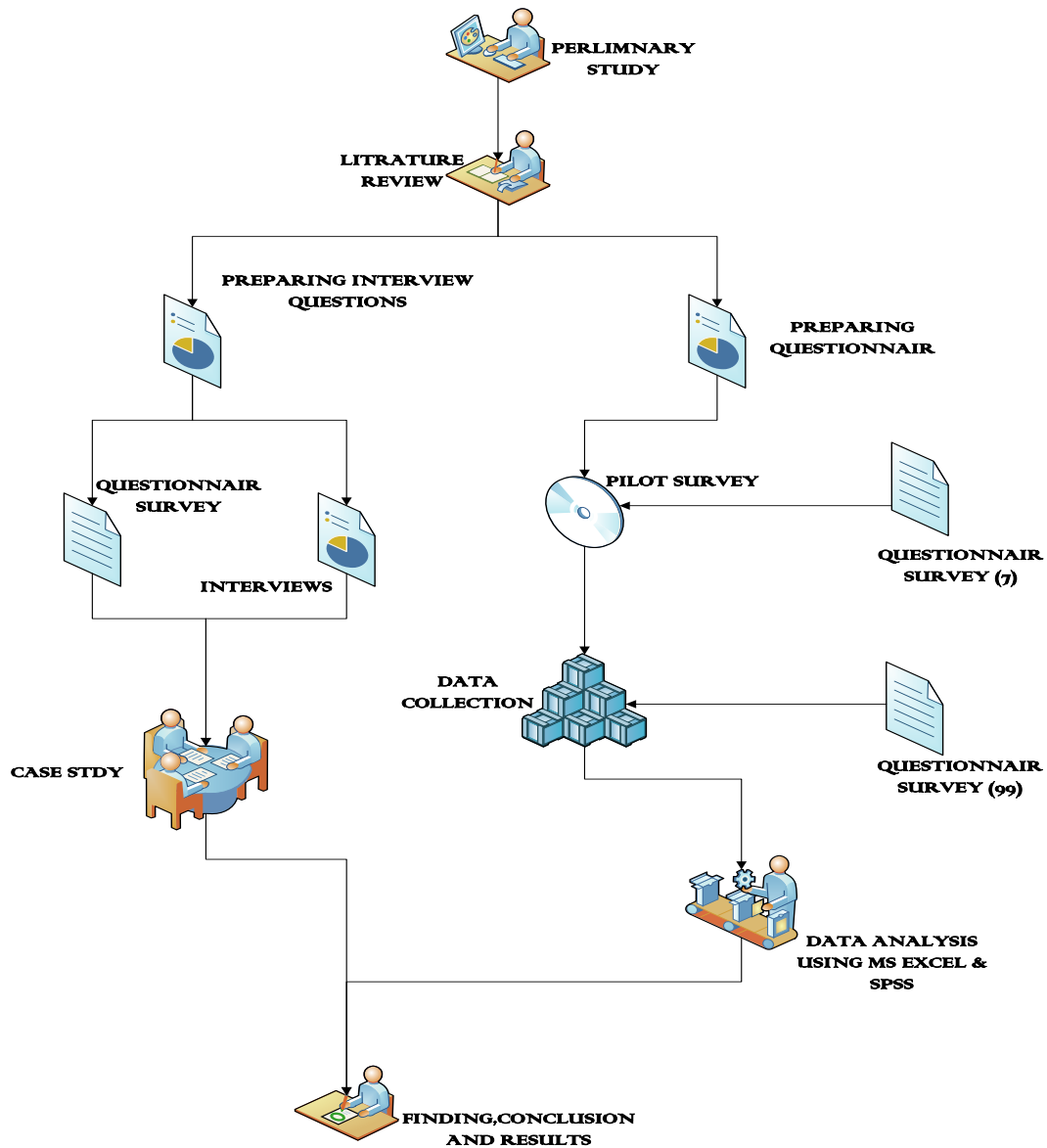
Figure 3. 1 : Research Methodology

Total 120 questionnaires were sent out, 106 were received. Respondents for this survey were included 26 Engineers / Consultants, 30 General / Specialty Contractors and 50 Developers / Facility Owners.

The data was collected and analyzed by using MS Excel and SPSS. Statistical procedures were applied to check and measure the validity and internal consistency of the collected data. The first procedure was performed by conducting the criterion-related validity test for non-parametric data (as this would be discussed in the relevant part of the next chapter). The second procedure was to use Cronbach's Coefficient Alpha value which is calculated when using likert scale for evaluation of internal consistency and reliability of the collected data. To chek that weather data is parametric or not Normality Test (Shapiro-

Wilk) was conducted. By using the expression (3-2) the sampling error was calculated. Kruskal-Wallis test was conducted to check the differences in awareness among the stakeholders about general awareness about knowledge management in the local context. Level of significance was taken as five percent to represent statistically significant relationships in the collected data. The local level of awareness, introduction to strategies and tools used in local construction industry about Knowledge Management was evaluated by using the frequencies, mean score (MS) and relative importance index (RII) method and by comparing the perception of the stakeholders from each other and the overall (through their responses).

3.2   Research Instrument Design

For questionnaire design for survey and interview questions for case study, many research papers and PhD thesis have been studied and referred. However, the concept for the questionnaire and interview questions was taken from the following research papers/ PhD thesis:

1. *"Application of Knowledge Management Technologies in Korean Small and Medium-sized Construction Companies (Moonseo Park, Youjin Jang, Hyun-Soo Lee, Changbum Ahn, and You-Sang Yoon-2012)".*

2. *"Exploiting Knowledge Management: The Engineering and Construction Perspective (Patricia Carrillo and Paul Chinowsky-2006)".*

3. *"Emerging issues in Knowledge Management for Irish Construction Organizations A Grounded Theory Approach (Brain Graham-2010)".*

4. *"Knowledge Management Within a Leading Irish Construction Organization(Brian Graham and Ken Thomas- 2009)".*

5. *"Knowledge management perceptions in construction and design companies(Nuria Forcada, Alba Fuertes, Marta Gangolells, Miquel Casals, Marcel Macarulla-2012)".*

6. *"Knowledge management practices in large construction organisation (Herbert S. Robinson, Patricia M. Carrillo, Chimay J. Anumba and Ahmed M. Al-Ghassani- 2005)".*

7. *"Knowledge Management Strategy for Construction : Key I. T. and Contextual Issues (Patricia M. Carrillo, Chimay J. Anumba, John M. Kamara- 2000)".*

8. *"The Significance of Knowledge Management in Civil Engineering Construction Firms in Nigeria(Kasimu M.A., Roslan Amiruddin, Fadhlin Abdullah-2013)".*

After this review, the specifics of the research survey were developed.

3.2.1. Survey Specifics

The questionnaire was divided into the following sections:

1. **The Covering Letter** (was having the information about the researcher, researcher's university, dissertation topic and the purposes for this research study.)
2. **Abstract to the Research Topic** (the abstract to the research study)
3. **Respondent's Profile** (to gather information about the respondent and to make sure that it was qualified to answer the questions)
4. **General Information about Respondent's Firm/ Organization** (to understand the type of respondent firm i.e. Engineering, Contractor or Client/Owner)
5. **KM Awareness and Commitment** (to know the general perception of CI stakeholders Knowledge Management)
6. **Introduction to KM Strategies** (the research variables regarding the different strategies for Managing Knowledge were grouped here)
7. **Introduction to Tools used for KM** (the research variables regarding the utilization of different tools for Knowledge Management were grouped in this section)

The purpose of this survey was to gather information about KM awareness and introduction to its strategies and tools/ techniques which are being used in Pakistani construction industry.

Keeping view the results of Pilot survey the questionnaire was further amended to successfully address all objectives.

3.2.2. Survey Scale

A five-point Likert scale, with 1 being Not at all beneficial to 5 Extremely beneficial, was utilized to judge the current level of perception of construction industry stakeholders about Knowledge Management in the local context. "The main consideration for applying Likert scale was to examine the extent to which respondents were agree or disagree with a particular research variable(Cormack 2000)".

In addition to Likert scale, there were research variables with multiple choices, in all sections of the questionnaire, which were analyzed in frequency analysis.

3.3 Mean Score (MS) for the Survey

"The mean score (MS) for each research variable was computed by the following formula(Chan and Kumaraswamy 1996)":

$$MS = \frac{\sum (f \times s)}{N}(1 \leq MS \geq 5) \hspace{2cm} (3\text{-}1a)$$

where 's' is score given to each research variable by the respondents and ranges from 1 to 5 where '1' is 'Not at all beneficial' and '5' is 'Extremely beneficial'; f is frequency of responses to each rating from l to 5, for each research variable; and N is total number of responses which were 10, concerning that research variable".

In addition to the mean score, "the five-point scale was transformed to relative importance indices using the relative index ranking technique to(Sambasivan and Soon 2007), (Chan and Kumaraswamy 1997), determine the rankings of the research variables and verify the evaluation by the mean score".

3.4 Relative Importance Index (RII) for the Survey

The responses to each statement or research variables were then used to calculate Relative Importance Index (RII). "The RII value had a range from 0 to 1 (0 not inclusive), higher the value of RII, more important was the cause or the effect (Sambasivan and Soon 2007), (Chan and Kumaraswamy 1997)". In this research, the perception level of construction industry stakeholders about the Knowledge Management was measured by using relative importance index (RII) and it was also used for comparing the perception of the stakeholders from each other and the overall through their responses.

$$\text{Relative Importance Index (RII)} = \sum w / (A*N) \hspace{1cm} (0 \leq RII \geq 1) \hspace{1cm} (3\text{-}1b)$$

$$RII = \left(\frac{1n1 + 2n2 + 3n3 + 4n4 + 5n5}{(A*N)} \right)$$

When

w = Weighting given to each research variable by the respondents from 1 to 5

n1 = Number of respondents for Not at all beneficial

n2 = Number of respondents for Not very beneficial

n3 = Number of respondents for Quite beneficial

n4 = Number of respondents for Very beneficial

n5 = Number of respondents for Extremely beneficial

A= 5 is the highest weight

N = Number of respondents (sample size)was taken as 106

The collected data was evaluated with the help of MS Excel and SPSS to check their frequency, validity, and reliability and RII values. Kruskal-Wallis test was conducted to

check differences or similarities in perceptions among the stakeholders about the Knowledge Management.

3.5 Sampling Criteria

The entire population for this research study was included Engineers/ Consultants, General Specialty Contractors and Developers/ Facility Owners.

3.5.1. Selected Sample

A random sample method was utilized for this research work in which sample was selected from the population of all civil engineers in Pakistan. The record of registered civil engineers is not publically available; therefore maximum population size of 1000,000,000 was taken from table 3.1. From this population size, the sample selection represents various construction experts including Engineers/ Consultants, General Specialty Contractors and Developers/ Facility Owners. For this research study, the selected sample included Engineers / Consultants 25%, General Contractors / Specialty Contractors 28% and Developers / Facility owners 47% (the details were included in the relevant chapter).

The questionnaire was sent via email and through facebook to 120 randomly selected potential respondents, working with 40 construction and design Firms / Organizations on different projects in different cities of Pakistan.

Respondents were amply qualified and experienced. The recorded percentage of professional experience of the respondents was 28 for 0 to 5 years, 60 for 5 to 10 years and 11 for 10 to 15. Therefore the information provided by these professionals was quite reliable.

3.5.2. Sample Size

The following aspects were taken into consideration while in determining an appropriate sample size:

    a) Population size

    b) Sampling error, and

    c) Confidence level

Equation (3-2) was used to calculate the appropriate sample sizes (Dillman 2000):

$$Ns = [(Np)\,(P)\,(1\text{-}P)] \,/\, [(Np - 1)\,(B / C)\,2 + (P)\,(1 - P)] \qquad (3\text{-}2)$$

When;

    Ns: sample size for the precision of required level

    Np: 1000,000,000 (population size)

P: population proportion that was expected to choose one of the response categories (yes/no); *P* = 0.5

B: sampling error to the acceptable level; (±10% or ±0.10)

C: Z statistic to the 95% confidence level

Sample sizes to the acceptable level for different populations with different sampling errors at 95% confidence level are shown in Table 3.1.

Table 3. 1 : Sample Size (Dillman 2000)

Completed sample sizes needed for various population sizes and characteristics at three levels of precision.

| Population Size | Sample size for the 95% confidence level | | | | | |
| | ±10% Sampling Error | | ±5% Sampling Error | | ±3% Sampling Error | |
	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	49	38	80	71	92	87
200	65	47	132	111	169	155
400	78	53	196	153	291	253
600	83	56	234	175	384	320
800	86	57	260	188	458	369
1,000	88	58	278	198	517	406
2,000	92	60	322	219	696	509
4,000	94	61	351	232	843	584
6,000	95	61	361	236	906	613
8,000	95	61	367	239	942	629
10,000	95	61	370	240	965	640
20,000	96	61	377	243	1,013	661
40,000	96	61	381	244	1,040	672
100,000	96	61	383	245	1,056	679
1,000,000	96	61	384	246	1,066	683
1,000,000,000	96	61	384	246	1,067	683
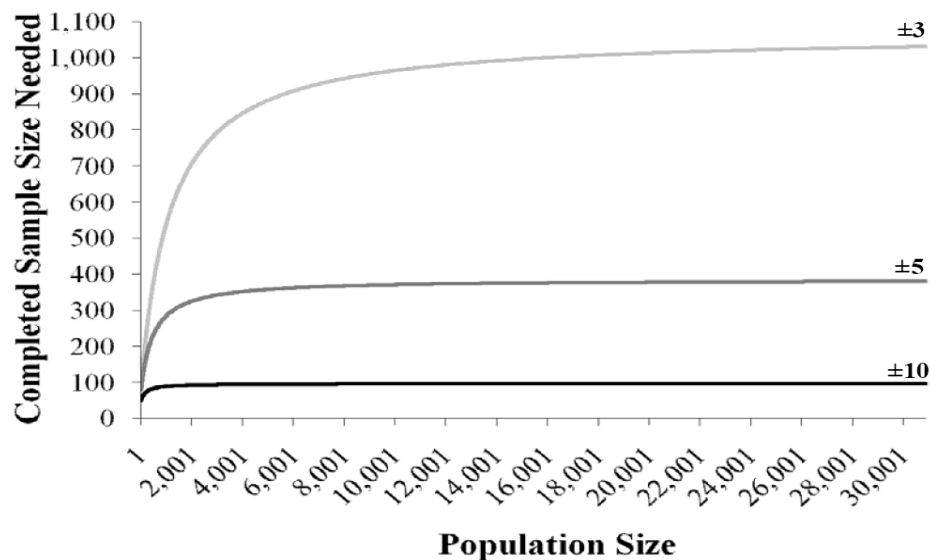
Figure 3. 2 : Sample Size

The overall responses rate was 88.83 % as 106 valid responses were received out of 120. A good response rate is around 30% in the construction enterprises (Black, Akintoye et al. 2000).Therefore, this response rate was acceptable for this research study.

"Until October 2012, more than 30000 building and civil engineering establishments have been registered with PEC(PEC 2012)". The record of registered PEC Civil engineers is not publically available therefore maximum population size from table 3.1 was taken which was 1,000 million. It was considered that the answers would be standardized and set the *p* value to 0.5 (with a 50% probability of occurrence. With 50% occurrence probability, the variance of the questions is increased demanding the largest sample size to control the differences among the response options. Using these values in equations (3-2), the calculated sample size was 96 with an allowable sampling error of ±10 percent. The calculated sampling error by using the equation 3-2 was ±7.10% which was less than ±10%. Therefore, any sample size over 96 was acceptable. Hence a sample comprising of 106 respondents was reliable for further analysis.

3.6   Validity and Reliability of Survey

To establish the reliability and validity, a pilot survey was conducted prior to launch of full scale survey, which resulted into some changes in the main questionnaire. These changes improved both reliability and validity of the main questionnaire. The collected data was evaluated with the help of MS Excel and SPSS to check frequencies, validity analysis, reliability analysis, normality test and Kruskal-Wallis test for non-parametric data to pin point the significant difference among the opinion of Engineers/Consultants, Contractors/Sub-contractors, and Developers/ Facility Owners.

3.7   Data Analysis Techniques

SPSS and MS Excel were used in data analysis. This research study follows the level of significance of 95%. Following techniques were applied for statistical analysis of the recorded data.

3.7.1. Normality Test

This was a pre-condition to evaluate the normality of collected data for the application of statistical tests. It was conducted to check whether the data was normally distributed or not and to identify whether the collected data was parametric or non-parametric. Shapiro-Wilk test is a good test to check normality of the collected data of about two thousands (2000) elements or less. The Significance (Sig.) value should be non-significant to be

counted as sufficiently normal and this means it should be larger than 0.05. Kolmogorov-Smirnov test, also known as K-S Lilliefors, is used where the data sets are more then 2,000. Therefore, in this research study Shapiro-Wilk test was applied to check the normality owing to the limitation of sample size of 106.

3.7.2. Kruskal-Wallis Test

The Kruskal-Wallis test is used to determine whether three or more independent groups (like Engineers / Consultants, Contractors / Specialty Contractors and Developers / Facility Owners) are same or not on the research variable as K-W test is used for non-parametric data or the data which is not normally distributed. The collected data did not passed the normality test which result the use of K-W test for further analysis. The null hypothesis for the test was that the means of variables are equal and is rejected if the result becomes significant. The results were tested against the value of significance of 0.05. If significance value was more than 0.05 then it means that the stakeholders have similar perception about the research variables or otherwise.

3.8   Case Study

3.8.1. Questionnaire Survey

Based upon literature review and infrastructure of the case study organization, separate questionnaire was prepared and conducted to evaluate the current practices being followed in case study organization for managing knowledge at organizational level, professional level and project level. Frequency analysis was conducted on all questions to extract the general point of view.

Questionnaire was circulated among 50 staff members of the case study organization and 35 replies were received with an acceptable rate of 70%. Majority of the respondents were young with 63% having age below 35years. More than 60% respondents have construction industry experience of 5 year and above. Majority of the respondents (57 %) have graduate or post-graduate degree and 20% respondents were working as supervisor in case study organization

3.8.2. Interviews

In second phase of case study, interviews of managerial level were conducted to establish face to face contact with the organizational managers and extract their point of view about Knowledge management.

An overview of the interviewees' profiles is presented in Table 3.2, summarizing their position, experience and highest qualification.

Position	Industry Experience (Years)	Case Study Experience (Years)	Highest Qualification
Director	20	20	B.Sc. Civil Engineering
Dy. Director A	19	15	B.Sc. Civil Engineering
Dy. Director B	17	16	B.Sc. Civil Engineering
Senior Engineer A	15	10	B.Sc. Civil Engineering
Senior Engineer B	10	8	B.Sc. Civil Engineering
Supervisor A	20	15	Diploma
Supervisor B	22	16	Diploma
Quantity Surveyor	15	13	Diploma

Table 3. 2 : Project Team profile

Based upon this information, it was obvious that the project team was mixture of individuals from a variety of different backgrounds, with differing levels of experience and education. The consideration of these multiple perspectives contributed to the identification of issues and subsequent construction of a KM framework.

3.9   Summary

This research work uses the questionnaire survey as the main research instrument in combination with a case study of client/ owner organization. In this chapter the adopted research design and methodology have been discussed in which the process of design of research instrument, the calculation of sample size, its sampling techniques, survey design and data collection, data reliability and its validity, the application of MS and RII along with some statistical procedures for data analysis were discussed in details. Further, the particulars of respondents of case study organization who participated in questionnaire and interview was discussed. The details of data analysis of general questionnaire and Case Study are coming in the next chapters.

DATA ANALYSIS AND RESULTS

4.1. Introduction

The analyses of the collected data and its results have been presented in this chapter in following order:

1. Sample Characteristics (Respondent and its Firm/Organization Profile), Respondents Frequencies and Percentages
2. Statistical Analysis of the collected data
   a. Collected Data Validity Test
   b. Collected Data Reliability Test
   c. Frequency Analysis of the Collected Data
   d. Normality Test to the Collected Data
   e. Kruskal-Wallis Test for all Research Variables and the Objectives
   f. Ranking of Research Variables and the Objectives by Mean Score (MS) and Relative Importance Index (RII)

The respondents to this survey were from engineering / consultants firms, contractors and owners organizations with the varied professional experience in the local construction industry.

4.2. Sample Characteristics, Respondents Frequencies and Percentages.

The first section of the questionnaire was about to collect the data for profile of the respondents and their firms/organizations. Its basic purpose was to establish that the responses were coming from the qualified respondents with sufficient professional experience. Also the respondents were belonged to or working in a reputable firm/organization.

Respondents' Grouping

There were 106 valid responses out of total 120, indicating a response rate was 82.72% with the details shown in Table 4.1:

Table 4. 1: Response rate

Responses	Received	Invalid	Valid	Response rate
Online	120	14	106	88.33%
By hand	0	0	0	0
Total	**120**	**14**	**106**	**88.33%**

Responses by Engineers / Consultants 25%, Contractors / Specialty Contractors 28%, and Developers / Facility owners 47%. Grouping was done on the bases of the information provided by the respondent in the questionnaire as construction industry stakeholder and is shown with the frequencies and percentages in Table 4.2 and Figure 4.1.

Table 4. 2: Respondent's grouping

Respondant Grouping			
CI Stake hOlders	Frequency	Percent	Cumulartive Percent
Engineering/ Consultants	26	25%	25%
General/ Spacialty Contrators	30	28%	53%
Developers/ Facility owners	50	47%	100%
Total	106	100%	
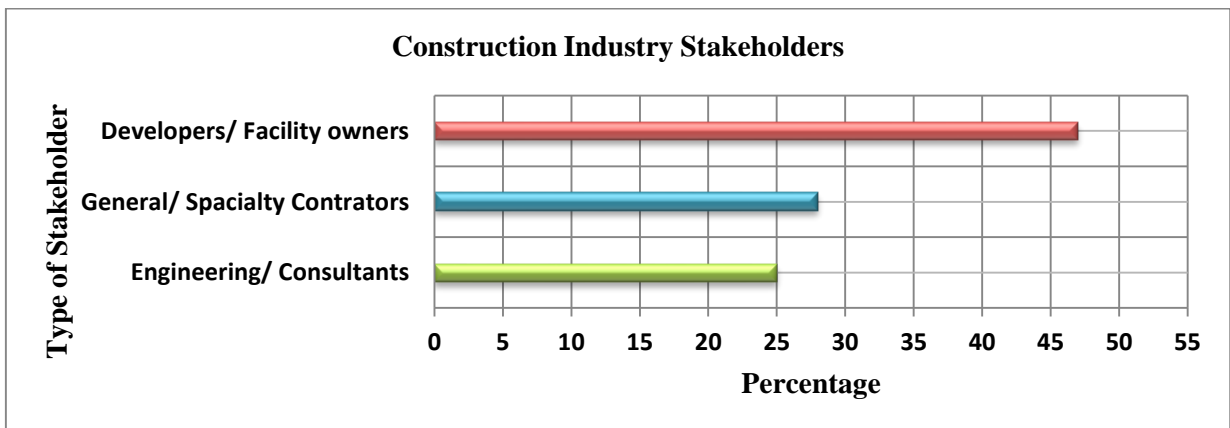
Figure 4. 1: Respondent's grouping

Respondent's Qualifications

Qualifications indicated by the respondents were Master Degree (MS/M Phil) 30%, Bachelor Degree 63% and no Diploma holder 7% were recorded. The details with frequencies and percentages are shown in Table 4.3 and Figure 4.2

Table 4. 3: Respondent's Qualification

Respondent's Qualification	Frequency	Percent	Cumulative Percent
Master Degree (MS/M Phil)	32	30%	30%
Bachelor Degree	67	63%	93%
Diploma Holder	7	7%	100%
Total	**106**	**100.0**	
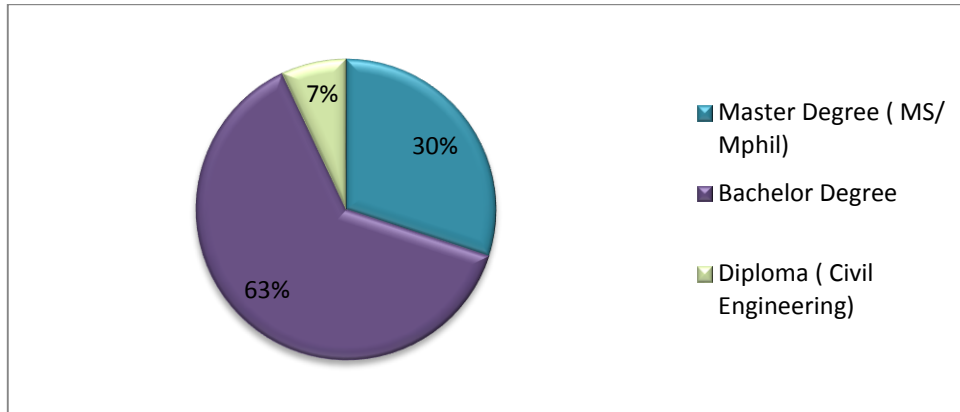
Figure 4. 2 : Respondent's qualification

Respondent's professional experience

The recorded percentage of professional experience of the respondents was 33% for 0 to 5 years, 54 for 5 to 10 years. The details with frequencies and percentages are shown in Table 4.4 and Figure 4.3.

Table 4. 4: Respondent's professional experience

Respondent's experience (in years)	Frequency	Percent	Cumulative Percent
0-5	30	28%	28%
5-10	64	60%	89%
10-15	12	11%	100%
Total	**106**	**100%**	

Respondent's professional experience (in years)
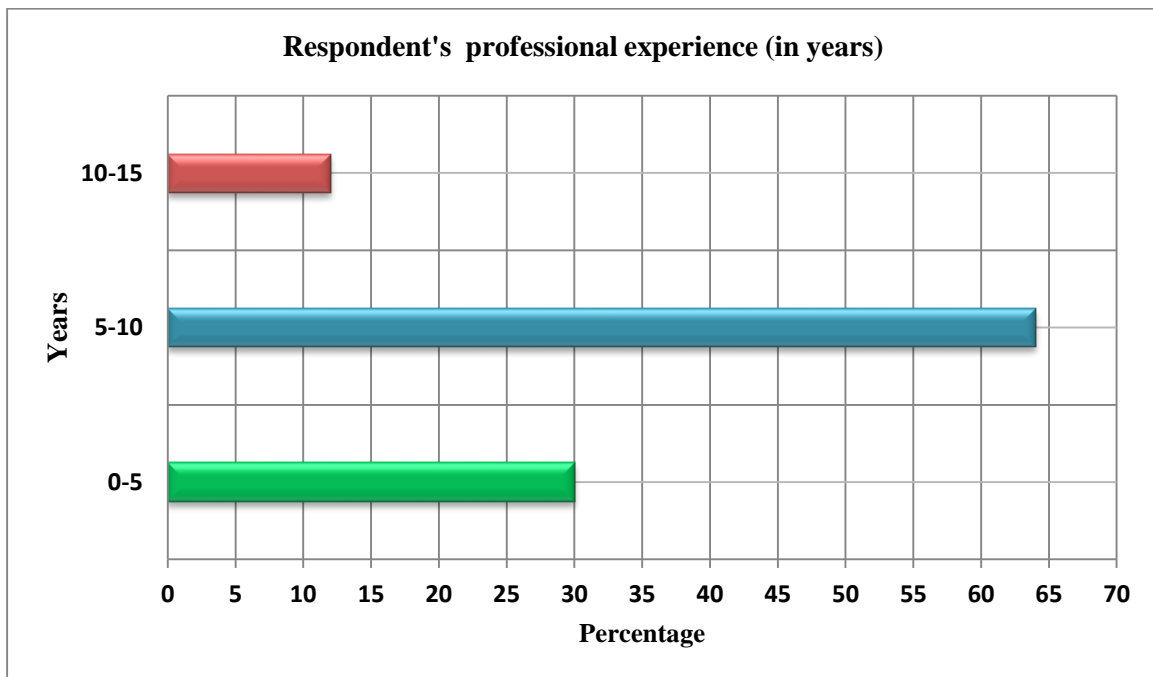
Figure 4. 3 : Respondent's professional experience

Respondent's General role in the organization

The recorded percentage of the respondent's general role in their Organization was 2% for Managing Director, 27% for Project Director / Manager, 13% for Project Architect / Engineer / Planner, 20% for Contract Manager, 24% for Site Manager, 4% for Site Supervisor, and 10% for Quality Control Engineers. The details with frequencies are shown in Table 4.5 and Figure 4.4.

Table 4. 5 : Role of the respondents in their firms

Role	Frequency	Percent	Cumulative Percent
Managing Director	2	2	2
Project Director / Manager	29	27	29
Project Architect / Engineer / Planner	14	13	42
Contract Manager	21	20	62
Site Manager	25	24	86
Site Supervisor	4	4	90
Quality Control Engineers	11	10	100
Total	106	100.0	
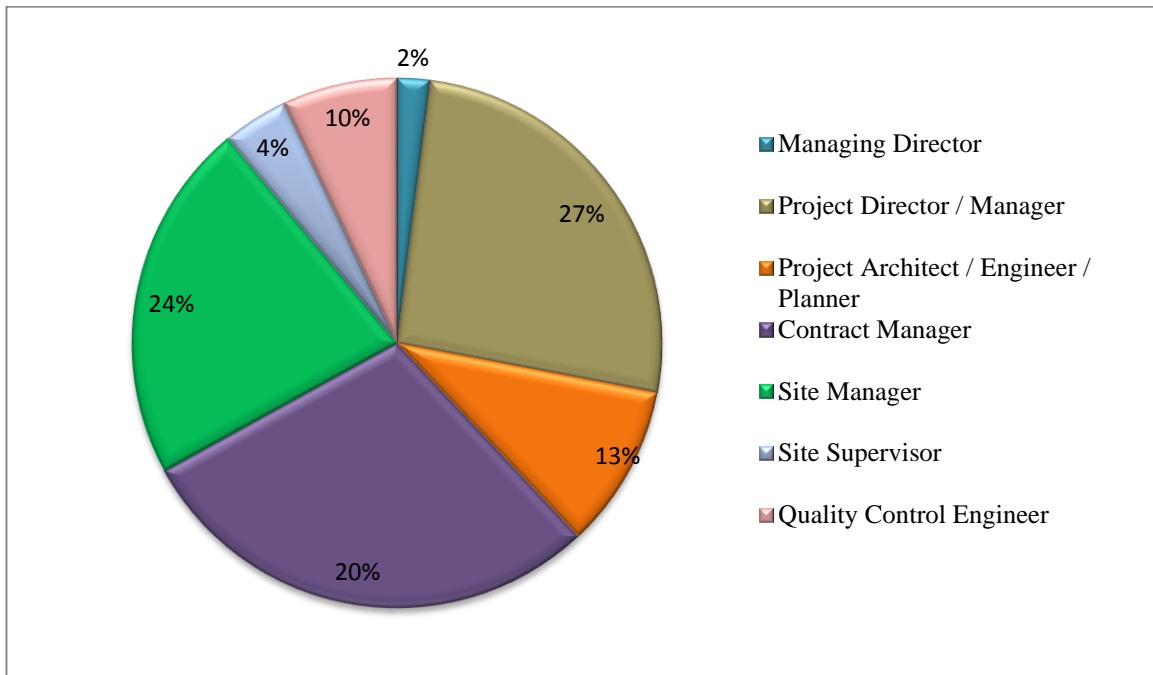
Figure 4. 4 : Respondent's General role in the organization

Firms/Organizations Responded to the Survey

The information gathered from the respondents in this survey about the Firm / Organization / Company they belonged shows that 23% were Engineers / Consultants, 27% were General / Specialty Contractors and 49% were Developers / Facility owners. The details with frequencies are shown in Table 4.6

Table 4. 6 : Firms/Organizations Responded to the Survey

Sr. No.	Organization	Frequency
1	Arif Consulting Engineers	1
2	Assign Engineering Consult International	3
3	Atelir ZN	2
4	C & W	3
5	CAA	1
6	CDM Constructors Inc	17
7	Comsian Consulting	1
8	Descon international Lhr	1
9	Design Inn	1
10	Designmen Consulting Engineers	6
11	Development Design Associates Pvt. Ltd.	1
12	Drake & Scull International	1
13	Engineering Concern	1
14	Global Energy	2

15	Hammad Husain Architects	1
16	ICC Pvt Ltd	1
17	ICI Pakistan	1
18	KRL	5
19	Maison Pvt Ltd	2
20	Natcom	1
21	NDC, NESCOM	1
22	NESPAK	8
23	NHA Islamabad	8
24	Omrania & Associates / Arif Consulting Engineers	1
25	PAEC	12
26	Pakistan Engineering Services (PVT) Limited	1
27	Pearl Real State Holding Company	1
28	PEBI	5
29	Punjab Highway Department	1
30	Qadri Associates (Islamabad/Quetta)	1
31	Raees Faheem Associates	2
32	SCHEMATICS Karachi	3
33	Secon (PEBI)	1
34	SPD	2
35	Tameer Associates	1
36	Tevta	2
37	UN	1
38	URS CORPORATION USA.	1
39	Wapda	1
40	Zong	1

4.3. Statistical Analysis of the collected data

Statistical tests were applied to collected data through the questionnaire to check the normality, validity and reliability of the collected data to conduct analysis and achieve the results with regard of the research objectives.

4.3.1 Validity Test

The validity of the collected data was performed statistically by conducting the criterion-related validity test for non-parametric data (as this would be discussed in the relevant part of this part of this chapter).

This test is performed to evaluate correlation coefficients between each option of each filed to the overall score of that field. The correlation between the two scores is the criterion-related validity coefficient. "It should be positive and strong validity is indicated by values close to 1 whereas weak validity is indicated by values close to 0 (Cronk 2008)".

Table 4.7 to 4.9 shows the correlation coefficient and p-value for each argument of the field to the whole field.

Table 4. 7 : Spearman's rho quantifying the effectiveness of KM

Sr. No.	Research Variables	Spearman's rho		
		Quantifying the effectiveness of KM (Item Sum)		
		Correlation Coefficient	Sig. (2- Tailed) (P-value)	N
1	Decision-making Improvement	.80**	.000	106
2	Efficiency Improvement	.8**	.000	106
3	Group Work Improvement	.79**	.000	106
4	Product/ Service Improvement	.74**	.000	106
5	Cost Cuts	.84**	.000	106
6	Flexibility Improvement	.75**	.000	106
7	Delivery Time	.75**	.000	106
8	Time reduction	.82**	.000	106
9	Customers and Suppliers relations	.83**	.000	106
10	Quality	.83**	.000	106
11	Employees experience exchange	.80	.000	106

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From Table 4.7 his could be seen that the p-values for each variable / argument is equal to 0. Therefore, correlation coefficients of this question is significant at α = 0.01 or

α = 0.05. So, it is evident that the variables / arguments of this part of the questionnaire are consistent and valid to quantifying the effectiveness of KM.

Table 4. 8 : Spearman's rho importance of Process, technology and process for KM

Sr. No.	Research Variables	Spearman's rho		
		Importance of Process, technology and process for KM (Item Sum)		
		Correlation Coefficient	Sig. (2- Tailed) (P-value)	N
1	People	.94**	.000	106
2	Technology	.96**	.000	106
3	Process	.96**	.000	106

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From Table 4.8 this could be seen that the p-values for each variable / argument is equal to 0. Therefore, correlation coefficients of this question is significant at α = 0.01 or α = 0.05. So, it is evident that the variables / arguments of this part of the questionnaire are consistent and valid to identify the importance of People, technology and process for KM.

Table 4. 9 : Spearman's rho Effective Tools for KM

Sr. No.	Research Variables	Spearman's rho		
		Effective Tools for KM (Item Sum)		
		Correlation Coefficient	Sig. (2- Tailed) (P-value)	N
1	E-mail	.79**	.000	106
2	Intranet	.77*	.000	106
3	Internet	.82**	.000	106
4	Communities of practices	.86**	.000	106
5	Video Conferencing	.79**	.000	106

6	Database	.80**	.000	106
7	Decision Making tools	.80**	.000	106
8	Brainstorming	.87**	.000	106
9	Small group meetings	.87**	.000	106
10	Trainings	.86**	.000	106
11	Consultancy	.87**	.000	106
12	Monitoring of projects by client	.84**	.000	106

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From Table 4.9 his could be seen that the p-values for each variable / argument is equal to 0. Therefore, correlation coefficients of this question is significant at α = 0.01 or α = 0.05. So, it is evident that the variables / arguments of this part of the questionnaire are consistent and valid to identify the effective tools used for KM in Pakistani construction Industry.

4.3.2   Reliability Test

While using likert scale it is compulsory to calculate Cronbach's alpha coefficient for internal consistency/reliability for any scales or subscales one may be using. Therefore results of the data will be these summated scales and not the result of individual items. This technique was used to measure the reliability of the collected data which ultimately check the internal consistency of all the research variables. "The normal range of Cronbach's coefficient alpha value is between 0 and 1, and the higher values reflect a higher degree of internal consistency (Gliem and Gliem 2003)".

The Table 4.10 shows Cronbach's Coefficient Alpha values are 0.972 for KM Awareness and Commitment, 0.96 in cacse of KM Strategies and 0.98 in case of Tools used for KM. Therefore, Cronbach's coefficient values verified the reliability of the collected data.

Table 4. 10 : Reliability Statistics

Sr. No.	Case Processing Summary	No. of Responses		% of Responses	No. of Items / variables	Cronbach's Alpha
1	KM Awareness and Commitment	Valid	106	100	11	.972
		Excluded	0	0		
		Total	106	100.0		
2	KM Strategies	Valid	106	100	3	.960
		Excluded	0	0		
		Total	106	100.0		
3	Tools used for KM	Valid	106	100	12	.980
		Excluded	0	0		
		Total	106	100.0		

4.3.3 Frequency Analysis of the Collected Data

4.3.3.1Frequency Analysis for Knowledge Management awareness and commitment

The frequency analysis was carried out for general perception about Knowledge Management in the following sections.

4.3.3.1.1   Meaning of Knowledge Management

Frequency distribution of two variables was analyzed to assess general perception of KM meanings and it was asses that the general perception of local construction firms about KM meaning is "a system for identification, optimization and reuse of knowledge which is generated during any knowledge activity"; details shown in Table 4.11:

Table 4. 11 : Variable's grouping

Variable's grouping			
Variables	Frequency	Percent	Cumulative Percent
A system for keeping office record of all correspondences i.e. letters, progress review meetings, minutes of meetings and drawings	20	19	19
A system for identification, optimization and reuse of knowledge which is generated during any knowledge activity	86	81	100
Total	106	100.0	
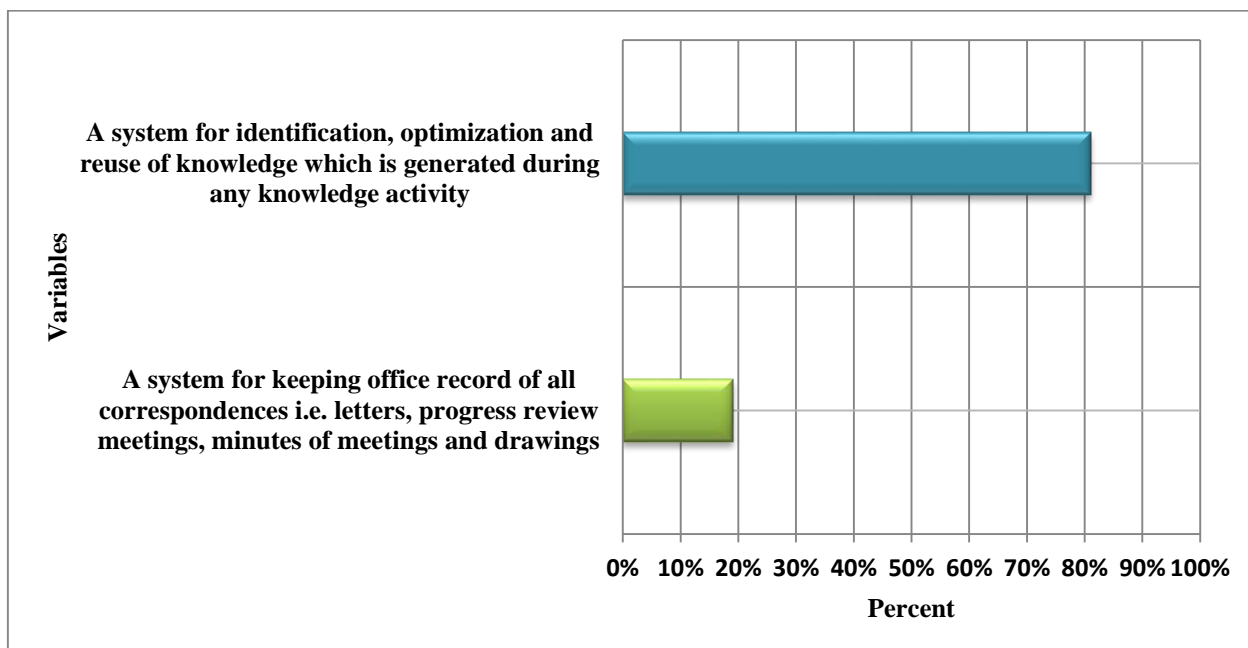
Figure 4. 5 : Variable's grouping

4.3.3.1.2 Effectiveness of Knowledge Management

A detailed frequency analysis for the responses for Effectiveness of Knowledge Management is given in Table 4.12.

Table 4. 12 : Frequency Analysis for Effectiveness of Knowledge Management

Sr. No.	Research Variable	Effectiveness	Frequency	Percent	Valid Percent	Cumulative percent
1	Decision Making improvement	Extremely Beneficial	18	17%	17%	17%
		Very Beneficial	79	75%	75%	92%
		Quit Beneficial	7	7%	7%	98%
		Not very beneficial	1	1%	1%	99%
		Not at all beneficial	1	1%	1%	100%
		Total	106	100	100	
2	Efficiency Improvement	Extremely Beneficial	12	11%	11%	11%
		Very Beneficial	79	75%	75%	86%
		Quit Beneficial	12	11%	11%	97%
		Not very beneficial	3	3%	3%	100%
		Not at all beneficial	0	0%	0%	100%
		Total	106	100	100	

3	Group work improvement	Extremely Beneficial	15	14%	14%	14%
		Very Beneficial	63	59%	59%	74%
		Quit Beneficial	26	25%	25%	98%
		Not very beneficial	0	0%	0%	98%
		Not at all beneficial	2	2%	2%	100%
		Total	106	100	100	
4	Product/ service improvement	Extremely Beneficial	11	10%	10%	10%
		Very Beneficial	42	40%	40%	50%
		Quit Beneficial	47	44%	44%	94%
		Not very beneficial	0	0%	0%	94%
		Not at all beneficial	6	6%	6%	100%
		Total	106	100	100	
5	Cost cuts	Extremely Beneficial	17	16%	16%	16%
		Very Beneficial	75	71%	71%	87%
		Quit Beneficial	11	10%	10%	97%
		Not very beneficial	2	2%	2%	99%
		Not at all beneficial	1	1%	1%	100%
		Total	106	100	100	
6	Flexibility improvement	Extremely Beneficial	11	10%	10%	10%
		Very Beneficial	66	62%	62%	73%
		Quit Beneficial	26	25%	25%	97%
		Not very beneficial	3	3%	3%	100%
		Not at all beneficial	0	0%	0%	100%
		Total	106	100	100	
7	Delivery time reduction	Extremely Beneficial	19	18%	18%	18%
		Very Beneficial	82	77%	77%	95%
		Quit Beneficial	5	5%	5%	100%
		Not very beneficial	0	0%	0%	100%

		Not at all beneficial	0	0%	0%	100%
		Total	106	100	100	
8	Time reduction	Extremely Beneficial	15	14%	14%	14%
		Very Beneficial	80	75%	75%	90%
		Quit Beneficial	10	9%	9%	99%
		Not very beneficial	1	1%	1%	100%
		Not at all beneficial	0	0%	0%	100%
		Total	106	100	100	
9	Customer and supplier's relation	Extremely Beneficial	11	10%	10%	10%
		Very Beneficial	13	12%	12%	23%
		Quit Beneficial	65	61%	61%	84%
		Not very beneficial	16	15%	15%	99%
		Not at all beneficial	1	1%	1%	100%
		Total	106	100	100	
10	Quality improvement	Extremely Beneficial	9	8%	8%	8%
		Very Beneficial	76	72%	72%	80%
		Quit Beneficial	18	17%	17%	97%
		Not very beneficial	3	3%	3%	100%
		Not at all beneficial	0	0%	0%	100%
		Total	106	100	100	
11	Employee's experience exchange	Extremely Beneficial	16	15%	15%	15%
		Very Beneficial	38	36%	36%	51%
		Quit Beneficial	40	38%	38%	89%
		Not very beneficial	12	11%	11%	100%
		Not at all beneficial	0	0%	0%	100%
		Total	106	100	100	

4.3.3.1.3   Knowledge as a strategic asset

Frequency analysis of the data was conducted. Details are given in table 4.13 below,

Table 4. 13 : Frequency analysis for Knowledge as a strategic asset

Knowledge as a strategic asset			
Variables	Frequency	Percent	Cumulative Percent
Yes	70	66%	66%
No	36	34%	100%
Total	106	100%	
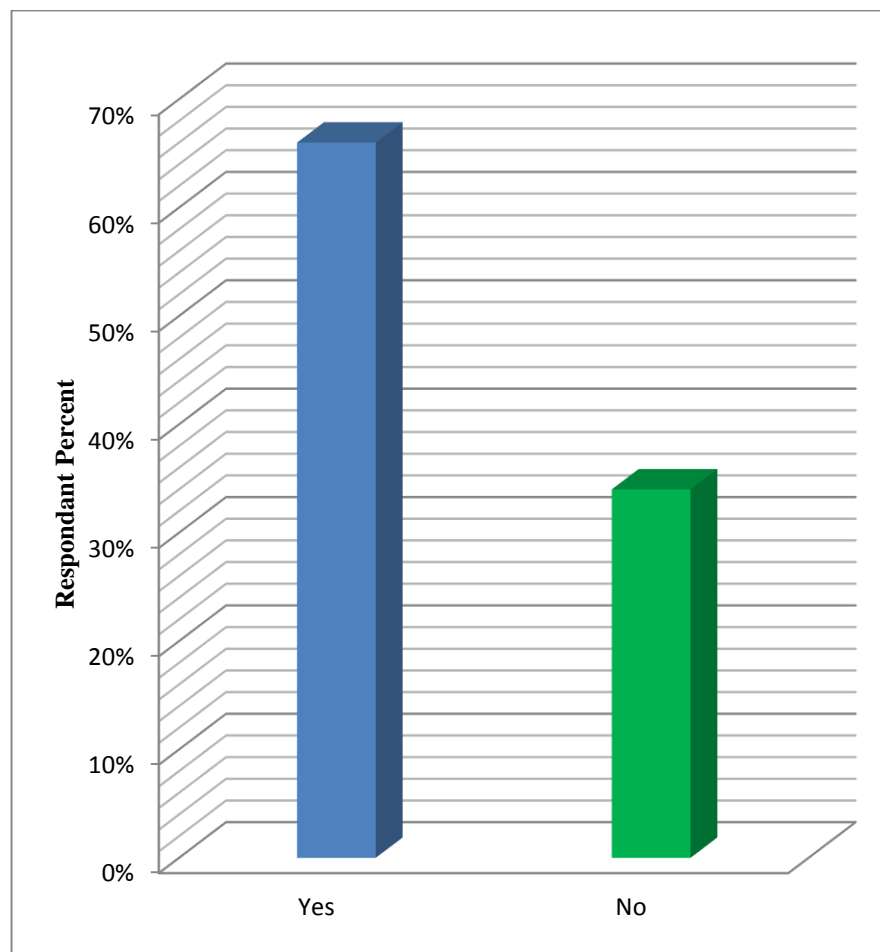
Figure 4. 6 : Variable's grouping

4.3.3.1.4   Cause of Costly Errors in construction firm with regard of Knowledge

Frequency analysis of the data was conducted and it was observed that with regard to knowledge, costly errors were made in Pakistani construction firms because of "insufficient knowledge about the process" followed by "Insufficient knowledge about customers" as second most dangerous cause of costly error. "Employees cannot interpret or use available information" is considered as least dangerous cause of costly error. Table 4.14 and figure 4.7 show details,

Table 4. 14 : Frequency analysis for Cause of Costly Errors in construction firm

Cause of costly errors		
Variables	**Frequency**	
	Agreed	**Disagreed**
Insufficient technological knowledge	63	43
Loss of knowledge of vital importance	37	69
Insufficient knowledge about competitors	63	43
Incomplete Information about customers	77	29
Incomplete Information about processes	85	21
Employees ineligibility to use available information	33	73
Knowledge unavailable when needed	58	48
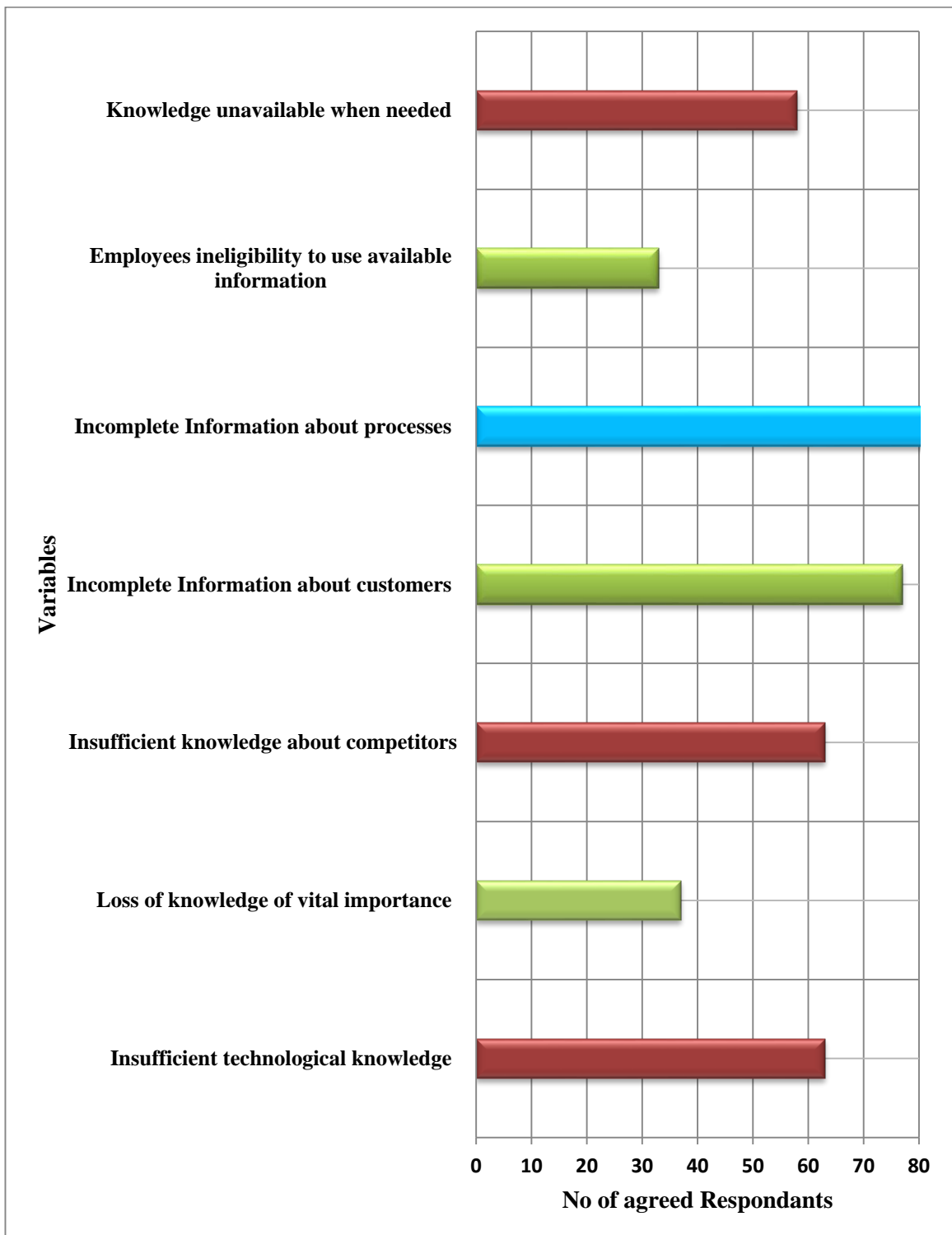
Figure 4. 7 : Variable's grouping

4.3.3.1.5   Missing Business opportunities

Frequency analysis of the data indicates that 56% respondents were considering the non utilization of available knowledge as a cause of missing out of business opportunities in Pakistani construction Industry. Table 4.15 and figure 4.8 Show details,

Table 4. 15 : Frequency analysis for Missing Business opportunities

Variables	Frequency	Percent	Cumulative Percent
Failing explore available knowledge is main cause of missing new business opportunities			
Yes	59	56%	56%
No	47	44%	100%
Total	106	100%	
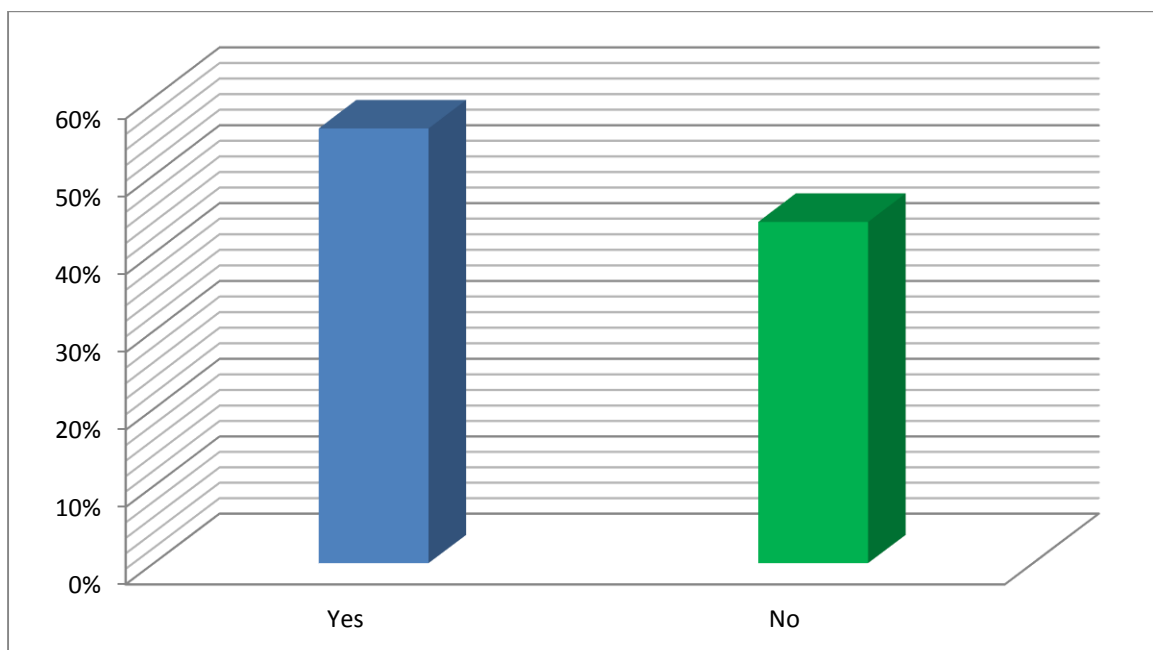
Figure 4. 8 : Variable's grouping

4.3.3.1.6 Obstacles in developing KM system

Frequency analysis of the data indicates that there was good competition between the two variables i.e. "Change of mentality needed to use these systems" and "People's fear of sharing what they know". However, majority of the respondent (46%) were of the opinion that "People's fear of sharing what they know" was the biggest obstacle in developing KM system in Pakistani construction industry. Table 4.16 and figure 4.9 Shows details,

Table 4. 16 : Frequency analysis for Obstacles in developing KM system

Description	Variables	Frequency	Percent	Cumulative percent
obstacles to developing a KM system	Requirement of mentality change for using this system	39	37%	37%
	Time and cost requirement in implementing a KM system.	5	5%	42%
	Low involvement of top management.	6	6%	47%
	People's fear to openly share their skills	49	46%	93%
	No reward system	3	3%	96%
	Absence of technical infrastructure for KM Implementation	4	4%	100%
	Total	106	100%	
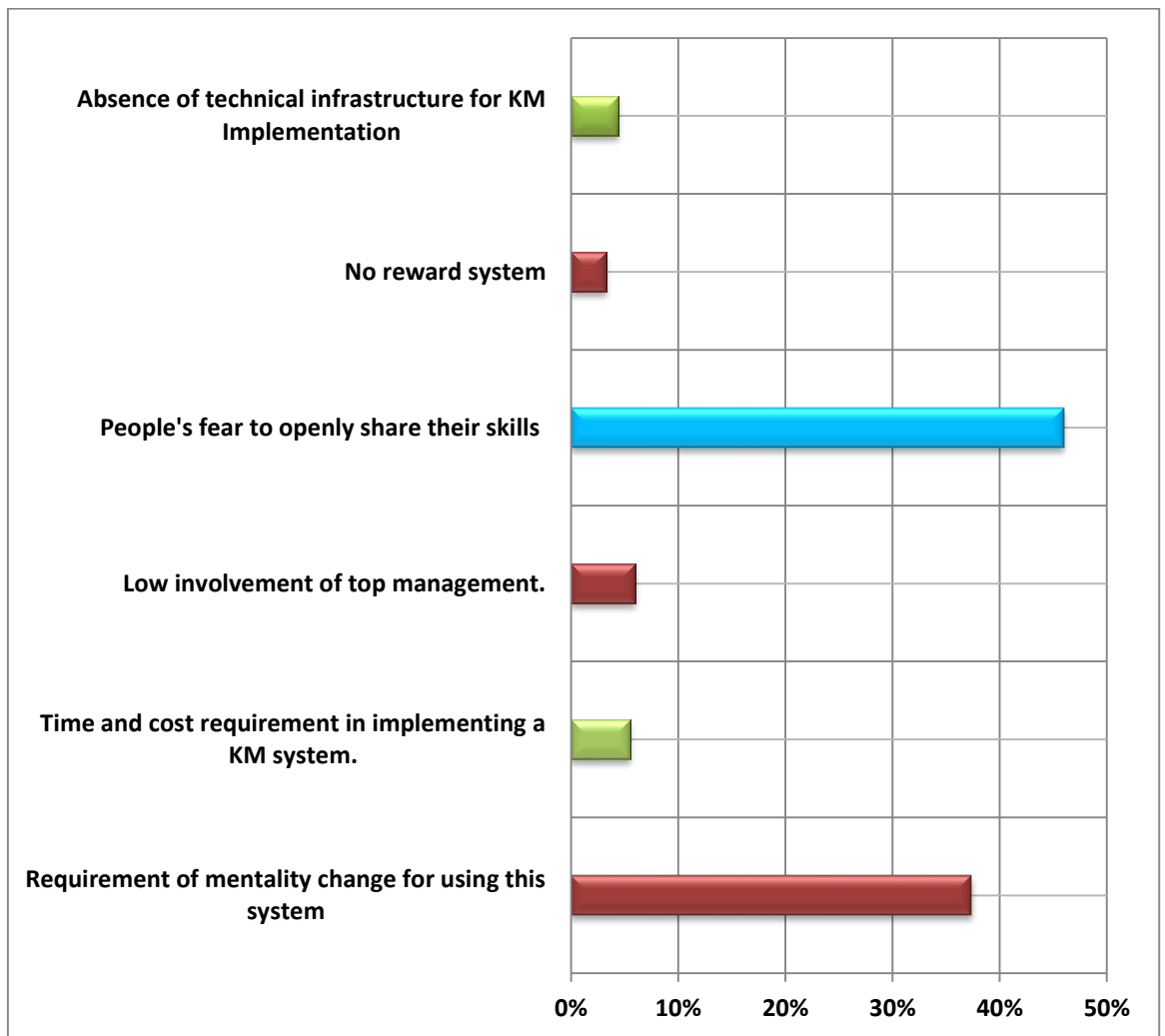
Figure 4. 9 : Variable's grouping

4.3.3.2 Frequency Analysis for Knowledge Management Strategies

The frequency analysis was carried out to evaluate strategies for Knowledge Management in the following sections.

4.3.3.2.1 Existing status of KM system

Frequency analysis of the data indicates that majority of the respondent's firms have not KM system available in their organization at the moment however they are working to have some proper system available in future for knowledge management. This indicates that Pakistani construction industry is lean towards the implementation of KM in future. Table 4.17 and figure 4.10 Shows details,

Table 4. 17 : Existing status of KM system

Description	Variables	Frequency	Percent	Valid Percent	Cumulative percent
Existing status of KM system	Yes it is available	15	14%	14%	14%
	No. But we are working in some dimensions to manage firms knowledge	67	63%	63%	77%
	No. but we are considering the possibility.	18	17%	17%	94%
	No and not planning to have one in future	6	6%	6%	100%
	Total	106	100%	100%	
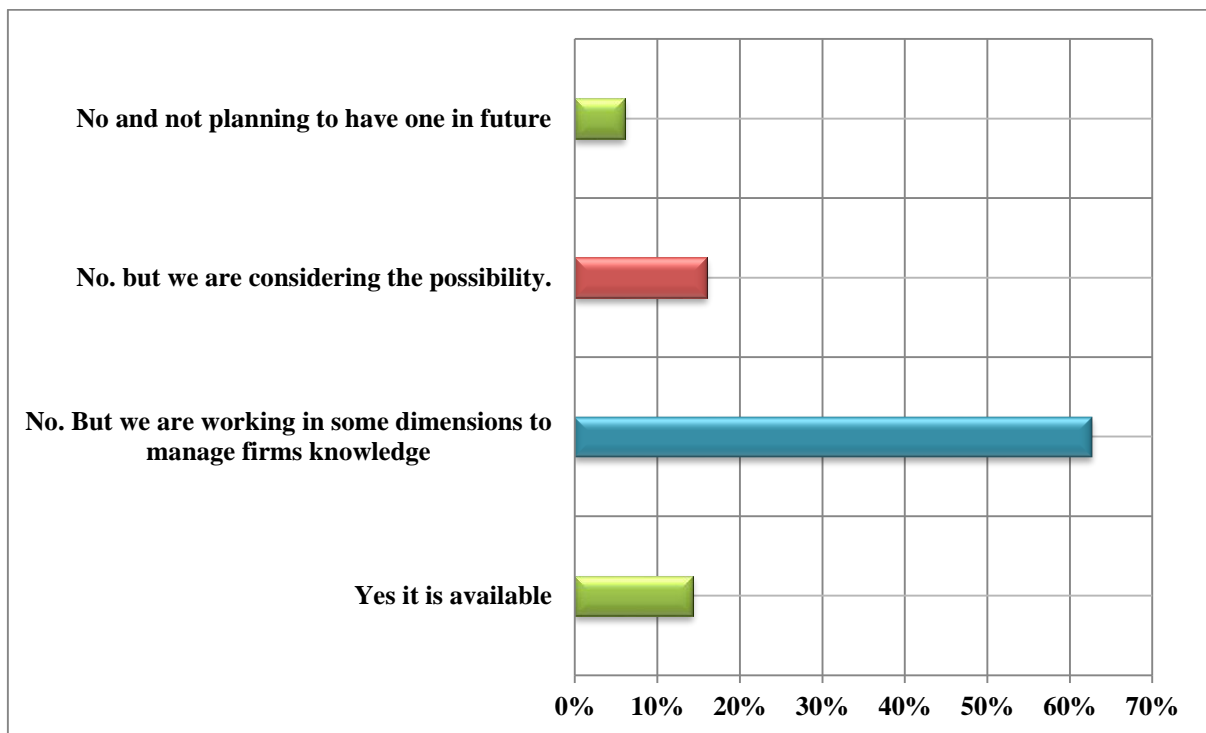
Figure 4. 10 : Variable's grouping

4.3.3.2.2 KM Meetings schedule

Frequency analysis of the data indicates that majority of the respondent's organizations have conduct meeting relevant to the Knowledge Management on monthly

basis. Such meetings includes progress reports, lesson learned, process improvement and new issues etc. Table 4.18 and figure 4.11 Shows details,

Table 4. 18 : KM Meetings schedule

Description	Variables	Frequency	Percent	Cumulative percent
Existing schedule KM meetings	Weekly	8	8%	8%
	Monthly	78	74%	81%
	Quarterly	7	7%	88%
	No proper schedule of such meetings	13	12%	100%
	Total	106	100%	
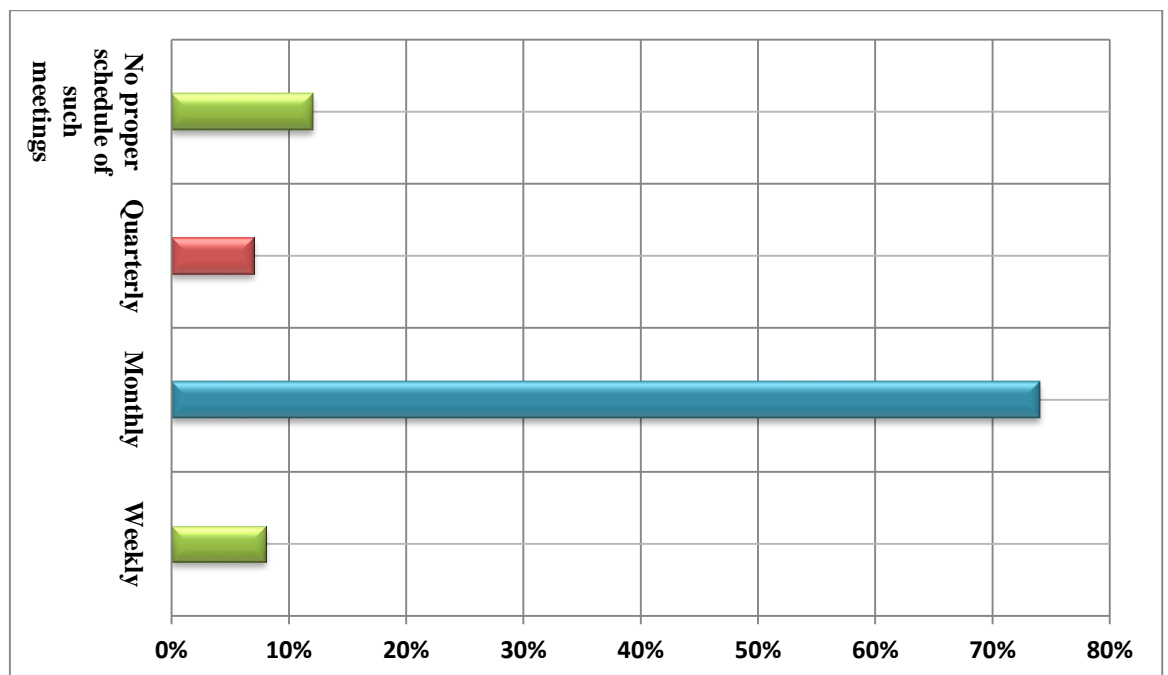
Figure 4. 11 : Variable's grouping

4.3.3.2.3   Importance of people, process and technology

A detailed frequency analysis for the responses for importance of people, process and technology is given in Table 4.19

Table 4. 19 : Frequency Analysis for Importance of people, process and technology

Sr. No.	Research Variable	Effectiveness	Frequency	Percent	Valid Percent	Cumulative percent
1	People	Extremely Beneficial	15	14%	14%	14%
		Very Beneficial	80	75%	75%	90%
		Quit Beneficial	11	10%	10%	100%
		Not very beneficial	0	0%	0%	100%
		Not at all Beneficial	0	0%	0%	100%
		Total	106	100%	100%	
2	Technology	Extremely Beneficial	12	11%	11%	11%
		Very Beneficial	78	74%	74%	85%
		Quit Beneficial	15	14%	14%	99%
		Not very beneficial	1	1%	1%	100%
		Not at all Beneficial	0	0%	0%	100%
		Total	106	100%	100%	
3	Process	Extremely Beneficial	12	11%	11%	11%
		Very Beneficial	79	75%	75%	86%
		Quit Beneficial	10	9%	9%	95%
		Not very beneficial	5	5%	5%	100%

		Not at all Beneficial	0	0%	0%	100%
		Total	106	100%	100%	

4.3.3.3 Frequency Analysis for techniques/ tools used for KM

The frequency analysis was carried out to identify most effective tools for Knowledge Management in the following sections.

4.3.3.3.1   Tools used for Knowledge Management

A detailed frequency analysis for the responses for effectiveness of different tools being used for KM is given in Table 4.20

Table 4. 20 : Tools being used for KM

Sr. No.	Research Variable	Effectiveness	Frequency	Percent	Valid Percent	Cumulative percent
1	E-mail	Very effective	25	24%	24%	24%
		Effective	77	73%	73%	96%
		Not very Effective	3	3%	3%	99%
		Ineffective beneficial	0	0%	0%	99%
		Not used	1	1%	1%	100%
		Total	106	100%	100%	
2	Intranet	Very effective	19	18%	18%	18%
		Effective	80	75%	75%	93%
		Not very Effective	6	6%	6%	99%
		Ineffective beneficial	1	1%	1%	100%
		Not used	0	0%	0%	100%
		Total	106	100%	100%	
3	Internet	Very effective	24	23%	23%	23%
		Effective	74	70%	70%	92%
		Not very Effective	8	8%	8%	100%
		Ineffective beneficial	0	0%	0%	100%
		Not used	0	0%	0%	100%
		Total	106	100%	100%	
4	Communities of practice	Very effective	6	6%	6%	6%
		Effective	20	19%	19%	25%
		Not very Effective	62	58%	58%	83%
		Ineffective beneficial	15	14%	14%	97%
		Not used	3	3%	3%	100%
		Total	106	100%	100%	

5	Video confrencing	Very effective	5	5%	5%	5%
		Effective	6	6%	6%	10%
		Not very Effective	57	54%	54%	64%
		Ineffective beneficial	36	34%	34%	98%
		Not used	2	2%	2%	100%
		Total	106	100%	100%	
6	Databases	Very effective	11	10%	10%	10%
		Effective	35	33%	33%	43%
		Not very Effective	58	55%	55%	98%
		Ineffective beneficial	2	2%	2%	100%
		Not used	0	0%	0%	100%
		Total	106	100%	100%	
7	Decision Making tools	Very effective	10	9%	9%	9%
		Effective	17	16%	16%	25%
		Not very Effective	51	48%	48%	74%
		Ineffective beneficial	27	25%	25%	99%
		Not used	1	1%	1%	100%
		Total	106	100%	100%	
8	Brainstorming session	Very effective	10	9%	9%	9%
		Effective	20	19%	19%	28%
		Not very Effective	54	51%	51%	79%
		Ineffective beneficial	16	15%	15%	94%
		Not used	6	6%	6%	100%
		Total	106	100%	100%	
9	Small group meetings (2-4 people)	Very effective	11	10%	10%	10%
		Effective	21	20%	20%	30%
		Not very Effective	51	48%	48%	78%
		Ineffective beneficial	22	21%	21%	99%
		Not used	1	1%	1%	100%
		Total	106	100%	100%	
10	Training and education plan	Very effective	13	12%	12%	12%
		Effective	28	26%	26%	39%
		Not very Effective	44	42%	42%	80%
		Ineffective beneficial	20	19%	19%	99%
		Not used	1	1%	1%	100%
		Total	106	100%	100%	
11	Consultancy	Very effective	13	12%	12%	12%
		Effective	23	22%	22%	34%
		Not very Effective	48	45%	45%	79%
		Ineffective beneficial	22	21%	21%	100%
		Not used	0	0%	0%	100%

		Total	106	100%	100%	
12	Monitoring of projects/ services by clints	Very effective	9	8%	8%	8%
		Effective	12	11%	11%	20%
		Not very Effective	70	66%	66%	86%
		Ineffective beneficial	15	14%	14%	100%
		Not used	0	0%	0%	100%
		Total	106	100%	100%	

4.3.3.3.2 Responsibility

Frequency analysis of the data indicates that generally department managers are considered responsible for undertaking KM activities in Pakistani construction firms. Table 4.21 and figure 4.12 shows details,

Table 4. 21 : Who is responsible for KM

Description	Variables	Frequency	Percent	Cumulative percent
Who is responsible for implementation of KM at organizational level	Top management	21	20%	20%
	Department Manager	83	78%	98%
	Individual	2	2%	100%
	Total	106	100%	
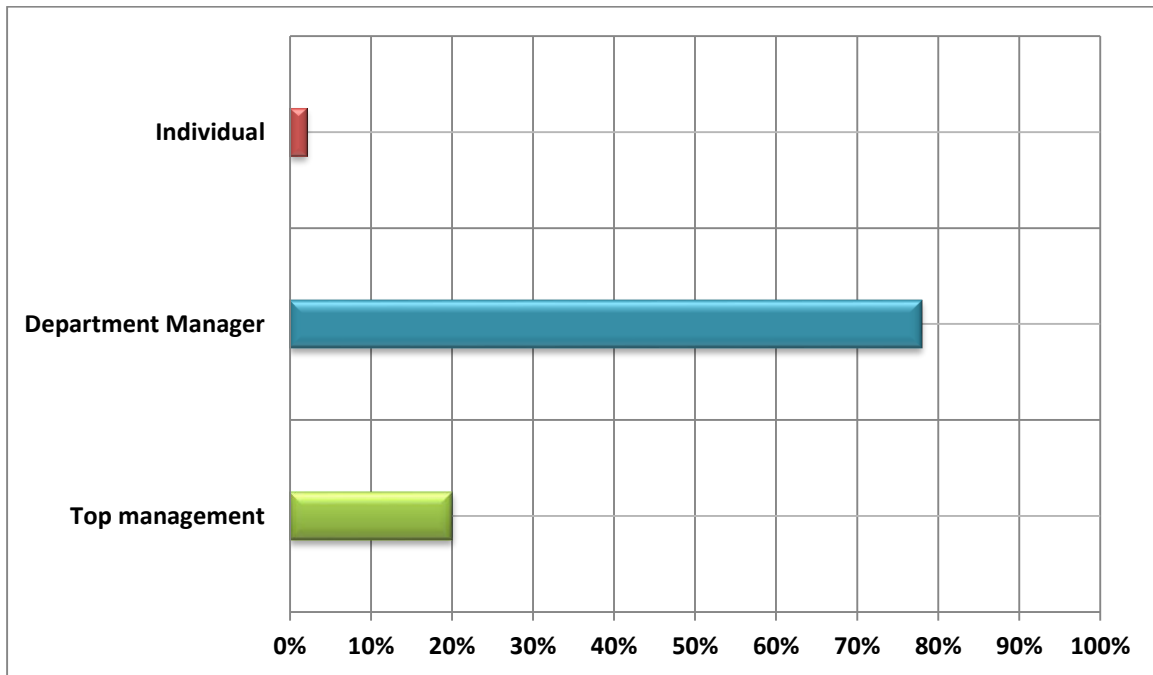
Figure 4. 12 : Variable's grouping

4.3.3.3.3 Knowledge Manger

Frequency analysis of the data indicates that as a whole specifically Knowledge Manager is not designated in Pakistani construction firms to take care of overall Knowledge Management. However, some officials are working for KM in addition to their own duties. Table 4.22 and figure 4.13 shows details,

Table 4. 22 : Appointment of Knowledge Manger

Description	Variables	Frequency	Percent	Cumulative percent
Is specifically Knowledge Manger is designated in Pakistani construction firms?	Yes	8	8%	8%
	No	40	38%	45%
	Some are working for knowledge management in addition to their other duties	58	55%	100%
	Total	106	100%	
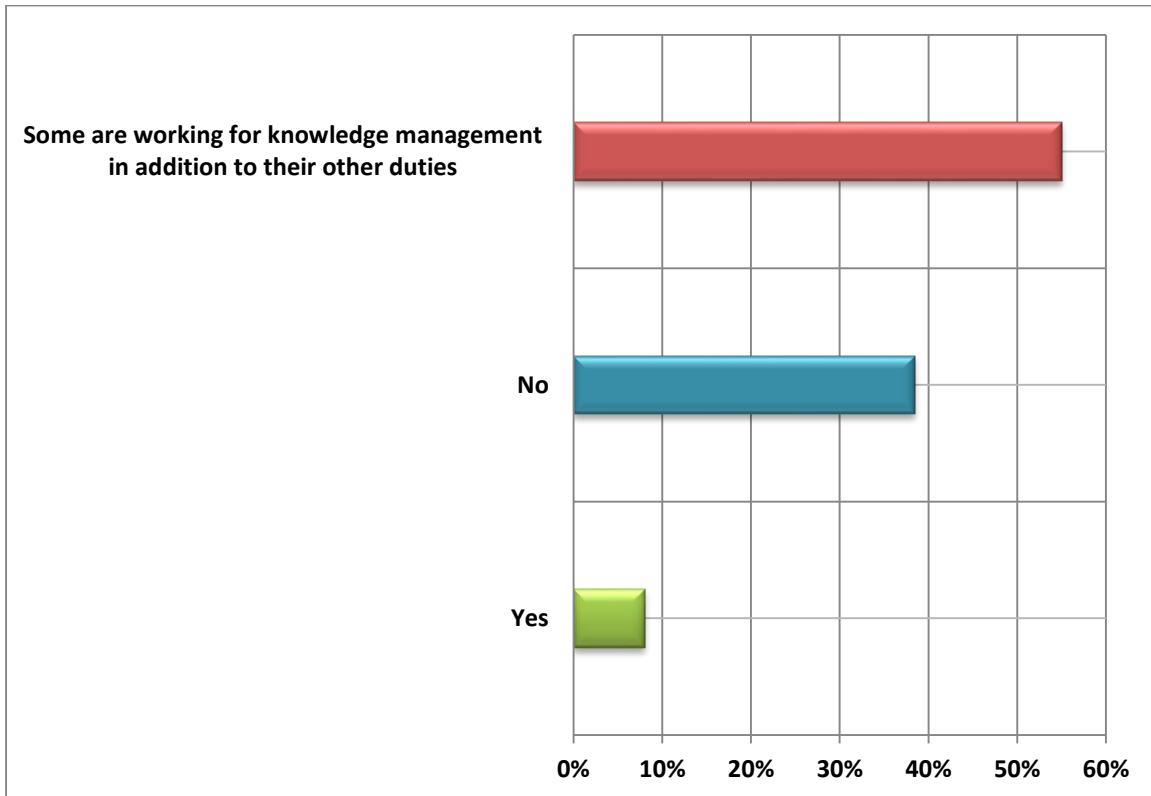
Figure 4. 13 : Variable's grouping

4.3.4 Normality Test

'Shapiro Wilk normality test' was conducted to check whether the collected data is normally distributed or otherwise. This test was conducted because of the fact that the sample size was less than 2000. The significance values were found to be 0 which were less than 0.05 which shows that the collected data is not normal (non-parametric) in nature and non-parametric tests will be carried out for further analysis. Regarding the normality of the data by ShaprioWilk test the details are shown in Table 4.23 to 4.25.

Table 4. 23 : Normality Test for KM Awareness

Sr. No	Variables	Shapiro-Wilk		
		Statistic	df	Sig.
1	Decision Making improvement	.570	106	.000
2	Efficiency Improvement	.620	106	.000
3	Group work improvement	.743	106	.000

4	Product/ service improvement	.784	106	.000
5	Cost cuts	.660	106	.000
6	Flexibility improvement	.739	106	.000
7	Delivery time reduction	.691	106	.000
8	Time reduction	.620	106	.000
9	Customer and supplier's relation	.862	106	.000
10	Quality improvement	.664	106	.000
11	Employee's experience exchange	.869	106	.000

Table 4. 24 : Normality Test for KM Strategies

Sr. No	Variables	Shapiro-Wilk		
		Statistic	df	Sig.
1	People	.613	106	.000
2	Technology	.647	106	.000
3	Process	.612	106	.000

Table 4. 25 : Normality Test for KM Tools

Sr. No	Variables	Shapiro-Wilk		
		Statistic	df	Sig.
1	E-mail	.669	106	.000
2	Intranet	.722	106	.000

3	Internet	.745	106	.000
4	Communities of practice	.871	106	.000
5	Video conferencing	.794	106	.000
6	Databases	.809	106	.000
7	Decision Making tools	.892	106	.000
8	Brainstorming session	.872	106	.000
9	Small group meetings (2-4 people)	.893	106	.000
10	Training and education plan	.893	106	.000
11	Consultancy	.879	106	.000
12	Monitoring of projects/ services by clients	.825	106	.000

4.3.5 Kruskal-Wallis Test for all Research Variables and the Objectives

TKruskal-Wallis test was conducted to check whether the stakeholders have the similar perception about all the research variables and the objectives or otherwise.

4.3.5.1 Kruskal-Wallis test for KM Awareness

A Kruskal-Wallis test was conducted comparing the outcome of all the stakeholders (Engineers / Consultants, General / Specialty Contractors and Client / Facility owners) and no significant difference (as *p> 0.05*) was found from each other with the values shown in the Table 4.26 indicating that all the stakeholders have the similar general awareness about Knowledge Management.

Table 4. 26 : Kruskal-Wallis Test KM awareness

Sr. No	Variables	Chi-square	df	Asymp. Sig.
1	Decision Making improvement	8.903	2	.012
2	Efficiency Improvement	.125	2	.939
3	Group work improvement	1.341	2	.512
4	Product/ service improvement	3.088	2	.214
5	Cost cuts	.439	2	.803
6	Flexibility improvement	3.833	2	.147
7	Delivery time reduction	.503	2	.778
8	Time reduction	1.561	2	.458
9	Customer and supplier's relation	.602	2	.740
10	Quality improvement	3.452	2	.178
11	Employee's experience exchange	8.348	2	.015

a. Kruskal Wallis Test
b. Grouping Variable: Construction Industry
Stakeholders

4.3.5.2 Kruskal-Wallis test for KM Strategies

A Kruskal-Wallis test was conducted comparing the outcome of all the stakeholders (Engineers / Consultants, General / Specialty Contractors and Client / Facility owners) and no significant difference (as $p> 0.05$) was found from each other with the values shown in the Table 4.27 indicating that all the stakeholders have the similar general awareness about Knowledge Management.

Table 4. 27 : Kruskal-Wallis Test KM awareness

Sr. No	Variables	Chi-square	df	Asymp. Sig.
1	People	.145	2	.930
2	Technology	1.252	2	.535
3	Process	2.508	2	.285

a. Kruskal Wallis Test
b. Grouping Variable: Construction
Industry Stakeholders

4.3.5.3 Kruskal-Wallis test for KM Tools Used

A Kruskal-Wallis test was conducted comparing the outcome of all the stakeholders (Engineers / Consultants, General / Specialty Contractors and Client / Facility owners) and no significant difference (as $p> 0.05$) was found from each other with the values shown in the Table 4.28 indicating that all the stakeholders have the similar attitude towards the utilization of various tools for Knowledge Management in Pakistani construction industry.

Table 4. 28 : Kruskal-Wallis Test KM Tools used

Sr. No	Variables	Chi-square	df	Asymp. Sig.
1	E-mail	1.027	2	.598
2	Intranet	2.090	2	.352
3	Internet	.900	2	.637
4	Communities of practice	.319	2	.853
5	Video conferencing	7.224	2	.027
6	Databases	3.720	2	.156
7	Decision Making tools	3.949	2	.139
8	Brainstorming session	3.339	2	.188
9	Small group meetings (2-4 people)	6.936	2	.031
10	Training and education plan	1.974	2	.373
11	Consultancy	3.308	2	.191
12	Monitoring of projects/ services by clients	1.635	2	.442

a. Kruskal Wallis Test
b. Grouping Variable: Construction Industry
Stakeholders

4.3.6   Ranking of Research Variables and Objectives by MS and RII

The ranking of the research objectives was analyzed individually and collectively through Mean Score and Relative Importance Index (RII) by using MS Excel and SPSS to compare the perception of the stakeholders from each other and the overall, and the level of importance they had attached to them through their responses.

4.3.6.1 Comparison of Ranks for Knowledge Management awareness and commitment

The Table 4.23 shows the comparison of the ranks for the construction industry stakeholders to evaluate KM awareness and commitment which could be summarized as:

General / Specialty Contractors and Engineers / Designers have ranked 'delivery time reduction' at the top while Clint/ Owner have ranked it the lowest. While "Time reduction", "Cost Cuts" and "Decision Making Improvement" where remained close to each other.

Table 4. 29 : Knowledge Management awareness and commitment

Sr. No.	Research Variable	CI Stakeholder	Mean	Percentage	RII	Overall Rank
1	Decision Making improvement	General/ Specialty Contractor	4.080	96%	.816	1
		Engineering/ Consulting Firms	3.762	71%	.752	3
		Owner/ Clint Organization	4.111	96%	.822	2
2	Efficiency Improvement	General/ Specialty Contractor	3.960	84%	.792	1
		Engineering/ Consulting Firms	3.714	81%	.743	3
		Owner/ Clint Organization	3.911	84%	.782	2
3	Group work improvement	General/ Specialty Contractor	3.760	64%	.752	2
		Engineering/ Consulting Firms	3.714	71%	.743	3

		Owner/ Clint Organization	3.822	71%	.764	1
4	Product/ service improvement	General/ Specialty Contractor	3.480	40%	.696	1
		Engineering/ Consulting Firms	3.286	38%	.657	3
		Owner/ Clint Organization	3.444	44%	.688	2
5	Cost cuts	General/ Specialty Contractor	4.000	92%	.8	1
		Engineering/ Consulting Firms	3.810	86%	.761	3
		Owner/ Clint Organization	3.956	80%	.791	2
6	Flexibility improvement	General/ Specialty Contractor	3.920	80%	.784	1
		Engineering/ Consulting Firms	3.667	71%	.733	2
		Owner/ Clint Organization	3.622	60%	.724	3
7	Delivery time reduction	General/ Specialty Contractor	4.160	100%	.832	1
		Engineering/ Consulting Firms	4.095	100%	.819	2
		Owner/ Clint Organization	4.067	89%	.813	3
8	Time reduction	General/ Specialty Contractor	4.080	96%	.816	1
		Engineering/ Consulting Firms	4.000	95%	.8	2
		Owner/ Clint Organization	3.911	80%	.782	3
9	Customer and supplier's relation	General/ Specialty Contractor	3.120	20%	.624	2
		Engineering/ Consulting Firms	3.095	19%	.619	3
		Owner/ Clint Organization	3.200	24%	.64	1

10	Quality improvement	General/ Specialty Contractor	4.040	88%	.808	2
		Engineering/ Consulting Firms	3.714	76%	.742	3
		Owner/ Clint Organization	3.889	82%	.778	2
11	Employee's experience exchange	General/ Specialty Contractor	3.400	40%	.68	2
		Engineering/ Consulting Firms	3.238	29%	.647	3
		Owner/ Clint Organization	3.533	53%	707	1

4.3.6.2 Overall Ranking for Knowledge Management awareness and commitment

The Table 4.24 and Figure 4.14 indicate the overall ranking for research variables to understand the perception of Pakistani construction industry about Knowledge management. As a whole "delivery time reduction" remained on top with close competition with cost cuts, time reduction and decision making improvement.

Table 4. 30 : Knowledge Management awareness and commitment

Sr. No.	Research Variable	Mean	Percentage	RII	Overall Ranking
1	Decision Making improvement	4.725	91.51%	.796	2
2	Efficiency Improvement	4.593	85.85%	.772	5
3	Group work improvement	4.473	73.58%	.753	7

4	Product/ service improvement	4.066	50.00%	.680	10
5	Cost cuts	4.648	86.79%	.784	4
6	Flexibility improvement	4.429	72.64%	.747	8
7	Delivery time reduction	4.813	95.28%	.821	1
8	Time reduction	4.692	89.62%	.799	3
9	Customer and supplier's relation	3.681	22.64%	.627	11

10	Quality improvement	4.495	80.19%	.776	6
11	Employee's experience exchange	4.132	50.94%	.678	9
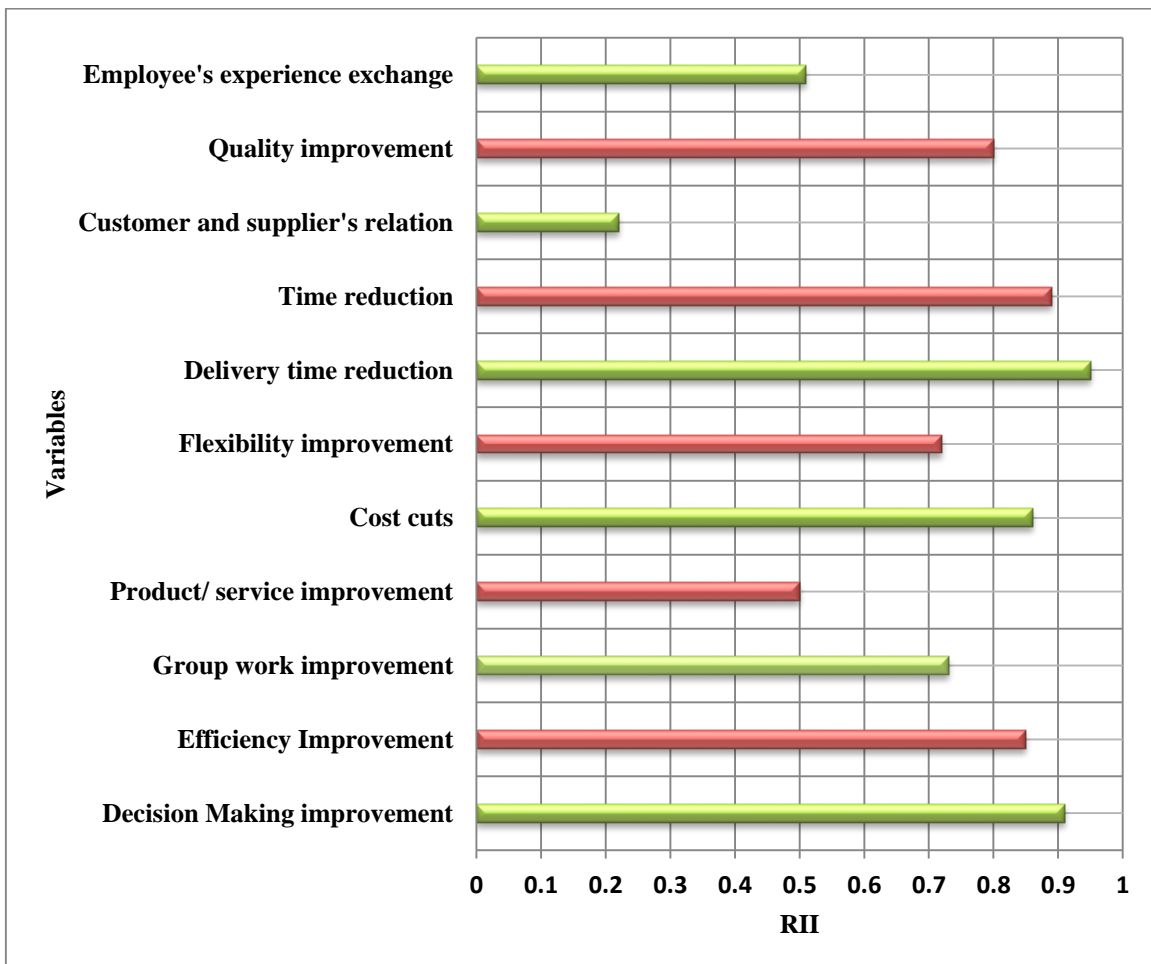
Figure 4. 14 : Variable's grouping

4.3.6.3 Comparison of Ranks for Knowledge Management Strategies (People, process and Technology)

The Table 4.25 shows the comparison of the ranks for the construction industry stakeholders to evaluate the significance of People, process and technology for KM which could be summarized as:

General / Specialty Contractors have ranked '*Process*' and ' *Technology'* as the most important in managing knowledge awhile Clint/ Owner and Consultants have ranked '*people'* at top most important in KM.

Table 4. 31 : Knowledge Management awareness and commitment

Sr. No.	Research Variable	CI Stakeholder	Mean	Percentage	RII	Overall Rank
1	People	General/ Specialty Contractor	3.960	0.880	.792	3
		Engineering/ Consulting Firms	4.000	0.952	.8	2
		Owner/ Clint Organization	4.067	0.889	.813	1
2	Technology	General/ Specialty Contractor	4.040	0.960	.808	1
		Engineering/ Consulting Firms	3.952	0.857	.79	2
		Owner/ Clint Organization	3.889	0.800	.778	3
3	Process	General/ Specialty Contractor	4.080	0.960	.816	1
		Engineering/ Consulting Firms	3.810	0.810	.762	3
		Owner/ Clint Organization	3.867	0.844	.773	2

4.3.6.4 Overall Ranking for Knowledge Management Strategies (People, process and Technology)

The Table 4.26 and Figure 4.15 indicate the overall ranking for research variables to understand the level of importance of people, technology and process in managing Knowledge in Pakistani construction industry. As a whole "people" remained on top with close competition with other two variables i.e. 'Technology' and 'Process'.

Table 4. 32 : Knowledge Management Strategies

Sr. No.	Research Variable	Mean	Percentage	RII	Overall Rank
1	People	4.009	91%	.801	1
2	Technology	3.960	87%	.792	2
3	Process	3.919	87%	.783	3
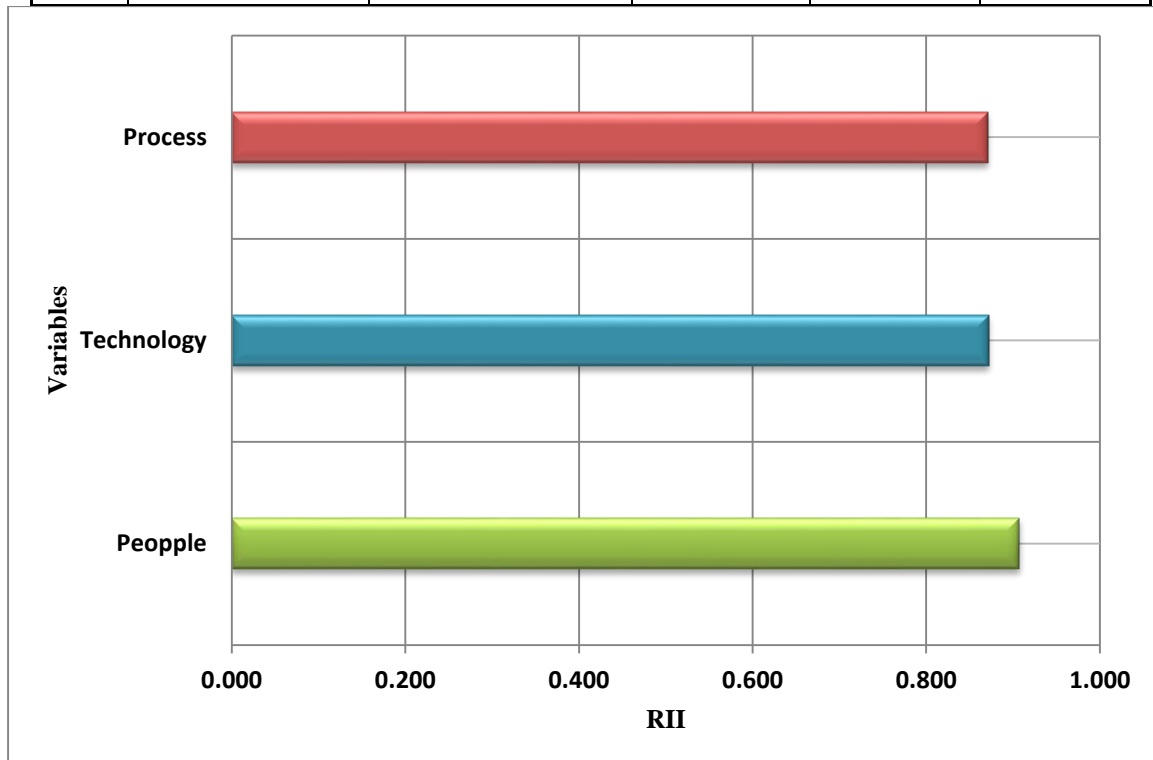
Figure 4. 15 : Variable's grouping

4.3.6.5 Comparison of Ranks for Knowledge Management Tools

The Table 4.27 shows the comparison of the ranks for the construction industry stakeholders to evaluate the different tools used for managing Knowledge which could be summarized as:

All stakeholders were agreed that 'e-mail' and 'intranet' are most effective tools for managing Knowledge in Pakistani construction industry. While 'internet' remained on second most effective tool for KM. 'Database' was also an effective tool in view of General/Specially contractors.

Table 4. 33 : Knowledge Management Tools

Sr. No.	Research Variable	CI Stakeholder	Mean	Percentage	RII	Overall Rank
1	E-mail	General/ Specialty Contractor	4.200	1.000	.84	1.000
		Engineering/ Consulting Firms	4.095	0.952	.819	3.000
		Owner/ Clint Organization	4.200	0.933	.84	2.000
2	Intranet	General/ Specialty Contractor	4.200	1.000	.84	1.000
		Engineering/ Consulting Firms	4.048	0.952	.809	2.000
		Owner/ Clint Organization	3.956	0.867	.791	3.000
3	Internet	General/ Specialty Contractor	4.200	1.000	.84	1.000
		Engineering/ Consulting Firms	4.048	0.905	.809	3.000
		Owner/ Clint Organization	4.133	0.867	.826	2.000
4	Communities of practice	General/ Specialty Contractor	3.240	0.280	.648	2.000
		Engineering/ Consulting Firms	2.905	0.143	.581	3.000
		Owner/ Clint Organization	3.267	0.311	.653	1.000
5	Video conferencing	General/ Specialty	2.920	0.160	.584	1.000

		Contractor				
		Engineering/ Consulting Firms	2.619	0.095	.523	3.000
		Owner/ Clint Organization	2.844	0.133	.568	2.000
6	Databases	General/ Specialty Contractor	3.833	0.640	.766	1.000
		Engineering/ Consulting Firms	3.524	0.476	.704	2.000
		Owner/ Clint Organization	3.511	0.378	.702	3.000
7	Decision Making tools	General/ Specialty Contractor	3.320	0.360	.664	1.000
		Engineering/ Consulting Firms	3.095	0.286	.619	3.000
		Owner/ Clint Organization	3.156	0.289	.631	2.000
8	Brainstorming session	General/ Specialty Contractor	3.200	0.240	.64	1.000
		Engineering/ Consulting Firms	3.190	0.286	.638	3.000
		Owner/ Clint Organization	3.289	0.400	.657	2.000
9	Small group meetings (2-4 people)	General/ Specialty Contractor	3.120	0.280	.624	3.000
		Engineering/ Consulting Firms	2.952	0.143	.59	2.000
		Owner/ Clint Organization	3.289	0.378	.657	1.000
10	Training and education plan	General/ Specialty Contractor	3.280	0.480	.656	3.000
		Engineering/ Consulting Firms	3.524	0.476	.704	1.000
		Owner/ Clint Organization	3.289	0.356	.657	2.000
11	Consultancy	General/ Specialty Contractor	3.160	0.200	.632	3.000
		Engineering/ Consulting Firms	3.333	0.286	.666	1.000

		Owner/ Clint Organization	3.222	0.267	.644	2.000
12	Monitoring of projects/ services by clients	General/ Specialty Contractor	3.440	0.240	.688	1.000
		Engineering/ Consulting Firms	3.190	0.190	.638	3.000
		Owner/ Clint Organization	3.222	0.267	.644	2.000

**4.3.6.6 Overall Ranking for Knowledge Management Tools**

The Table 4.28 and Figure 4.16 indicate the overall ranking for research variables to understand the importance of tools used in managing Knowledge in Pakistani construction industry.

As a whole 'e-mail' was the most effective tool for managing Knowledge in Pakistani construction industry. While 'Intranet' and 'internet' remained on second and third most effective tool for KM, respectively. 'Database' was also an effective tool in view of General/Specially contractors and remained at no.4 in overall ranking.

Table 4. 34 : Knowledge Management Tools

Sr. No.	Research Variable	Mean	Percentage	RII	Overall Rank
1	E-mail	4.165	0.962	.833	1.000
2	Intranet	4.068	0.940	.813	2.000
3	Internet	4.127	0.924	.825	3.000
4	Communities of practice	3.137	0.245	.627	10.000
5	Video conferencing	2.794	0.130	.558	12.000
6	Databases	3.623	0.498	.724	4.000
7	Decision Making tools	3.190	0.312	.638	6.000
8	Brainstorming session	3.226	0.309	.645	7.000

9	Small group meetings (2-4 people)	3.120	0.267	.624	8.000
10	Training and education plan	3.364	0.437	.672	5.000
11	Consultancy	3.239	0.251	.647	9.000
12	Monitoring of projects/ services by clients	3.284	0.232	.656	11.000
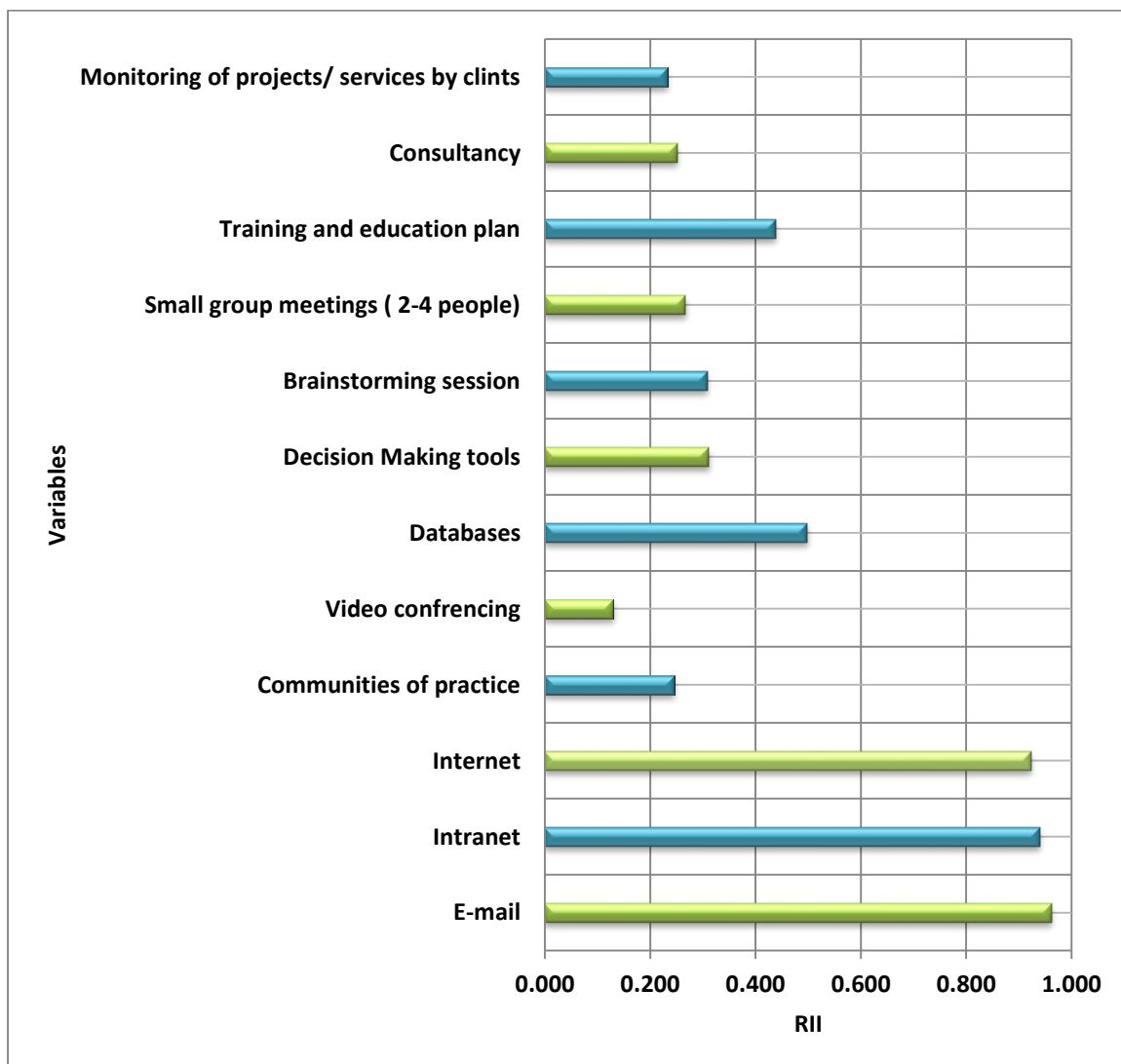
Figure 4. 16 : Variable's grouping

4.4   Summary

In this chapter the analyses of the collected data and its results had been discussed in details in which the sample Characteristics (like Respondent Profile), Respondents Frequencies and the Percentages were analyzed. Also the statistical procedures like Validity Test, Reliability Test, Frequency Analysis, and Normality Test to the collected data were carried. After this a Kruskal-Wallis Test was applied to all the Research Variables and the Research Objectives to find the difference in perception of CI stakeholder and this process was concluded by ranking the feedback (from respondents) through Mean Score (MS) and Relative Importance Index (RII) to compare the perception of the stakeholders from each other and overall.

The respondents to this survey were from engineering / consultants, contractors and owner firms with the varied professional experience in the local construction industry.

CASE STUDY

5.1   Background

One client organization working for government was selected to conduct case study which was comprises of interviews and questionnaire. This organization has an intranet facility to organize and manage knowledge within the organization. The company's director was interested to ascertaining that whether the intranet facility is effective to manage knowledge in better way and make it available at the time of need.

Following this, the findings were presented to the director of the organization. This case study sought to identify the emerging issues associated with adopting KM and encouraging construction professionals to engage with KM through alignment with existing organizational practices. In seeking to develop the emerging issues further, this chapter also discusses the findings of case study.

5.2   Staff Survey Findings

The questionnaire was sent to 50 professional staff based in Case Study construction division, with 35 staff responding. The following is a profile of the survey respondents' age, experience, work location, role, education, professional body membership and motivational factors.

5.2.1   Age

The findings suggest a relatively young workforce with a total of 63% of respondents age 35 and below. Figure 14 shows the overall age profile of the sample.
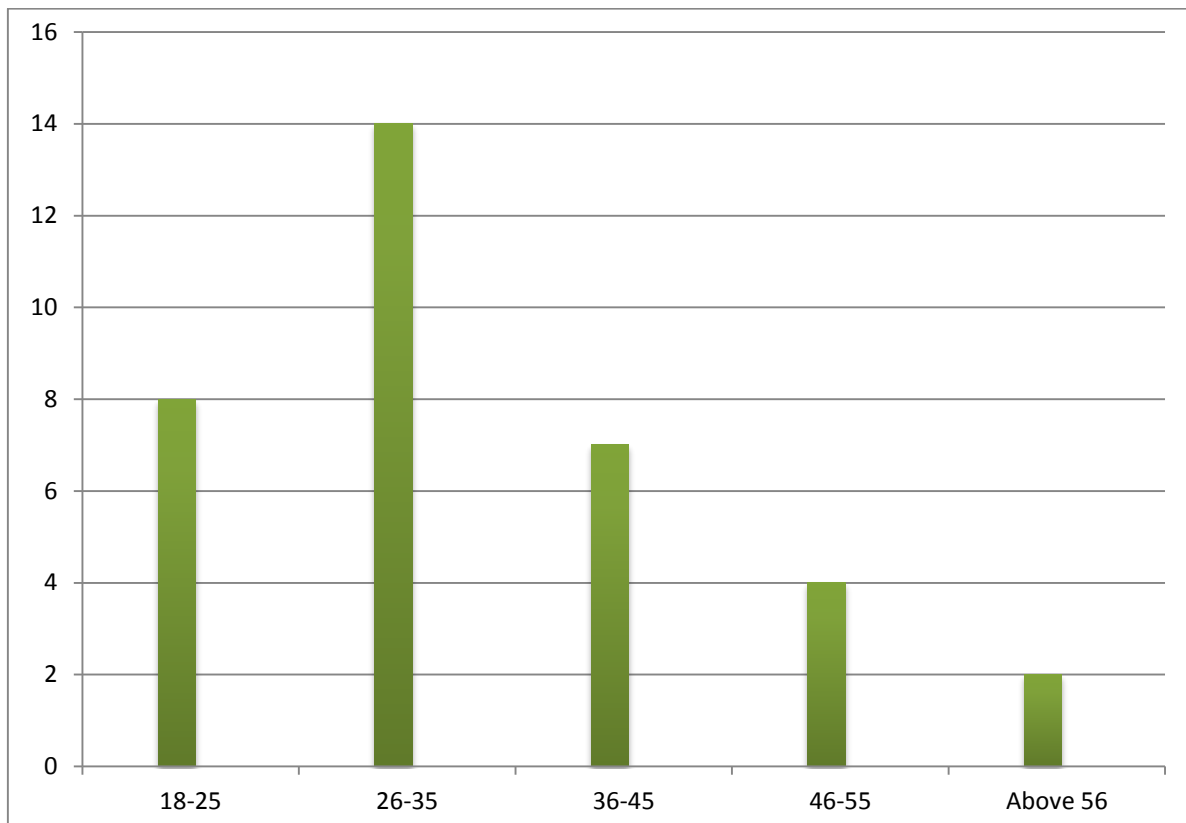
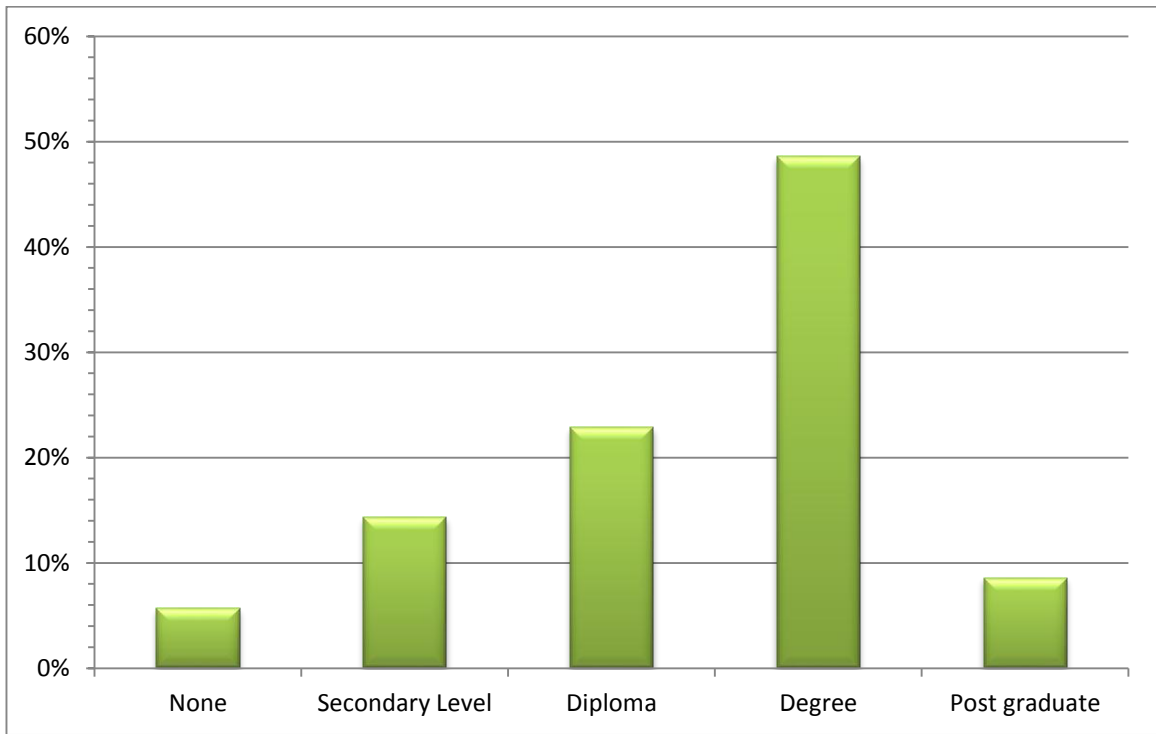**Figure 5. 1   Age Range of Survey Respondents**

5.2.2   Experience

As can be seen in Table 5.1, the survey respondents have a good range of expertise in construction. 29% of the respondents are working with Case Study for less than 5 years and 37% have less than 5 years overall construction experience, this supports arguments which acknowledged the migrant nature of the industry.

	< 5 years	5-10 years	11- 20 years	>20 years	Total
Working in Construction	37%	25%	14%	24%	100%
Working for Case Study	29%	15%	35%	21%	100%

Table 5. 1 : Survey respondents' construction industry experience

5.2.3   Education

In terms of an educational qualification, 80% of the respondents hold a trade education background and a further 57% possess a graduate or post-graduate qualification. The distribution of educational qualifications is shown in Figure 2.2 and includes secondary level (14%) and diploma in civil engineering (23%).

Figure 5. 2   Age Range of Survey Respondents

5.2.4   Role

The highest ranking role to take part in the survey was Site Supervisors (20%), closely followed by Project Managers (17%). The remainder was drawn from a variety of roles as illustrated in Figure 2.3.
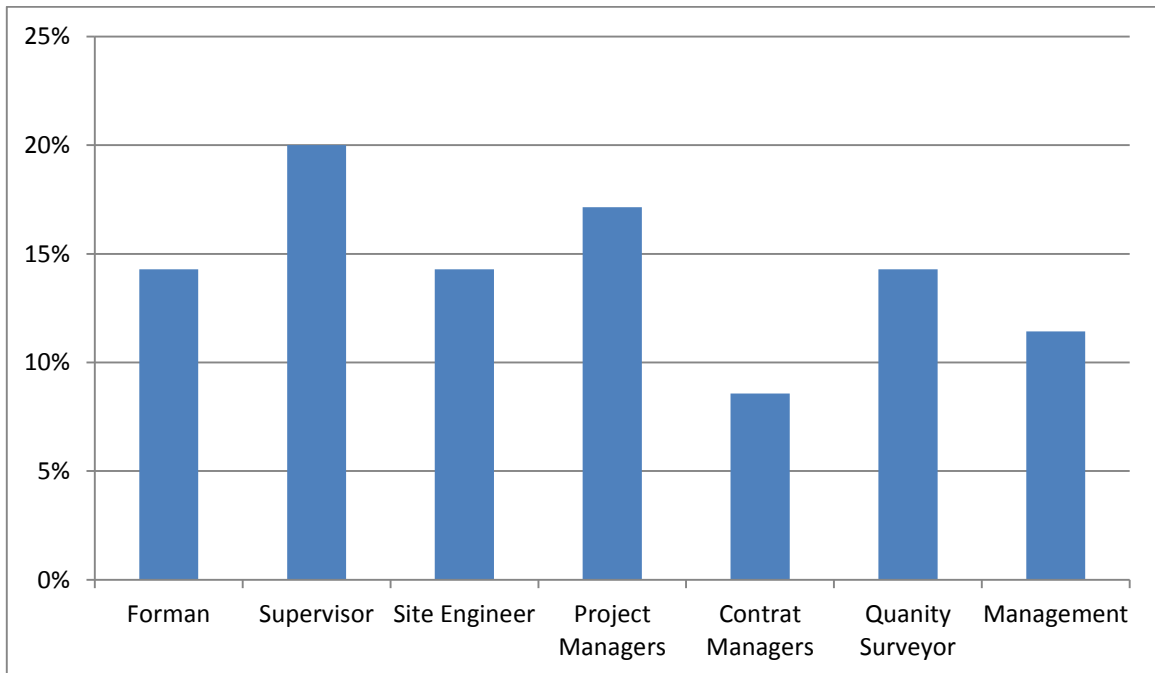
Figure 5. 3   Age Range of Survey Respondents

5.2.5   Motivational Factors

As evidenced in Figure 2.4, apart from financial incentives, being given 'responsibility to work on own initiative' was rated the most important motivational factor, followed by 'recognition of your skills and talents,' 'good training and development program' and 'being part of a team.'
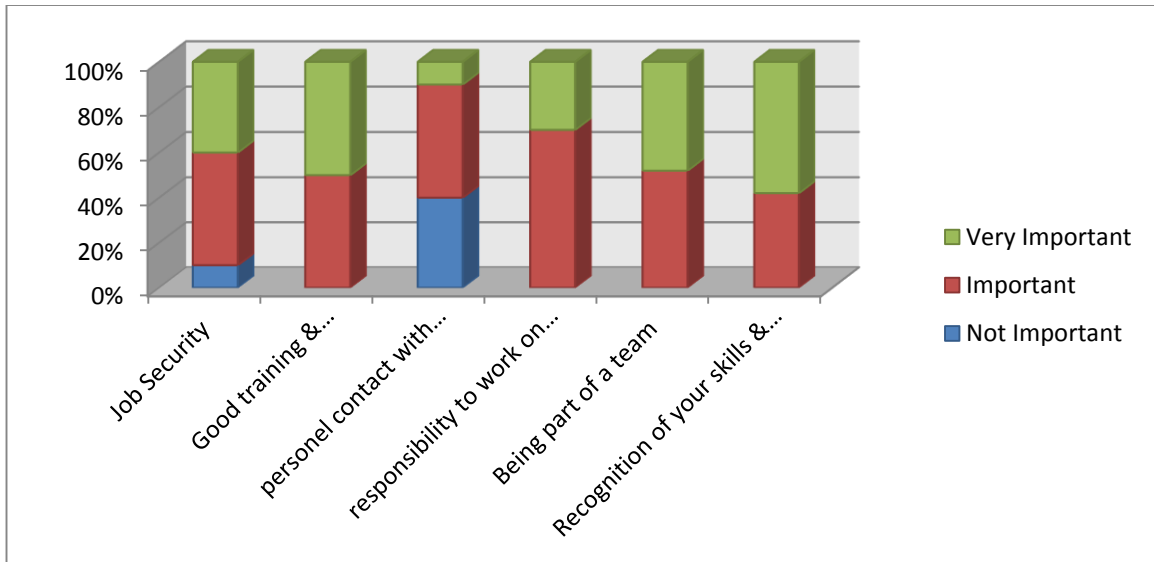

Figure 5. 4   Non-Financial Motivational Factors

5.2.6   Engagement with CPD Activities

The survey sought to explore the level of engagement with a number of identified formal CPD activities, including induction, mentoring, training and site visits.

- Induction: 23.1% had completed an induction upon joining the organization
- Mentoring: 60% of respondents are involved in the company's mentoring program, with 43% being mentees and 17% identifying themselves as mentors
- Training: the areas where respondents have received most training include: computer skills (80%), health and safety (70%), quality management (58%) and communication skills (55%); other areas where formal training has been received can be seen in Figure 5.6
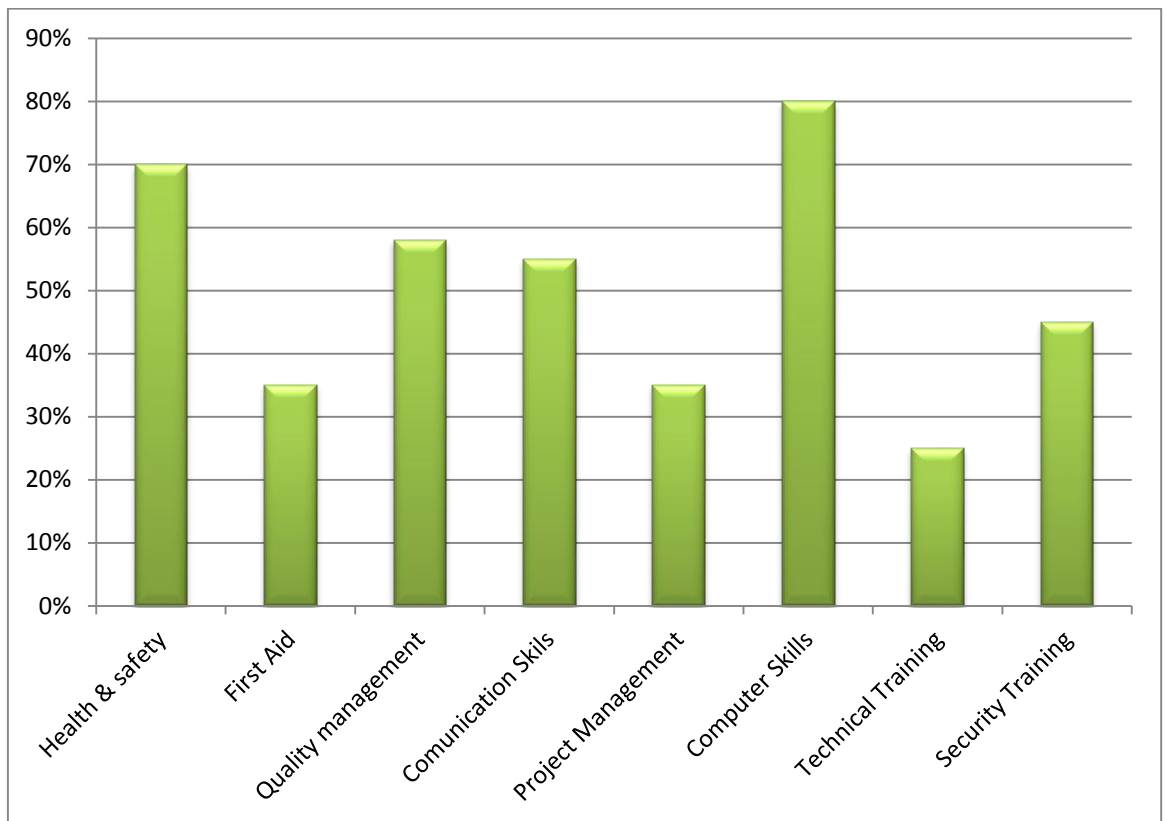
Figure 5. 5   Areas where training has been under taken

• Site Visits: 80% indicated that they had visited other sites within the organization. Table 5.2 indicates that the longer employees spend working for the organization, the more likely they are to have visited other sites. Of the 10 respondents who have been with the company for less than 5 years, only 3 have visited other sites within the organization

	Years Working for case Study				
	<5	5-10	11-20	>20	Total
Yes	2	3	12	5	22
No	8	1	3	0	12
Total	10	4	16	5	35

Table 5. 2 : Site Visits versus years working for Case Study

5.2.7   Use of IT

As can be seen in Table 2.3, the majority of those surveyed (92%) viewed IT as being an integral part of their job, with 74% stating that computers are used effectively within the organization. Whilst 80% of respondents have received training in computers, only 52% feel that they are sufficiently trained in this regard.

	Yes	No
Computer are used effectively	74%	26%
Sufficently trained in use of computers	52%	48%
IT is an intergral part of your Job	92%	8%

Table 5. 3 : Respondents view on use of IT with in Case Study

5.2.8 Engagement with KM Activities

A number of KM-related issues were investigated, including knowledge-sharing seminars, the lessons learned database, ability to identify expertise within the organization and meeting with peers.

The survey found that over half of the respondents (53.1%) attend an average of 1 to 4 seminars per year, with a further 31.3% attending between 5 and 9 over the same period. On a scale of 1 to 5, respondents ranked 'good way to meet colleagues' as being the most important reason for attending these seminars; Table 5.4 presents the other reasons in order of importance

| Rank	Reasons for attending seminars	Mean Score
1	Good way to meet colleagues	4.04
2	Interesting content	3.04
3	Good discussion and interaction	2.98
4	See experience of others	2.42
5	Helps improve own work	1.91

Table 5. 4 : Reasons for Attending Seminars

The survey found that the LLDB is primarily used when staff have a specific problem or query. Although 73.8% were of the opinion that they found it advantageous to them in their work, the use of the database on intranet in Table 5.5 shows that 'very rarely' and 'never' ranking quite highly in terms of usage (39.8% when combined). Irrespective of the Director's views at the start of this chapter about when the LLDB should be used, it is interesting to note that 'when a work package commences' ranked lowest.

| Rank	Use of LLDB (Intranet)	%
1	When I Have a Specific Problem/Query	40.9
2	Very Rarely	27.3
3	Never	12.5
4	Quite Often	10.2
5	When work Package Commences	9.1

Table 5. 5 : Use of Lessons Learned Database

Figure 5.7 illustrates a number of factors related to using the database, which overall; indicates that staff is satisfied with the LLDB, rating relevance and amount of information, easy to understand, easy to access, well organized, and easy to access quite highly. The question of whether lessons were up-to-date appears to have divided respondents, with 35.4% stating that it is not kept up-to-date, whilst both the identification of key people and ease of search, are also problematic.
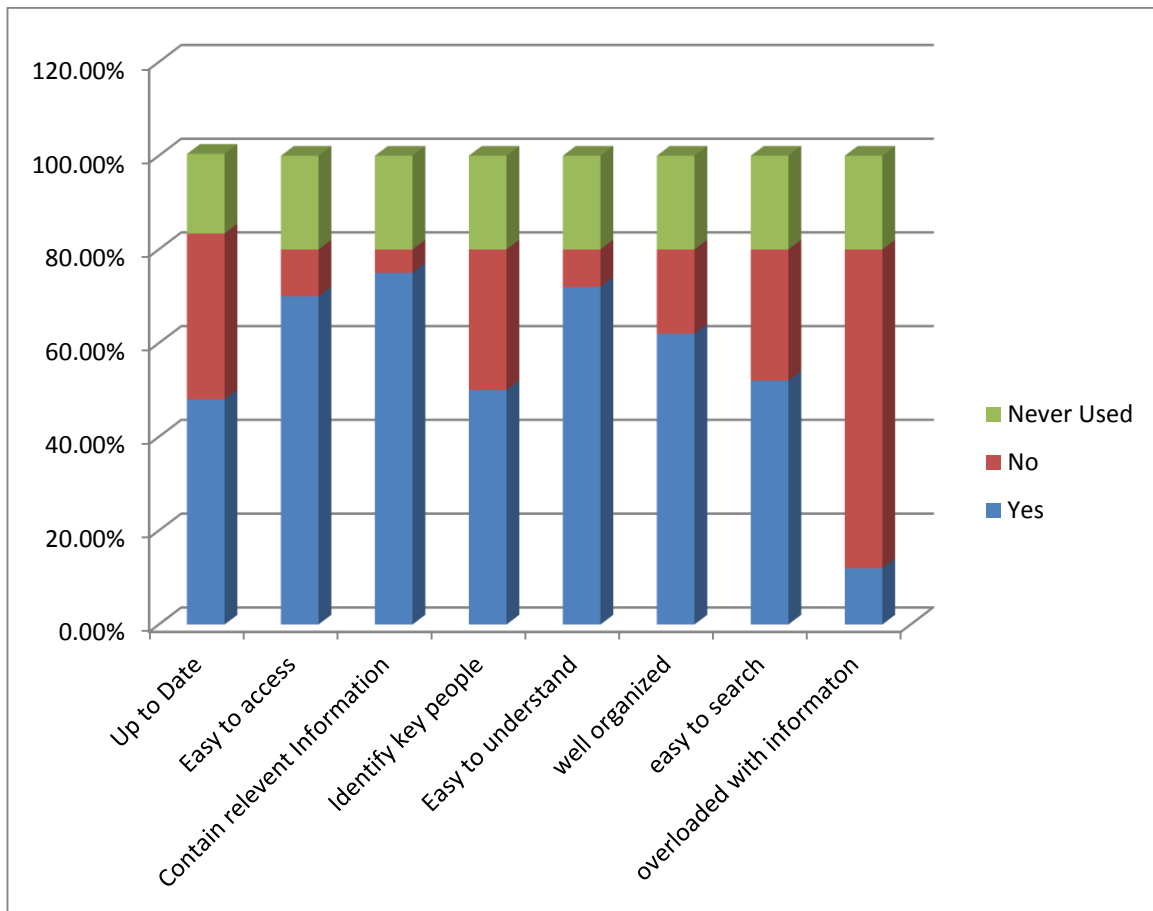
Figure 5. 6   Factors Influencing Use of Lessons Learned Database

It was requested from the respondents to tell about the easiness with which they were able to identify people with certain domain expertise within the organization. As can be seen in Figure 21, both "in own workplace" and "in head office" ranked (75% and 60% respectively), while 35% of respondents stated their opinion that they can easily identify expertise on other sites within the company. However, only 10% felt that they could identify skills in the division's regional offices in Rawalpindi and Islamabad.
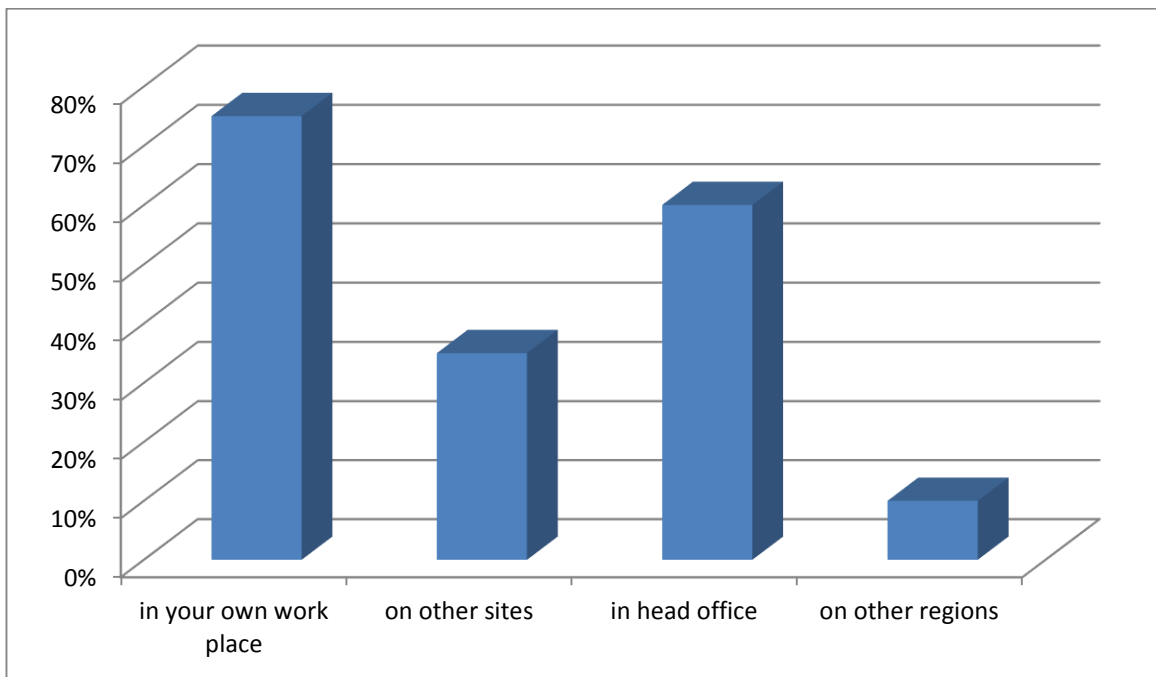
Figure 5. 7   Identifying Organizational Expertise

As can been seen in figure 5.9, just under half of the survey respondents (52%) indicated that they never meet with their peers on a regular basis. While 25 % claim that they meet on monthly basis and 10% meet 3 or 4 times in a year.
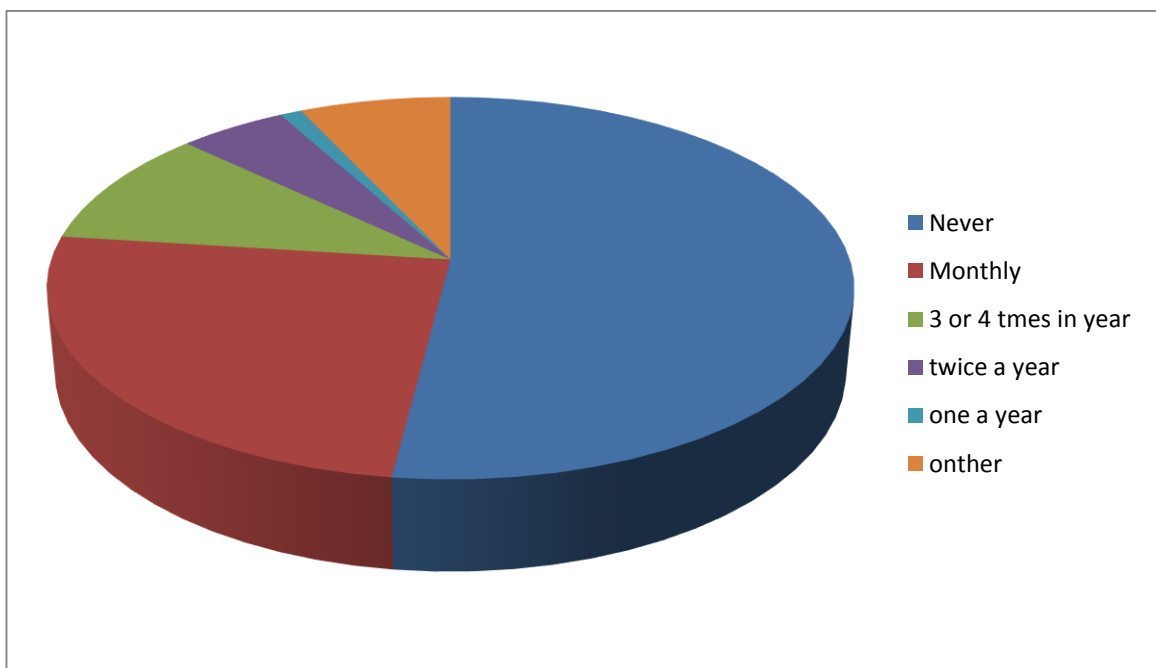
Figure 5. 8   Meeting with peers

The majority of those who meet with peers on a regular basis (97%) found such interaction makes benefit for their work and for those who do not have opportunity to meet their peers are willing to have such opportunity in future.

It is evident from the survey findings that young, energetic and professional work force is available in Case Study. It is also emerged that an individual experience influences issues like motivation, engagement with CPD and KM activities.

5.3   Project Team Interview Findings

An overview of the interviewees' profiles is presented in Table 5.6, summarizing their position, experience and highest qualification.

Position	Industry Experience (Years)	Case Study Experience (Years)	Highest Qualification
Director	20	20	B.Sc. Civil Engineering
Dy. Director A	19	15	B.Sc. Civil Engineering
Dy. Director B	17	16	B.Sc. Civil Engineering
Senior Engineer A	15	10	B.Sc. Civil Engineering
Senior Engineer B	10	8	B.Sc. Civil Engineering
Supervisor A	20	15	Diploma
Supervisor B	22	16	Diploma
Quantity Surveyor	15	13	Diploma

Table 5. 6 : Project Team profile

Based upon this information, it is obvious that the project team is mixture of individuals from a variety of different backgrounds, with differing levels of experience and education. The consideration of these multiple perspectives, will contribute to the identification of issues and subsequent construction of a KM framework that reflects the diversity of construction organizations.

5.3.1 Engagement with CPD

Role of CPD is vital for efficient KM. In this regard, Quantity Surveyor discussed CPD in the context of career progression, "everyone has opportunity to grow in the division. They offer trainings, good framework for work experience, you get your ACR, and you move up a grade, you can see yourself progressing."

The Director echoed that view, "They have separate division for career development program of all employees and they offer trainings on regular intervals" The Senior Engineer was of the opinion that "Although they offer trainings regularly but we have not

enough time to get proper trainings and either we have to compromise on productivity or training."

The Director stated: "at my level, training is driven by me, and I tried to nominate the right man for specific trainings program" A similar theme was followed by the Dy. Director A, "it's up to the nominee that how much he leans from the opportunity." On becoming a professional engineer, Senior Engineer B stated that while the company encouraged CPD, "it would be me deciding that how much I can get out of the training". The Senior Engineer A believes that motivation is an important factor in becoming professional, "once you are professional, you're going to be career inclined and make sure that you keep sharpening the saw."

The Dy. Director B discussed the need for skills conversion of engineers, "one of our biggest challenges is converting them from engineers to managers, giving them the proper training to switch from a technical work system to a management work system where they are dealing with people…it is something that we need to put more effort into." In this regard, the Senior Engineer A spoke of his increased involvement in management issues on the project: "I'm after going into the management of all civil maintenance works which is very different to being a senior engineer. In a maintenance management role you're dealing with people, managing subcontractors, monitoring quality within minimum budget and lengthy procedures."

The Dy. Director A realizes the value of on-the-job experience, "especially for younger people that they're not just a site engineer and you forget about them, it's important that they're introduced to different parts of the work." The Senior Engineer B discussed attending both internal and external seminars, "the company would probably send you on 1 external course every year, paid for by them and then they have their in-house courses which would probably be 2 or 3 again in a year. So you're talking one every 4 months, where you're gaining knowledge."

The Director commented that "we find it's actually quite hard to get good technical courses, technical building courses, so we do a lot of that in-house, with our own senior managers, who give seminars on a range of topics." Mentoring was viewed as a worthwhile endeavor by the Dy. Director B; "I think that it's a good scheme, it gives them [the

mentees] an opportunity to discuss their career with a senior member of staff. I'm a mentor and I find that it works well."

Supervisor B discussed the benefit of meeting with his peers: "at in-house training seminars, you'd meet with a lot of the youngsters and you'd get chatting and find out about how things are running on other sites." The Director confirmed this view, "at seminars and lessons learned talks, inevitably there's some informal chat, and we catch up on what's happening. The Dy. Director A discussed the problems with staff leaving site to attend CPD events, "it's difficult to get away from sections/ workshops, and you can't really have more than one or two people from one workplace going to it." He suggested that "there should be more CPD done on the site."

In terms of CPD, the interviews indicate that Case Study are supportive of their staff's development, providing opportunities for learning both internally and externally, through a range of activities including training and mentoring. Such activities also present an opportunity to meet with peers and discuss various work-related issues.

5.3.2 Use of IT

Arising from the interviews with the project team, it was found that the main IT applications utilized were a central server known as the 'K-drive,' and general software applications.

All of the interviewees indicated using Office applications and in some cases Auto CAD, structure designing softwares. The Director spoke of his use of IT, "basically I can use the computer for whatever I need, it's pretty much email first, Excel second and Word third." The Dy. Director A spoke about learning how to use computers through "picking it up as you go, I have done course. I suppose with computers, I know enough for what I need, which I can get from Excel and World." The Quantity Surveyor, in his day-to-day work uses "the basic Microsoft packages, Word, Excel and PowerPoint." The Dy. Director B mainly uses "Word and Excel. I wasn't comfortable on it when I started, but I'm good now. It does what I need," admitting that "I wouldn't be stuck to the computer!"

Supervisor B acknowledges that "I could do with a bit more training. I can get on alright; there are a few aspects that I need to polish up on." While Supervisor A is unable to

use computers, he was of the opinion that "I'm more geared to sorting out things outside on site, than punching the keyboard. If you value your time, it's a waste of time for me to use the computer."

The Senior Engineer A estimates that he uses "computers for 2 hours a day, at least…reading and writing letters, checking drawing. you have to keep on top of it." Senior Engineer B, who spends most of his time out on site, checks K-drive "every 3 days or so, if I'm lucky, because I'm so busy on site, I'm outside most of the time. I get a lot of stuff that doesn't apply to me, but I get sent it anyway!" The Director agreed, "it can be time consuming when you spend time out of the office, but it's probably better than not knowing what's going on." The coordination of finishes on the project requires Supervisor B to use his computer "every single day, for a few hours, I use to study relevant material on K-drive. It does take you off site quite a bit, but bear in mind that finishing very complicated all the time."

The Director described the development of the K-drive: "the system that we use on the server is one that we put together on paper, and then our IT department made it work. A lot of it is transferring what we used to do in hard copy to computers, so it is a customized system."

In discussing connectivity to the centralized server, the K-drive, the Senior Engineer B had the following to say: "being a well established setup, the connection is good and it is always easy to connect and get past experiences. Al that I need is time for studying relevant material."

It is apparent that the interviewees use IT to varying degrees, depending on their role, IT literacy and experience. The physical location of their work on the project also seems to influence their IT usage, with some staff spending more time out on site and hence using IT less than those based in the site offices. It is also predicted that the staff has not sufficient time to spend on computer.

5.3.3 Lessons Learned Practices

Case Study developed a lessons learned database (LLDB) to capture and share knowledge gained on work sites. Their lessons learned practices were described by the Director, "at the end of every job, a number of things are taken from the job, a number of positives and negatives and they're written up and put into the lessons learned database,

which is based upon single folder named LLDB- Civil Works on K-Drive. Senior Engineer on respective work zone is responsible to update this LLDB on regular bases, as the work packages are completed".

The Director questioned whether the LLDB actually worked in practice, "before you start everything you're supposed to look it up, I mean it's a good idea, but in practice I don't know if it works that well." In relation to his own use of the LLDB, the Dy. Director A admitted to not having used it recently, "There is probably new stuff in it. I haven't checked it in about a year. you don't get time to."

Despite being aware of the LLDB, both Supervisor A & B and Quantity Surveyor admitted that they didn't use it. A number of the interviewees debated who should actually use the LLDB, the Director spoke about foremen in this regard, "you don't want them in front of a computer all day, and it's definitely not for the foremen." However, the Senior Engineer A who was involved in setting up the database had a different view, "A lot of the things on the lessons learned are relevant to a foreman, they are the ones who are dealing with these issues on site but that's where the breakdown is, the people who really need to know the lessons learned haven't got access to a computer."

In recognizing the problems associated with the database, the Division arranged workshops on use of LLDB. After attending workshops the Supervisor A stated "It was a good workshop. I came to know that how can I use the stuff out there on LLDB. However, the real problem is that we can't afford to spend much time on computer as our real match is on site". Superisor B echoed these comments, "I think people physically getting together and trashing out things, what's the best way to communicate to people? Well face to face is, rather than leaving it on the K drive."

Quantity Surveyor stated that "people are so focused on the goal of getting the job done, that they don't look at the database." Supervisor B suggested that lessons learned should be "printed out and display on notices boars." The Senior Engineer B suggested "a seminar once a year to refresh everybody's memory to tell them what's in it."

The LLDB developed by Case Study are not without their challenges, particularly in ensuring that relevant staff reviews lessons before the start of new job. To counter this, regular LL seminars may be delivered to staff.

5.3.4 Role of HRM

The Interview with the Director identified a number of areas where the Human Resource Management (HRM) function could potentially support KM, such as orientation program, appraisals and managing CPD.

The Director described the Divisional orientation program as follows: "it centers on where to find people of interest, where to find relevant material and how to assess K-drive, because we have a wealth of information, but with somebody starting off, they don't really know where to look for it. Our experience is there's no point in bombarding somebody with tons of information on their first day, because it just goes straight over their heads, so we concentrate on telling them where to find information, so in their own time, they can go back and dig it out."

Quantity Surveyor felt that the orientation program was more beneficial in giving him an opportunity to meet people on all working locations, "while the orientation program itself gave the information about how to use their systems, it really gave me a chance to have a look around the division, meet a few people, so you know when you're up there who's who." The company's ACR procedures were described by the Director, "You're appraised by your immediate boss that ACR is then passed on to your director, who goes through the ACR and recommend certain training for the year. Further these appraisals are forwarded to HR with recommended trainings and filed in individual personal folder."

The Dy. Director A viewed the annual ACR as "essential," going on to discuss "a period of self-assessment beforehand to figure out what do I need to do to develop my career over the coming year. That's a useful exercise to do." According to the Quantity Surveyor, during the ACR, "they try to look at areas that you want to improve upon or areas that you think you're lacking knowledge."

In discussing CPD within the organization, the Director commented, "the framework is there, we have a HR Division which works separately in coordination with this Division, so it's reasonably well logged and documented." Senior Engineer B confirmed that "the HR Division sent letters and e-mails about different courses going on," Dy. Director B stated, "our HR Division is not only responsible for conducting training and courses. We also conduct internal workshops, technical trainings, and presentations as a part of CPD".

Activities such as orientation program, ACRs and CPD, which are overseen by the HR Division, can be viewed as being relevant to KM, particularly in terms of finding, capturing and creating knowledge.

5.3.5 Knowledge

Knowledge was discussed from a variety of perspectives during the course of the interviews in terms of relevance, level of experience, workload, and role. The relevance of knowledge was discussed by a number of the interviewees.

In terms of knowing about other projects within the company, the Supervisor A commented, "you have enough to deal with on your own project, unless you're expected to have some involvement, really you don't want to have any knowledge of it, because you've so much on your own plate." Whilst discussing site visits, Supervisor B spoke, "if you've something new to tell them, they will appreciate it."

The Senior Engineer A felt that if CPD seminars were "of no relevance to you, you'd be inclined to say that you can't go to the next one." Quantity Surveyor recently attended a seminar on data security and stated, "it was very beneficial to understand the sensitivity of our jobs and the importance of its secrecy". In relation to the lessons learned, Supervisor A stated, "it's normally just a little bit of information that you want, if the information is not there and its relevant to you, you'd talk to the people who were involved."

In terms of 'individual knowledge' the interviewees discussed their level of experience, the relevance of knowledge to them, their workload and role. Supervisor B felt that his lack of experience impacted on his CPD activities: "the different talks and seminars that I would have gone to, say concrete and formwork, there was joinery, block work, they are fairly relevant. Once you've seen it being done, I find it's easier to go to a seminar and talk about it. It's hard to visualize something when you go in and listen to someone in a room talk about it for an hour, whereas when you experience it on-site".

When discussing the problems with committing to training courses, the Director admitted, "I suppose time is the thing, the best intentions is to go out the window when you're handing newly completed job!" Whilst acknowledging the need for KM-related

activities, the Dy. Director stated that "it's just the nature of our business. We're trying to get more done all the time but we probably don't do as much of it as we could." Quantity Surveyor felt that "there is a good culture within the organization and that people are generally willing to share their knowledge. Within reason, sometimes people are just too busy, but I've never had anyone say that to me."

A number of key themes relating to knowledge have been identified in the interviewees that might influence an individual's engagement with KM. Relevance, level of experience, workload and role all impact on how an individual views knowledge from their own perspective.

5.3.6 Managing Knowledge

Based on the interview with the Director, a number of identified KM-related activities were discussed with the interviewees, relating to creating, capturing, finding and sharing knowledge.

In terms of purposefully creating knowledge, the Dy. Director A discussed his role in researching new methods of job completion "needs to be done at the start, because once you've committed the design team to designing something in a particular way, you cannot then change it and look at a whole new system, so it needs to be done early on."

The post-job review was described by the Dy. Director A as a method for capturing project knowledge, "where you get your lessons learned, performance of subcontractors, any client complaints, all these things are gone through." With regards to the level of detail of the project review, he commented, "I would be happy that most of the major items are picked up on, quite often in the middle of a job, you get hung up on small things, and it is always the end of a job and look back to say "what were the big issues here," you cannot cover all issues, if the big issues are addressed it man you are doing good job

Finding knowledge is all about finding right people who had a particular expertise. The Director had identified CV's as being useful in this regard, but continued, "CVs aren't something we share freely for obvious reasons, but it's open to senior people, you can check all subcontractors and the key person on any particular job, that's how you would find out". Quantity Surveyor had previously worked on a large who employed such a tool, "it was like a CV for everybody. There wasn't too much information, just the jobs they'd

worked on within the company and outside the company and the value of them, to know who would have experience in other areas."

A number of formal and informal knowledge sharing activities identified in the interview with the Director were discussed with the project team. The formal activities included departmental meetings, project reports, site meetings, site visits, workshops and seminars; whilst the informal activities comprised informal get-togethers and social activities.

• Departmental Meetings: both the Dy. Directors organize regular meetings for their staff to discuss relevant issues. According to the Dy. Directors A, "about once a month, there's a meeting in head quarter," where the Senior Engineer can raise any issues they have

• Project Reports: at the end of each project, the Dy. Director compiles a project report which is "circulated around senior personnel, it would be lessons learned, both the good and the bad, innovative systems of work used, new contractors who were found to perform particularly well, so it's a useful updating tool for senior management"

• Site Meetings: the Senior Engineer B holds a weekly site meeting for the on-site project team; "it's good to let everybody in the team know what's going on."

• Site Visits: according to the Director, "happen if something comes up and it's relevant somewhere else, but also if a site manager is between jobs, one of the things we would ask him to do is look around and visit all the other sites, see what he can pick up." The Dy. Director A believes that direct experience of new systems and products is very important, "you see it first hand, rather than being told it's a great system, you can talk to the lads on site and they'll tell you the problems or the issues" The Senior Engineer A would visits a number of sites on a regular basis, and found them useful where "something that turns up that's new to you. You ask the question, see how it's done, then you know for the next time." Senior Engineer B described a site visit, "whenever I go to site, there is some new happening. It is always full of knowledge and interesting"

• Workshops and Seminars: the division organizes workshops and seminars on a variety of topics including lessons learned, with the Director adding, "We'd also take specific

topics, and somebody would take a specific seminar on aluminum partition or roof water proofing or DPCs, so we would have a series of these going on throughout the year." Senior Engineer A described a typical seminar, "you might get 8 – 10 people at them, around the table, about an hour and a half long and if you want to ask questions you can. You do learn from it."

• Informal Communications: the Dy. Director B keeps up to date on other projects within the company through "word of mouth, there's no newsletter or update report issued on a regular basis." Supervisor B had a similar view, "only through word of mouth, I wouldn't visit them or anything like that." He then spoke about knowing people throughout the Division: "I'd like to think that I know quite a few people in the Division still, but its constantly changing, yes, there are people on other locations I know that I can refer to, I can ring so and so and say 'listen we're getting paint from this company, have you ever dealt with them before?'"

• Social Activities: according to the Director, "they have some social activities at inter division level like cricket match, badminton tournament, football match, which ultimately do help to get staff together, and inevitably work is discussed." In terms of getting to know people, the Dy. Director B admitted that "most people I know in the Islamabad office, I know them through the cricket match"

A recurring challenge to managing knowledge discussed during the interviews was the geographically dispersed nature of jobs, which the interviewees spoke about in relation to a variety of issues. As stated by the Director, "It is not possible to distribute information regularly up to all concerns at lower level due to scattered nature of jobs and some vital security barriers".

The regional structure of the division was described by the Director, "we've offices in multiple cities, and it is not simple to circulate information in between. There are probably more similarities than differences, but there are a lot of differences also, every in-charge has a different attitude towards jobs and they all are good at their own". Dy. Director B stated, "We deal with all kind of civil works and we have our own manpower in almost all specialized fields, when you're in other locations you wouldn't have all type of skilled manpower and may be dependent upon this office or the subcontractor". Supervisor B felt

that there was potential to learn from other regions, "I think it would be quite beneficial to go from one location to other to view places, sooner than going from site to site".

The interviews confirmed a variety of activities associated with the processes for managing knowledge. Furthermore, the concept of intra-divisional fragmentation was confirmed as a significant barrier to managing knowledge in construction organizations.

5.3.7 Supportive Learning Environment

In terms of the Supportive Learning Environment within the organization, the Director praised them, "I think they're good, they've a good attitude to staff, they support training, and they support career development." Supervisor A stated, "I think they're not the best payer in the country, but they're inclined to try and look after their staff." Upon finishing college, Senior Engineer B said "I was offered two jobs and this organization seemed to be a bit of a better deal, more involved in CPD with more of an emphasis on it".

On being committed to the company, the Dy. Director B made the following comment: "I suppose I'm with them sixteen years, that probably answers that question, every year you think about "there's more out there" but when you come down to the brass tacks of it, it generally doesn't work out. So I suppose I'm happy enough at the moment." Conversely, Supervisor A spoke about people who joined the company with industry experience, "they don't seem to stay that long, they come in for a job and they leave at the end of it. Normally, the people who stay come in from the start, as graduates." Quantity Surveyor who has also worked elsewhere commented, "if you start out of college, and stay with them for 6 or 7 years, you will move up very quickly because you're in a set program, but how many people do stay in the first job they go into out of college?"

Having worked in construction for 22 years, the last 16 of those with Case Study, Supervisor B stated, "they're quite good, they're quite loyal to their employees as long as you make an honest effort to do your work to the best of your ability and be loyal to them."

At project level, it was noted by the Dy. Director that "there's a good team spirit here. However, this varies from project to project and from team to team." The ability to learn from experience is also hindered by the project-based nature of the industry. The Quantity Surveyor discussed the importance of learning from experience, "you'd hope that you're

not making the same mistake twice, but every project is different, you might come across a different type or a different brand of problem that might in some way relate to it, but it's a totally different scenario. You shouldn't be making the same mistake twice, but…" Dy. Director A spoke of learning from the experience of others at seminars, "they are all very beneficial because you're there and you have some of the directors sitting in on it there, they voice their own experiences with the presenter, you pick up a lot of stuff at them."

The Director felt that there was enough time given to problem-solving and reflection during the course of the project, "if there is a problem we just get whoever is involved and we've a wide range of people here with different experiences, like we have young people with new ideas, we've the foremen there, the old heads on site, there's a good wealth of knowledge there."

The Senior Engineer A discussed the potential to learn from experience, given the nature of the construction business, "sometimes you do have time to reflect, sometimes you just don't and most likely not. But then that's the nature of it, if they some pending job, they're not going to leave you sitting in the office here".

The Division has an SOP of giving all staff "access to a director," according to the Director. However, "as the work increases with passage of time which include maintenance of old buildings and new construction, it has become more difficult to see your director" as commented by Supervisor B. Senior Engineer A finds the DG and directors to be very approachable, "they're up to speed with what's going on out there, they're very approachable, my main person to deal with in the Division is the director on this project, and we have a good rapport." According to the Quantity Surveyor, the ACR with a director "show that they're interested in your career development and to be able to even get time from a director, because everyone is flat out, for them to even spare you time does mean an awful lot."

Overall, the Division was praised by staff for its commitment to their development, with a supportive learning environment evidenced through employee commitment, good communications, learning from the experience of others and senior management support.

5.4   Summary

Based on a survey of professional staff and interviews with a construction project team, the main findings from Case Study can be considered as follows.

The company has developed lessons learned practices which include post-project reviews, a lessons learned database on K-Net and lessons learned seminars. The impetus for the research contained in this chapter arose from the Director's interest in the use of the LLDB which had been developed. Contrary to his belief, referring to the database when a new subcontract package starts ranked lowest in terms of frequency of use. Whilst there are a number of problems with the lessons learned practices adopted by the Case Study organization, the research points to an organization that recognizes the importance of KM and is dedicating resources to managing knowledge.

In terms of managing knowledge, the respondents confirmed the previously identified processes of creating, capturing, finding, and sharing knowledge. The main challenges to managing knowledge included geographical dispersion and intra-Divisional fragmentation between project teams, locations and Divisional HQ. Other issues of note include:

• Regular performance appraisals are a good for both the individual and the organization, opening new doors of development

• The use of IT is vital to most people's work, and centers around Office applications and K-net drive

• The identification of expertise within the division is not very much difficult and most of the employees have good awareness about the other's expertise.

• The opportunity to meet with peers on a regular basis was found to be extremely beneficial by those who had the opportunity to do so, particularly in discussing those problems which occur time and again after a regular inter and of time, new construction methods and company news

• The provision of CPD and learning opportunities, continuous improvement, employee commitment, opportunities for reflection, and access to senior management all contribute to a supportive learning environment within the organization

The divisional capacity building programs like CPD, mentoring, inductions technical training and seminars are encouraging the staff to engage with KM. Despite the recognized challenge of providing CPD opportunities, it was fond that the staff has high level of

engagement with CPD activities, all of which is visibly supported by senior management. The company employs a work force from almost all age groups, youngster with new ideas and the elders with priceless experience. In attempting to understand the concept of KM and its implementation in construction organizations, the Director acknowledged the need to understand how KM integrated with existing practices.

DISCUSSION

6.1   Review of Research Objectives

The objectives for this study were to:

    v.   Assess general awareness and commitment of Pakistani construction industries for managing Knowledge.

   vi.   Introduction to various strategies being used for Knowledge Management in Pakistani construction industry.

  vii.   Introduction to various tools and techniques for Knowledge Management which are being used in Pakistani construction Industry.

 viii.   Identify the emerging issues associated with KM in the Pakistani construction organizations.

The above three research objectives were achieved by collecting the data for 63 research variables in main questionnaire while a complete case study was conducted to address last objective. Research variables were grouped in the respective sections of the questionnaire with the order and details as given below:

1. Thirty two research variables grouped in the section '*Knowledge Management Awareness and Commitment*',

2. Thirteen research variables grouped in the section '*Introduction to Knowledge Management Strategies*',

3. Eighteen research variables grouped in the section '*Introduction to Tools and techniques for Knowledge Management*',

The recorded data of the questionnaire was analyzed statistically by using MS Excel and SPSS, and then Mean Score and RII for research objective which were on Likerd scale was measured and compared for CI stakeholders. While the case study discussion was summarized in the light of literature review to meet objectives.

6.2 Discussion

6.2.1 Main Questionnaire

This research survey was one of the first steps towards documenting the perceptions of local construction industry for KM, its strategies, tools and techniques and to formulate the emerging issues associated with KM. The data obtained from main questionnaire suggested that KM is being implemented in almost all constructions firm. However, it is not specifically known with the name of Knowledge Management. All construction firms are interested to store and share past experiences on timely and effectively.

6.2.1.1 General Characteristics

a) *Respondent's Profile*:

According to the collected data, the respondents to this survey were employees of engineering / consultancy, contractor owner firms/ organizations with the varied professional experience in the field of construction (Fresh to more than 15 years of professional experience) and holding the positions in their Firms/Organizations of Managing Director, Project Director / Manager, Project Engineer, Contract Manager, Site Manager, Site Supervisor and Quality Control Manager.

Majority of the respondents (27%) were playing role equal to Project manager in their organization followed by the role of site manager (24%). With regard of the qualification of the respondents, 63% were Graduate Engineers with majority followed by 30% Post-graduates.

b) *Organization Profile of the respondents*:

The type of the Firms / Organizations participated in this survey were engineering / Consultancy, Contractors and client/ owners. As a whole, respondents from 40 construction firms from all over the Pakistan were contributed in the survey. Majority of the participants were from client/ owner organizations (47%) followed by contractors (28%) and engineering/ consultant firms (25%).

c) *Nature of the collected data***:**

The valid collected data was based upon the multi-dimensional questions of the questionnaire survey. Out of 42 research variables 26 variables were measured against likerd scale while 16 variables were measured against predefined answers based upon literature review. The data was analyzed to check validity and it was observed that the *p*-values for all research variables which were on likert scale were less than 0.05 or 0.01. It was also observed that correlation coefficient was positive and significant at α = 0.01 or α = 0.05.

The significance values in normality test were observed to be 0 which were less than 0.05 pretending that the received data was not normal (non-parametric) in nature which raised the necessity of conducting non-parametric tests for further analysis. Keeping in view the results it is confirmed that the received data have significant correlation, a higher degree of internal consistency, and is non-parametric in nature, which is reliable and valid for further analysis.

6.2.1.2 KM Awareness and Commitment:

After the data analysis, the following were the outcomes about the general perception of CI stakeholders with regard of Knowledge Management which was the first objective of this research:

a) *Meaning of Knowledge Management:*

This question was measured against two pre-defined options. First option was depicting the perception of Knowledge Management as a system of record keeping only. The purpose behind was to evaluate the level of local perception about Knowledge Management. It is evident from literature review that record keeping is not the whole KM but a small part of it. The second options was evaluating KM as a system for identifying Knowledge, optimizing it with respect to the organizational needs and then reuse it on appropriate time and location.

Frequency analysis was conducted on the collected data. It was evident that more than 80% of the respondents were of the opinion that KM is not just record keep by a complete system of identification, optimization and reuse of knowledge which is generated during any knowledge activity

b) *Effectiveness of Knowledge Management:*

The question was measured against likerd scale. Eleven variables were presented in front of the respondents to evaluate the variables which show maximum improvement with the application of KM. When the results of research variables for effectiveness of KM System were ranked through Mean Score (MS) and Relative Importance Index (RII) to compare the perception of the stakeholders individually and from each other, the following outcome were summarized:

I)   General / Specialty Contractors and Engineers / Designers have ranked 'delivery time reduction' at the top while Clint/ Owner have ranked "Decision making Improvement" at the top. Followed by three variables "Time reduction", "Cost Cuts" and "Decision Making Improvement" where remained very close to each other.

II)   In overall ranking for effectiveness of KM in all variables "delivery time reduction" remained on top with close competition with cost cuts, time reduction and decision making improvement.

Kruskal-Wallis (K-W) test was carried out comparing the outcome of all the stakeholders and no significant difference in their opinion (as $p > 0.05$) was found from each other which showed that they have the similar general awareness about Knowledge Management effectiveness in various fields.

c) *Knowledge as a strategic asset:*

This question was measured against two pre-defined options. First option was depicting that the Knowledge Management is considered as a strategic asset. The purpose behind was to evaluate that whether the construction firms are interested to consider KM as an asset which is to be planned in systematic way or otherwise. The second options was opposite of the first one depicting that Knowledge is not such an important asset which may be planned in more sophisticated way and consume companies resources such as time, manpower and money.

Frequency analysis was conducted on the collected data. It was evident that more than 65% of the respondents were of the opinion that Knowledge is a strategic asset, which

means it should be planned and manage in systematic way like other important assets of the construction firms.

d) *Cause of Costly Errors in construction firm with regard of Knowledge:*

This question was measured against seven variables having two options (Agreed/Disagreed). First was depicting that the 'insufficient technological knowledge' causes costly errors. The purpose behind was to evaluate the general perception about the impact of technological knowledge upon costly errors in construction. The second was 'loss of knowledge of vital importance' to check the impact upon costly errors in construction. The third was 'insufficient knowledge about competitors' to check the impact upon costly errors in construction. The fourth was 'insufficient knowledge about customers' to check the impact upon costly errors in construction. The fifth was 'insufficient knowledge about processes' to check the impact upon costly errors in construction. The sixth was 'Employees cannot interpret or use available information' to check the impact upon costly errors in construction. The seventh was 'Knowledge unavailable when needed' to check the impact upon costly errors in construction.

Frequency analysis was conducted on the collected data. It was evident that 85 respondents were of the opinion that 'Insufficient knowledge about processes' leads to costly errors in construction firms, followed by ' Insufficient Knowledge about customers' being the second most effective reason of costly errors with regard of Knowledge in construction firms. 'Insufficient technological knowledge' was remained on third in this race.

e) *Missing Business opportunities:*

This question was measured against two options (Yes/No). First was depicting that the non-utilization of available knowledge is a cause of 'Missing out of business opportunities' in Pakistani construction Industry. The purpose behind was to evaluate the general perception about the importance of KM in context of new business opportunities. The second was reverse of the first one.

Frequency analysis was conducted on the collected data. It was evident that 59% of the respondents were of the opinion that insufficient knowledge affects the tendency of getting

new business in construction industry. However, the opinion that construction firms can't get new business in the absence of sufficient knowledge was failed to get very big score.

f) Obstacles in developing KM system

This question was measured against six different variables. The purpose behind was to identify the obstacles which are retarding the implementation of KM in Pakistani construction industry. First was depicting that the 'Change of mentality needed to use these systems' which was closely related to cultural change. The second was 'Time and cost' retarding the implementation of KM. The third was 'Less participation from top management' retarding the implementation of KM. The fourth was 'People attitude toward knowledge sharing' retarding the implementation of KM. The fifth was 'NO incentive program' retarding the implementation of KM. The sixth was 'Non availability of technical infrastructure' retarding the implementation of KM.

Frequency analysis was conducted on the collected data. It was evident that 46% respondents were of the opinion that the big hindrance in implementation of KM system in Pakistani construction industry is "People's fear to share what they know". Behind the scene, people feel more secure if they have something new. Therefore, they hesitate to share it with other fellows, to maintain their importance among fellows. This requires cultural change with incentive programs and appreciations tied with new ideas. Second big obstacle (37%) was 'change of mentality to use these' system which is again a cultural issue. This depicts that Pakistani construction firms require knowledge sharing culture to successfully implement KM systems.

Above discussion is evident that Pakistani construction industry does consider the preservation of their knowledge assets and understand the consequences of miss managing Knowledge. To implement Knowledge management systems into Pakistani construction firms, favorable cultural ground is required which will be only possible with continues improvement and with the passage of time.

6.2.1.3 Introduction to knowledge management strategies

After the data analysis, the following were the outcomes about the Knowledge Management strategy in Pakistani construction firms which was the second objective of this research:

a) *Existing status of KM system*

This question was measured against four different variables. The purpose behind was to identify the current status of KM in Pakistani construction industry. First was depicting that the 'respondent's firm has proper Knowledge Management system'. The second was 'currently there is no KM system available, but we are working on one or two dimensions to manage knowledge' showing firm's strong inclination towards KM. The third was 'No, but we are considering the possibility' showing weak inclination towards KM. The fourth was 'No, and not planning to have one in future' showing no interest in managing company's knowledge.

Frequency analysis was conducted on the collected data. It was evident that 63% respondent's firms have not implemented complete package of Knowledge Management Systems at the moment. However they were working to implement KM system completely ASAP'. Which was showing that majority of the respondents firms have strong inclination towards implementation of KM. From the collected data, 17% result was depicting firm's weak inclination towards KM System implementation. While 15 respondents like from NESPAK and KRL have quoted that their organizations have develop some systems to manage Knowledge asset up to some extent.

b) *KM Meetings schedule*

This question was measured against four different variables. The purpose behind was to identify the frequency of Knowledge sharing meetings. First was depicting that the respondent's firm conduct Knowledge sharing meeting on 'weakly bases'. The second was on 'quarterly bases. The third was on 'monthly bases'. The fourth was 'no proper schedule of such meetings'.

Frequency analysis was conducted on the collected data. It was evident from the results that 74% respondent's firms conduct meetings on "monthly" basis which are considered main source of sharing and managing Knowledge. These meetings produce valuable knowledge which is based mostly upon the firms experience during the last month. Staff meets with each other during such meetings and gets new experiences which ultimately increase the tacit knowledge of construction firms. Followed by 12% of the respondent's firm do not conduct meetings on regular basis.

c) Importance of people, process and technology

The question was measured against likerd scale. Three variables were presented in front of the respondents to evaluate the variables which show maximum improvement for their firms with regard of managing Knowledge. When the results of research variables for importance of people, process and technology were ranked through Mean Score (MS) and Relative Importance Index (RII) to compare the perception of the stakeholders individually and from each other, the following outcome were summarized:

I)   General / Specialty Contractors have ranked '*Process*' and ' *Technology*' as the most important in managing knowledge awhile Clint/ Owner and Consultants have ranked '*people*' at top most important in KM.

II)   In overall ranking for importance of people, process and technology with regard of Knowledge Management, "people" remained on top with close competition with other two variables i.e. 'Technology' and 'Process'.

Kruskal-Wallis (K-W) test was carried out comparing the outcome of all the stakeholders and no significant difference in their opinion (as $p > 0.05$) was found from each other which showed that they have the similar general awareness about importance of people, process and technology for managing Knowledge.

The above discussion indicates that construction industry stakeholders have the perception that KM systems are not yet completely implemented in construction industry however Knowledge is being managed in multiple domains in a non-systematic way and construction firms are lean towards implementation of system to manage company's knowledge assets. Main event of knowledge sharing is monthly meetings which are held on regular bases in majority of the respondent firms. People are considered most important asset for Knowledge Management in Pakistani construction firms.

6.2.1.4 Introduction to Tools and Techniques used for Knowledge management

After the data analysis, the following were the outcomes about the tools and techniques used for KM in Pakistani construction firms, which was the third objective of this research:

a) *Tools used for KM*

This question was measured against twelve different variables. The purpose behind was to identify the most successful tool for management of knowledge in Pakistani construction industry. Variables are given below;

E-Mail: It is used for communication from one participant to another. No matter how far they are, the delivery speed remains independent. In this technique, the drafter may address one or more participants at a time. Internet & intranets are prime source for delivery of this technique.

Intranet: It is the organizational own network of sharing information. It comprises of multiple local networks which combines to provide internal communication system irrespective of the external traffic. Usually these systems of communication are considered more secure. The organization has all rights of this system.

Internet: It is the network that ranges the whole glob. It is combination of networks of the network and covers the whole world. It contains bulk of information which is less secure w.r.t the intranet. Communication through internet is beyond the boundaries of the organization.

Communities of Practices: This comprises of a group of people who have similar background experience and are working in the same field. They join each other in the form meetings, get together and share their experiences with each other. "It is through the process of sharing information and experiences with the group that the members learn from each other, and have an opportunity to develop themselves personally and professionally (Lave & Wenger 1991)".

Video Conferencing: It is a method of more accurate communication in which the participants may have not only the audio contact but they can see each other visually & live. This method is based upon internet or intranet facility.

Data Bases: It is a well arranged set of information which contains bulk of data on a specific field. The data bases are formed on internet or intranet. The user can get latest and bulk of information as he/she connects to relevant data base.

Decision Making Tools: different tools used for making decisions on complicated and important issues like cost benefit analysis, etc.

Small group Meetings: two or more members may join on an issue to discuss it and explore it based upon their knowledge by sharing.

Training & Education Plans: Training and education plans to keep up to date with latest technology in relevant field.

Consultancy: out source of knowledge may be hired for energizing the firm's data bank with latest technology in relevant field.

When the results of research variables were ranked through Mean Score (MS) and Relative Importance Index (RII) to compare the perception of the stakeholders individually and from each other, the following outcome were summarized:

I)   All stakeholders were agreed that 'e-mail' and 'intranet' are most effective tools for managing Knowledge in Pakistani construction industry. While 'internet' remained on second most effective tool for KM. 'Database' was also an effective tool in view of General/Specially contractors.

II) As a whole 'e-mail' was the most useful tool for management of knowledge in Pakistani construction industry. While 'Intranet' and 'internet' remained on second and third most effective tool for KM, respectively.

Kruskal-Wallis (K-W) test was carried out comparing the outcome of all the stakeholders and no significant difference in their opinion (as $p > 0.05$) was found from each other which showed that they have the similar general awareness about KM tools.

b) *Responsible for Knowledge Management*

This question was measured against three different variables. The purpose behind was to identify the key personnel who is responsible for knowledge management. Option one was that the top management is responsible for KM while option two was that departmental mangers are more responsible to manage firms knowledge. Option three was that KM is every one's responsibility.

Frequency analysis was conducted on the collected data. It was evident from the results that 78% respondent's were of the opinion that KM is responsibility of the departmental manager followed by 20% respondents thinking it as a job of top management.

c) *Knowledge Manager*

This question was measured against three different variables. Frequency analysis was conducted on the collected data. It was evident from the results that 55% respondent's firms have specified staff member which is managing knowledge in addition to his/ her other duties and is not full time devoted for knowledge sharing followed by 38% respondent's firms which have neither Knowledge manger no any specified staff member for KM.

The above discussion indicates that in Pakistani construction Firms emails are considered most effective tool for knowledge management. While for implementing KM systems departmental mangers are deemed overall responsible. So for as the appointment of knowledge manager is concerned, most of the construction firms in Pakistan have no separate Knowledge manager for KM, instead few staff members are made responsible for such activities.

6.2.2 Case Study

The fourth objective of the research work was to identify the emerging issues associated with Knowledge management in Pakistani construction firms. To address this objective a case study of the client/ owner organization was conducted. Incorporating the findings from the case study, five paradigms have been developed. They are as follows: management of organizational knowledge, management of project knowledge, management of professional knowledge, the role of IT and the role of HRM.

6.2.2.1 Managing Organizational Knowledge

Identifying the different KM processes has proven to be a challenging undertaking, particularly as there is considerable overlap between processes. "Given the fluid nature of knowledge, as identified by Davenport and Prusak (1998) and the constructivist perspective discussed by Schwandt (1994) where knowledge is continually being shaped and refined through interaction with others in a variety of social processes, it further compounds the ability to distinguish between these apparently discrete, yet complex interrelated processes".

"From an organizational perspective, much of the literature refers to a wide variety of activities which feed into these processes, such as reliance on accumulation of individual knowledge, long-standing agreements with suppliers, post project reviews to capture lessons learned, transfer of people in different activities, formal and informal feedback, informal networks and collaboration, reliance on Departmental / divisional heads to disseminate knowledge and the use of IT tools to support information sharing and communication (Kamara et al., 2002b)". Whilst a number of these activities are evident elsewhere within this chapter; in this section it is intended to discuss the various processes further in relation to the identified activities.

a) Creating Knowledge

The most important process in knowledge management is to create new Knowledge. It is always challenging to formulize centralized system for knowledge creation in construction organization due to its stratified nature. "The constructivist perspective indicates that knowledge is 'created' or constructed through a variety of social processes (Schwandt, 1994)". It could be argued that CPD allows professionals to 'create' new knowledge; particularly as "Egbu et al. (2005) argue that it is concerned with adding value to previous knowledge, such as developing new skills and competencies of employees". Roscoe (2002) talks about CPD in the context of 'developing' technical and managerial knowledge, a theme which was discussed by the Director from Case Study, in terms of the range of CPD he undertakes including management training, researching new method of executing jobs and reading technical literature; "it's a multi-faceted thing."

As a project perspective, "Kazi et al. (2005) and Orange et al. (2003) stated that, through the daily problem-solving process on construction sites, specialist and technical knowledge is created which is socially constructed". "According to Nonaka and Takeuchi, (1995), creating knowledge in a purposeful manner is typically concerned with innovation". Some evidence of this was provided by the Senior Engineer A, "when I was in Divisional HQ, things were a bit quiet and they were wondering about new materials and new processes, and I had to do a bit of investigation of them, visiting other sites, local market and factories, ring people about it."

b) *Finding Knowledge*

In view of Offsey (1997) KM should improve awareness of where to find knowledge within the organization. The main focus with regard to identifying knowledge in Case Study centered on 'people knowledge,' which, according to Egbu and Robinson (2005), consist of knowledge which deals with the skills, the characteristics of staff and the inherent alliances and relationships with suppliers, clients, subcontractors, consultants, universities etc. In this regard, "Bolisani and Scarso (1999) discuss the importance of general understanding; information about who knows what and who knows how".

Based on the survey in Case Study, staff fined it relatively easy to identify people knowledge within their own workplace and HQ; it was might because of the long term commitment of staff with the organization. Another determining factor in this regard, was that locations were not very much diversified, as the services are limited to one already established specialized setup. The less diversified the sites, the more people they get to know; thus their ability to identify expertise increases. The Supervisor in Case Study, admitted that they were able to identify such knowledge in many cases as they know each other very well.

Whilst many of the participants in Case Study admitted to contacting senior managers to find people knowledge, some felt that an online people finder would be more useful. However, it was agreed by majority of the staff that due to security reasons it may not be possible to share complete detail of all staff online. While shot details like name, contact detail and expertise may be share within the division on K-drive for identification of the right person with right skills. "Egbu et al. (2005) confirm that skills databases can prove useful in identifying people with specific skills, particularly knowing who to contact when there is a problem". One element that could potentially feed into such a tool is the ACRs,

which both organizations conduct with all staff. "These are useful, particularly as they allow an organization to measure an employee's accomplishments over a period of time (Wiese and Buckley, 1998)".

c) *Capturing Knowledge*

Capturing knowledge is concerned with transforming tacit knowledge into explicit forms, through documentation (Egbu et al., 2005). While Hussain and Lucas (2004) focus on capturing best practices, the area of lessons learned practices is focused on capturing project experiences, successful or otherwise, in order to avoid the repetition of previous mistakes (Carrillo, 2005b, Kartam, 1996).

Considering LL practices, the challenge of both identifying and capturing lessons can be extremely difficult, with tools such as post-Job reviews and debriefing used in this regard (Disterer, 2002, Kartam, 1996). Case Study utilize post-Job reviews to identify and capture lessons learned on their projects, with the Director commenting "It is not possible to capture all lessons at the end of the job. It is therefore, if we capture only major lessons at end of the job, then I think it's a good work". In Case Study the Senior Engineer is held responsible to document any new experience after completion of every work package and update it on K-Drive. The concept of 'loss of context is particularly relevant in relation to capturing knowledge.

While Smith and Rupp (2004) confirm that it is difficult to develop metrics of knowledge, the appraisal process is an area that both the literature and findings identify for capturing staff's 'knowledge' in relation to their experience, training, previous projects etc. A further area where synergy could be achieved in this regard is the recording of CPD which is required by professional bodies.

d) *Storing Knowledge*

For Egbu et al. (2005), storing knowledge involves recording valuable experience in electronic form. One of the most important organizational resources in this regard is the intranet, which, according to Payne and Sheehan (2004) is "widely used as the single point of access to an organization's knowledge."

Case Study uses a central server known as the 'K-Net' to support the storing and filing of organizational resources and information, which the Director views as "excellent, there isn't a big paper trail." Storing knowledge is an art and it is always difficult to choose between what is exactly relevant and what should be discarded, as the time over. In Case Study it is the responsibility of Senior Engineer to update any new information on K-Net Lesson Learned Database folder at completion of work packages. However, it is observed that no one is responsible for discarding unnecessary information or out of date information from the LLDB folder. Which will lead huge junk of information after time and will ultimately increased search time.

In Case Study it is observed that the LLDB folder is full of explicit knowledge which is mostly refined from tacit knowledge and lesson learned. This source is strongly effective if arranged under the supervision of responsible person.

e) *Sharing Knowledge*

The sharing of knowledge is one of the very important processes associated with KM, having a no. of activities in this area. The previous phase of the research identified a wide variety of such activities, which were categorized as either formal or informal. A number of these activities including site visits, workshops and seminars, meeting with peers, mentoring, email, meetings, conferences, informal communications and social activities were discussed by the case study participants.

• Site Visits: Case Study reported the staff visits to other sites as a useful method of sharing knowledge, although these visits were undertaken on an ad-hoc basis. The more experienced employees used their contacts within the organization to arrange such visits; however, a number of respondents felt that they got chance of visit to other site for some specific job which was related to their work. However, during visit, miscellaneous useful information was captured. Site visits are proved to be particularly useful in the early stages of a project, when there was a need to find out about a specific aspect of a project, such as bathroom pods and roof insulation system Case Study.

• Workshops and Seminars: a variety of workshops and seminars are organized by Case Study. Seminars are conducted on lessons learned, which allows for interactive discussion. The survey in Case Study found that almost a third (31.3%) attended between 5 and above seminars annually and found them useful. The role and level of

experience of participants was a recurring issue, with the Director in Case Study commenting, "they get people at similar levels together, when they wouldn't normally get together and they give people a chance to learn from others, from the experience of others"

• Meetings: It was noted that regular meetings are conducted in Case Study organization. It was felt by the Director that meeting is a good toll for sharing Knowledge. It helps to provide participants to achieve mutual consensus on issues and reduces chances of miscommunication. The Dy. Director had initiated weekly meetings for the site team as an opportunity to share knowledge on all aspects of the project. Sharing knowledge with peers forms an important part of KM, particularly in geographically dispersed construction organizations, where opportunities for such interaction can be limited. The survey in Case Study found that, of those respondents who met with their peers on a regular basis (48%), the majority reported such interaction as beneficial to their work, particularly in terms of discussing those problems which occur time and again after a regular time interval, new construction techniques and company news. Those who did not have an opportunity for meeting with peers indicated a desire to do so.

• Mentoring: transferring knowledge from experienced staff to the less experienced through mentoring is important for developing the organization's future leaders (Mondy and Noe, 1996; Scandura et al., 1996). It was reported during Case Study that using mentoring for graduates, which was linked into their graduate development program. The Dy. Director B in Case Study suggested that such an arrangement can be beneficial to the mentor as well

• Email: the use of simple applications such as email to aid KM was discussed by Egbu et al. (2005). Email is now one of the most widely used forms of communication. On construction sites, email appears to be predominantly used by project staff based in the site office, with foremen and site engineers generally reporting a low level of use. In Case Study, access to email was not very much easy because of security issues. Emails were processed though organization's intranet facility.

• Informal Communications: many of the participants spoke about finding out about something through word of mouth, based on a network of contacts that they have built

up over a period of time. Again, time spent working with the organization would seem to influence the ability of an employee to use informal channels of communication, such as telephone or email to contact colleagues. The directed stated, "We regularly take tea immediately after lunch, collectively and discuses routine issues in an informal environment. Our tea team includes Director, Dy. Directors, Senior Engineers, and Assistant Engineers.

• Social Activities: Case Study has special consideration for arraigning sport events on yearly basis. All divisions of this organization have their teams for cricket, football, badminton, and squash. These events invariably lead to staff discussing work-related issues. In Case Study, the Dy. Director A admitted that "most people I know in the Cork office, I know them through the golf society"

6.2.2.2 Managing Project Knowledge

Lessons learned practices have emerged as an appropriate method for managing project knowledge. Within this section, case study organization is initially discussed separately, focusing on evaluating existing LL practices in Case Study and then in relation to improving the implementation of LL practices and the development of a paradigm model.

a) *Evaluating Existing LL Practices*

The staff survey in Case Study reported a low level of use of the LLDB, while the interviews confirmed a number of challenges in adopting LL practices in construction previously identified in the literature review including:

• Loss of Context: the Senior Engineer B in Case Study admitted that in attempting to document LL it was difficult to capture the context, which presented a challenge when delivering LL presentation that he was not familiar with

• Out-Of-Date: one of the main problems identified in the Case Study survey, was the currency of the LL on the database; it is suggested by "Davidson (2006) that existing LL should be regularly reviewed to ensure accuracy, reliability and relevance". This would also help to identify and delete unnecessary data early in time.

• Difficulty in Using the LLDB: some of the site-based staff, including the Site Engineers, Foremen and Supervisors, admitted that they did not have the time to sit at a computer searching the LLDB. Such 'pull' methods leave the burden on the individual to search the LLDB, whereas Weber and Aha (2002) contend that 'push' methods could deliver LL to relevant staff based on their role, interests, training and experience which may include letter of information, display on notice boards and pre-job meetings.

• Information Usefulness: the perceived usefulness of the LL in relation to an individual's current job responsibilities, as identified by Voit and Drury (2006), was a recurring theme during the Case Study interviews. For example, the Senior Engineer who had been involved in setting up the database, stated that many of the lessons were relevant to the foremen, whilst the Director, and Dy. Directors reported using the LLDB at various stages during the project

• Experience: with regards to the LL seminars, the Contracts Manager viewed them as useful, if people with similar experiences participated. During the management presentation in Case Study, the involvement of younger, less experienced staff in the LL process was discussed, which, according to the Director, led to "a surprising amount of detailed suggestions came up."

• Fragmentation: Fisher et al. (1998) contend that overcoming departmental silos and fragmentation in large construction organizations is one of the main reasons for implementing LL practices; it was found that LL are not shared within Case Study at lower staff level

In general, the use of both an LLDB (codification) and LL seminars (personalization) appears to work well; however, as Dixon (2004) notes, further integration of technology and social processes is required to help the organization to overcome some of the above problems.

b) The Lessons Learned Process

Having evaluated the LL practices of Case Study the following are some of the main issues observed relating to the LL process:

• Collection: "it is acknowledged by Disterer (2002) that the identification and capture of LL is an extremely difficult process: the Director from Case Study felt that only the main lessons will be captured at the end of a job". "The sought input type collection process as identified by Fisher et al. (1998) seems to be the best method for collecting LL". The Senior Engineer A told about an old employer that this employer considered that the staff should submit LL after completing main tasks, as part of their job. For effective collection of LL, it is very important that the senior managers provide their moral, time and monitory support. Presence of highly senior staff in LL meetings lubricates the wheel of LL process.

• Analysis: After capturing the LL, most important process is to analysis these lesson that whether these lessons are factually true. "Furthermore, the documentation of LL requires consideration of the following: title; information on its source and context, and its classification for easy retrieval (Kartam, 1996)". In Case Study, all LL are entered into a standard template and checked by the LL manager to ensure sufficient contextual information. A LL report was developed for Case Study which included a description of the job, the job team contact details, a list of stakeholders and a brief description of the main LL. It was the view of the research participants that such a structure was worthwhile, particularly as most people would be more inclined to contact the relevant person to follow-up on specific queries

• Dissemination: "one of the biggest challenges in disseminating LL through pull methods such as a database is the distribution gap, as identified by Weber and Aha (2002)". Dissemination through LLDB is a pull method of communication in which user is expected to get information by itself from a single source. Keeping in view the human psychology, dissemination must be supported with push methods of communications. "The need to retrieve the lesson quickly, and by multiple parameters, is something that Kartam (1996) identifies as a key component of LL practices". "As well as using LL for training, Davidson (2006) suggests that they should be incorporated into business processes, and be used to develop checklists".

c) *Improving the Implementation of LL Practices*

Many of the challenges discussed in Case Study contribute to communication gap, which can occur because LL practices are not linked to organizational policy, users may not

know or forget about the database, and users may not have the time or skill to retrieve and interpret textual lessons, and subsequently apply them. In order to address some of these issues, a number of suggestions are offered including:

• Integrate LL into existing work practices: make LL practices part of people's work and organizational procedures, including tendering and contract procedures, health and safety, quality, reporting, and performance appraisals

• Incorporate major lessons into company policy: any major conclusions derived from experience should be "taken forward as organizational policy"

• 'Push' lessons to relevant people: while a number of interviewees acknowledged that they do not use the LLDB, there is potential to 'push' relevant LL to them via print format i.e. on notice boards or through letters and they may be asked to read and reply with comments, based upon their role, interests, training and experience

• Provide training: deliver regular refresher training on the use and benefit of LL practices

6.2.2.3 Managing Professional Knowledge

We have discussed the specific issues with regards of individuals including their role, educational qualification, experience and workload. Given the close alignment of CPD practices with the individual, this has also been considered from the perspective of the construction professional, with elements of the CPD category. Within this section, the role and level of experience of the individual will be given due consideration, particularly the potentially important role of middle managers.

The participants in Case Study represent a variety of different roles which commonly occur in construction organizations, including: Directors, Dy. Directors, Senior Engineers, Quantity Surveyors and Supervisors. The individual's role dictates their responsibilities and level of involvement within construction projects.

The survey in Case Study found a relatively high level of respondents with a third level qualification. Of the eight project team interviewees, five have a third level qualification,

whilst the remaining three (who work in supervisory roles) have trade certificates. Those with third level qualifications also reported holding membership of Pakistan Engineering Council.

With regards to Case Study, the project team interviewees had a range of experience, with both Supervisor A and B having 20 and 22 years industry experience respectively. Senior Engineer A & B has experience of 15 & 10 years in the construction industry. All interviewees were 'veterans,' with a minimum experience of 10 years industry experience of Senior Engineer B. It is worth noting that significant experience does not prevent further learning; with 22 years' experience Supervisor B admitted that he continues to learn about construction.

"The complexity of experience and its pervasiveness is something which, according to Grisham and Walker (2005), spans locations, cultures, languages, technical expertise, education and political experiences, and encompasses people skills and attitudes". "Leonard and Swap (2005) posit that the sharing of knowledge between individuals is dependent upon experience and individuals possessing similar frameworks, domain knowledge and prior experience". Discussion elsewhere has identified a number of different areas where experience holds influence, including engagement in CPD, performance appraisals, site visits, mentoring, use of IT, engagement in LL practices and identifying expertise within the organization. Overall this indicates that experience has an important role to play in managing knowledge.

a) *Engagement with Continuing Professional Development*

According to Shipton and Shackleton (1998), in terms of CPD, the support and encouragement of the individual's line manager is very important, a view confirmed by the Senior Engineer A in Case Study, who praised the Dy. Director as being "proactive on our CPD, if you ask for something you've no problem getting time off." Roscoe (2002) identifies professional body recognition, credibility with employers and colleagues, improving job performance, and developing capacity for career progression as the main reasons for individuals to undertake CPD.

A lack of time, geographical dispersion, reluctance to change and lack of interest were cited as the main barriers to the uptake of CPD by Thomas et al. (2006). The impact of time

pressures featured prominently in Case Study, with the Dy. Director B stating, "for a construction company there is a constant battle between trying to get the job done and the area of continuing professional development."

One of the main inhibitors of engagement with CPD identified in Case Study was the location of CPD activities. With the work site based in Kahuta, and CPD activities taking place in the Islamabad, it proved challenging for staff to commit to travelling to CPD events. To overcome these issues, the Dy. Director B suggested that "there should be more CPD done on the site."

The potential use of the company's intranet in overcoming geographical dispersion was discussed. Senior Engineer B stated that the intranet would appeal to younger professionals that could act as CPD for younger staff, the intranet would be an excellent and easy way to enhance tendency of individual interest in CPD." In this regard, Best et al. (2005) found that e-learning solutions had been used to improve CPD engagement for geographically-dispersed dental practitioners.

In transferring knowledge from experienced to less experienced staff, both Mondy and Noe (1996) and Scandura et al. (1996) contend that mentoring is particularly useful in developing the future leaders of an organization. With 60% of the Case Study survey respondents indicating involvement in the company's mentoring scheme.

Training is viewed as one of the main CPD activities, with Case Study having "a separate section of HR Division who inform to all Divisions about ongoing concerned trainings in different cities of Pakistan and facilitate nominees for successful training completion which is particularly good for the younger staff," according to Director.

In Case Study, It is stated by Dy. Director that it is very difficult to assess that who one is actually beneficial for the organization after getting training, as the no. of employees left the division after they got expensive training on organizational behalf. Such training also includes the higher study program, nominee for M.Sc. and PhD in relevant disciplines.

Again, the areas of training seem to change as the individual becomes more experienced, with the Senior Engineer B "more external trainings, chairing meetings, motivation and delegation and I'm down for another one, conflict resolution." These soft

skills, according to Smith and Rupp (2004), form an important part of the development of future leaders.

Regardless of the level of experience, Supervisor A (from Case Study) was of the view that training is important for keeping up-to-date with new developments, stating that it is good to keep abreast of, because times change.

According to Grisham and Walker (2005) participation in CPD activities can provide the benefit of informal learning through discussions with colleagues. This was a view confirmed by a number of interviewees from both case studies, particularly for staff who had been with the company for some time. For example the Dy. Director B in Case Study, who has been with the company for 16 years commented, "at seminars and lessons learned talks, inevitably there's some informal chat, because I might meet somebody that I haven't seen for 6 months or a year, or more and we catch up on what's happening."

b) *The Effects of Experience on Engagement with CPD*

Both Buck and Newton (2002), and Rothwell and Arnold (2005) identify age and experience as having an influence on engagement with CPD. This was a theme discussed in Case Study by Director, who spoke about the different approaches to training and CPD depending on experience, "generally there are different types of training depending on the level you are at within the company." He also identified the individual's role/discipline having an effect on engagement with CPD. Again, this is a view confirmed by Maxwell-Hart and Marsh (2001) who suggest that different approaches to CPD are required depending upon the individuals experience and management level.

For younger staff, CPD has charm because of fast learning as well as recognition with professional body and career progression. The survey respondents from Case Study in the 18 – 25 age brackets rated a 'good training and development program' as their most important non-financial motivational factor. Such program can typically be categorized as high level knowledge production, which is concerned with discipline-specific, scientific knowledge.

Once younger staff gain experience and become professional, the main focus of CPD appears to be upon skills conversion (from engineer to manager), which the Director in

Case Study discussed in detail, "one of our biggest challenges is converting them from engineers into managers, giving them proper training to switch from a technical work system to a management work system."

The more experienced professionals spoke of their CPD as being more self-directed, with Dy. Director B in Case Study confirming this view. Whilst Rothwell and Arnold (2005) contend that less experienced practitioners have a higher uptake of CPD, both the Dy. Director B and Director were of the view that as staff become more experienced, it is difficult to get suitable training for them. "It appears that as an individual gains experience and progresses through the management levels, their training and development needs change, requiring different approaches to both CPD and KM. Junior staff are more concerned with 'gaining experience' and are typically involved in high level knowledge production(Gibbons et al., 1994)".

c) *The Important Role of Middle Managers in KM*

"A number of authors view the middle level of management as being crucial to KM-related activities (Nonaka and Takeuchi, 1995; Mohamed et al., 2004; Davenport and Volpel, 2001)". This correlates with the earlier findings from the senior manager interviews, where middle managers were found to have a 'filter up-down effect' within the organization. In this regard, the Senior Engineer A and B from Case Study viewed themselves as "the hub" in terms of communications and knowledge sharing between their project team and head quarter. They also holds a central role in a number of KM-related activities, including conducting performance appraisals with site-based staff, capturing lessons learned, reviewing the LLDB when commencing projects, mentoring less experienced staff, delivering seminars to other staff, and researching new building systems and products.

Senior Engineers in the Case Study were purposely selected based to evaluate the importance of middle managers in KM. The following comment from the Director reflected this, "if you get the knowledge in to the guy leading a project team, the Senior Engineer, it then filters down." Apart from the Director, the other six mangers were all deemed to be 'middle managers,' based on the management levels proposed by Maxwell-Hart and Marsh (2001). With all participants having 10 years or more experience of working with Case Study, and significant industry experience, from a constructivist perspective, it was

perceived that these individuals would have similar concepts, models and schemes relating to the management of routine jobs/ minor works.

6.2.2.4 Use of Information Technology

Case Study confirmed some issues regarding connectivity between remote sites and the head office IT infrastructure, in general "the platform for implementation of KM technologies such as email, an intranet and people finder, is in place (Al-Ghassani et al., 2005)". In addition to the widespread use of Office applications, the findings from Case Study confirm the prevailing use of email as a communication tool, both within the organization and externally.

Whilst a lower level of computer access on sites was identified, this appears to be due to the fact that not all site-based staff uses computers on a regular basis. Apart from Supervisor B in Case Study, who was heavily involved in coordinating finishes, and Supervisor A, reported spending most of their time 'out on site' as opposed to in the site office on a computer. Those who used IT on a more frequent basis have identified email and Office as their main applications.

An intranet is viewed as an important KM technology, providing a single point of access to an organization's knowledge across geographically dispersed construction organizations (Payne and Sheehan, 2004, Al-Ghassani et al., 2005). Case Study has implemented an intranet, known as the K-drive, which acts as a central source for correspondence, project documentation and lessons learned.

In discussing the use of a people finder/skills database to identify expertise within the organization, many of the participants expressed an interest in the adoption of such a tool. In discussing the use of such technology, the Directors from Case Study felt there was merit in it, particularly in identifying expertise in other locations, a view echoed by the Quantity Surveyor in Case Study. The participants in Case Study also recognized the potential of such a tool, particularly if it was linked to the LLDB. Rather than connecting people with information, such an approach could encourage the sharing of tacit knowledge as discussed by Payne and Sheehan (2004).

6.2.2.5 Role of Human Resource Management

Both Gourlay (2001) and McDougall and Beattie (1998) suggest that HRM specialists have an important role to play in KM initiatives with regards to both formal training (mode 1 knowledge production) and informal learning (mode 2 knowledge production) strategies. The findings from Case Study suggest that the HR Division is actively involved in managing CPD activities, liaising with professional bodies, organizing inductions, and overseeing the performance appraisal process.

Mondy and Noe (1996) and Fowler (1990) agree that induction is an important process for ensuring that new employees adjust to the company, their job and work group, settle in effectively, and become productive as quickly as possible. Topics covered should include general company information, policy and procedures, introduction to other employees, safety and job requirements, and should involve both the HR function and the employee's supervisor or senior manager (Mondy and Noe, 1996). Case Study has an induction for new employees which typically lasts three hours and covers general company information, safety, quality and the K-drive. It was suggested that induction information could be posted on the company's central server for staff to refer to after the induction.

The main focus of ACRs relates to performance planning and goal setting, pay increases, promotion and transfers, training and employee development, and feedback and counseling (Cleveland et al., 1989, Longenecker, 1997). Whilst Case Studies A have annual performance appraisals for staff, it was primarily the project team interviews in Case Study which focused on this. The Director of Case Study cited the link between training and development and pay increases through the appraisal process, "we find with having that structured approach once a year, it's written down, and people are slow to come back the next looking for a raise, if they haven't done their training." This is a view shared by Shipton and Shackleton (1998), who state that a performance management system should promote a culture of learning and development, and recognize and reward those who actively participate in such activities.

The Director from Case Study uses the appraisal to review his staff's progression, "where they are going and whether they are staying on the technical side of things or drifting to the management side of things." This, according to Wiese and Buckley (1998) is a trait of an effective manager who will try to motivate, direct and develop their subordinates.

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Both the Dy. Director and Quantity Surveyor spoke about the value of reflection and self-evaluation as part of the appraisal process. The latter described appraising an individual's knowledge as "very good for people that want to move up or gain more knowledge." While it is reasonable to suggest that appraisals could have a potential role in KM, developing metrics of knowledge is a difficult task, particularly as much professional knowledge is substantially tacit, making it impossible for workers to articulate (Smith and Rupp, 2004). There is evidence to suggest, however, that criteria such as communication skills, product knowledge, attitude, initiative and aggressiveness, enthusiasm, knowledge of competition, time management and motivation should be in the appraisal process (Pettijohn el al., 2001). Indeed, evidence from Chapter 4 indicates that criteria such as job knowledge, problem-solving, team-building and communications are already being used in the performance appraisal process.

The interviews yielded both positive and negative feedback on ACRs. The Dy. Director B viewed the ACRs as "essential," with Senior Engineer B indicating improved motivation, commitment and satisfaction. On the negative side, Senior Engineer A felt that the follow up on training was lacking. Similar to mentoring, there appeared to be differences with regards to the running of ACRs, with both Quantity Surveyor and supervisor B.

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Based upon this research work following conclusions are drawn,

a) Knowledge Management is identified as a system for identification, optimization and reuse of Knowledge generated during any knowledge activity.

b) Knowledge management is considered most effective in delivery time reduction of the construction projects

c) Knowledge management is considered as a strategic asset in Pakistani construction firms

d) Insufficient knowledge about the processes is cause of costly errors in construction firms with regard of Knowledge.

e) Insufficient knowledge affects the tendency of getting new business in construction industry.

f) Big hindrance in implementation of KM system in Pakistani construction industry is "People's fear to share what they know". People feel more secure if they have something new. Therefore, they hesitate to share it with other fellows, to maintain their importance among fellows. In order to successfully implement KM, cultural change is very important along with incentive programs and appreciations tied with new ideas.

g) Majority of construction firms have not implemented complete package of Knowledge Management Systems at the moment. However they were working to implement KM system completely ASAP'.

h) Construction firms conduct meetings on "monthly" basis which are considered main source of sharing and managing Knowledge.

i) People are considered most important as compare to process and technology for managing Knowledge in construction firms.

j) E-mail was the most effective tool for managing Knowledge in Pakistani construction firms.

k) Departmental manger is considered responsible for implementation of KM systems in construction firms

l) Majority of construction firms have specified staff members which are managing knowledge in addition to their other duties and are not full time devoted for knowledge sharing.

Building upon the findings of the Case Study, the emerging issues associated with KM in the Pakistani construction organizations have been consolidated into five paradigm models as follows:

a) Managing Organizational Knowledge: now seen as a critical resource, due to the nature of the construction industry, and the inherent characteristics of these organizations, in developing a more formal approach to KM there is a need to consider resources, culture, the nature of knowledge and senior management support, amongst other things. Whilst it must be acknowledged that much knowledge is 'managed' in an unplanned manner, there are a variety of formal strategies associated with creating, capturing, analyzing, storing, findings and sharing knowledge, the development of which can lead to improved organizational performance

b) Managing Project Knowledge: one of the main areas of concern to construction organizations is the management of project knowledge, the loss of which can lead to reinventing the wheel and repeating mistakes across the organization. The adoption of lessons learned practices can aid the management of specialist technical, management and performance knowledge. The nature of construction projects inhibits the capture of important lessons learned, with other factors such as intra-organizational fragmentation, perceived usefulness of the LL, and the need for an effective process also having an effect. A combination of human interaction and IT tools appears to be the preferred approach to lessons learned, with the lessons captured during a post-project review being subsequently verified by an expert and stored on a database. The lessons should also be integrated into existing work practices and become part of company policy where relevant. Whilst the adoption of such practices should lead to improvements in organizational performance, it is

imperative that the engagement of staff in the entire process is given careful consideration

c) Managing Professional Knowledge: as construction professionals progress through their careers, their learning and development needs change, moving from formal training towards mode 2 knowledge production (which is socially generated and anchored in practical, context-specific here-and-now problems). The individual's age, background, role and experience, the presence of a supportive learning environment, and visible senior management support, all have an impact on engagement with CPD. There are a variety of both formal and informal activities which are recognized as CPD, which can deliver benefits not only to the individual, but the organization also. Middle managers have been identified as having a central role in managing knowledge within construction organizations, through their involvement in a range of CPD and KM related activities

d) The Role of Information Technology: IT has a role to play in facilitating KM within the Pakistani construction organizations, overcoming some of the challenges of geographical dispersion and intra-organizational fragmentation and aiding the connection of people within the organization. The use of an intranet as a central source of information could potentially facilitate a people finder/skills database, a lessons learned database and online CPD activities; whilst email could aid the sharing of information/explicit knowledge across the organization. However, the use of such technologies may not have a positive effect if there is a tendency for information overload. It should also be recognized that site-based staff such as Foreman and Site Engineers tend to use IT on a less frequent basis than their counterparts who are based in an office

e) The Role of HRM: the selection, recruitment, retention, rewards and development of construction professionals is of great concern to the Pakistani construction organizations. The HRM function, which typically oversees such issues, is also responsible for formal training, informal learning strategies, managing staff records, identifying expertise, and managing performance appraisals and inductions. The effective deployment of these can facilitate the use of available knowledge, and encourage people to learn more effectively

Subsequent discussion identified significant overlap and interrelationships between all of these paradigms, whilst also highlighting the need for additional exploration of the role of HRM

7.2   Recommendations for implementation of Knowledge Management

The following general recommendation which could be taken in the light of this research work:

a) All stakeholders should be motivated through workshops to implement KM systems.
b) In order to evaluate the benefits of KM small pilot projects may be initiated.
c) The outcomes of pilot projects may be shared with industry for better awareness.
d) Best practices for KM may be taken as a guideline for Implementation of complete KM system..
e) KM should be included as Core subject in MS level program in Construction Engineering and Management.
f) Academia and PEC should establish standard formats and templates for documentation construction industry's Knowledge
g) Government should also encourage the implementation of Knowledge Management in construction Industry.

7.3   Contribution to Body of Knowledge

This research work would contribute:

a. In understanding the local awareness about the importance of knowledge management in construction firms
b. To help the construction firms to understand the benefits of KM
c. To provide better knowledge of KM framework in local environment
d. To learn more sophisticated use of project management
e. To understand how effectively Pakistani construction firms are managing their knowledge assets

7.4　Recommendations for Future Research

The following are the general recommendations for future research work:

a) A study may be conducted to explore the benefits of Knowledge management by comparing the outputs of two similar type of constructions (i.e. Commercial Constructions) executed by two different contractors

b) A study on KM may be conducted at industry level. The interest expressed in KM by CI Stakeholders will act as a catalyst for the encouragement and maturity of KM across the construction sector in Pakistan.

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Appendix I

(Covering Letter)

Research Survey for evaluating the knowledge management practices/ perceptions of Pakistani construction firms

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Attention: Designers, Engineers, Consultants, Contractors and Facility Owners

Date: March 15, 2014

Respected Industry Members:

This is Engr. Khalid Farooq, has been taking graduate classes at National University of Science and Technology (NUST), Islamabad to obtain a Masters of Science in Construction Engineering & Management (MS CE&M) with an emphasis in Knowledge Management. I am currently working on my research Thesis at NUST to fulfill my degree requirements. The research topic of the dissertation is **"Evaluation of knowledge management practices/ perceptions of Pakistani construction firms"**. This might be a good opportunity to get feedback from respected industry members who are practicing and involve in the above mentioned areas of construction industry, especially any experience related to KM which you feel is most practical and applicable to our industry.

Please take a moment to complete the enclosed questionnaire survey. The purpose of this survey is to begin to gather information about KM awareness, company's strategies and importance of various tools and techniques used for managing knowledge. This survey may be followed by a possible telephone interview for those respondents indicating that they would be willing to participate further in this study. All the provided information will be kept confidential and be used only for this research and academic purposes.
After you have completed the survey, please return it via e-mail to myself at khalid_engg2000@yahoo.com or fill it online at the attached link.

Again, I appreciate your participation in this important research project for our industry. If you have any question about the survey or research project, you may contact me by telephone at 03216029803 or e-mail at khalid_engg2000@yahoo.com.

Thank you in advance for your help and support.

Sincerely,
Engr. Khalid Farooq

MS (CE&M) Candidate, March 2014,
Department of Construction Engineering and Management (CE&M),
National Institute of Transportation (NIT),
School of Civil and Environmental Engineering (SCEE)
National University of Sciences and Technology (NUST)
Sector H 12, Islamabad, PAKISTAN

Appendix II

(Main Questionnaire)

A. Respondent's details

Name _____   Designation: _____

Role: _____   Date: _____

Tel.: _____   E-mail: _____

No of employees: _____ Company _____

Section B. Knowledge management awareness and commitment

1. What does knowledge management (KM) mean to you?

☐ A system for keeping office record of all correspondences i.e. letters, progress review meetings, minutes of meetings and drawings etc.

☐ A system for identification, optimization and reuse of knowledge which is generated during any knowledge activity.

2. Qualify the effectiveness that KM can offer your firm in the Following aspects:

	Extremely Beneficial	Very beneficial	Quite beneficial	Not very beneficial	Not at all beneficial
Decision-making improvement	☐	☐	☐	☐	☐
Efficiency improvement	☐	☐	☐	☐	☐
Group work improvement	☐	☐	☐	☐	☐
Product/service improvement	☐	☐	☐	☐	☐
Costs cuts	☐	☐	☐	☐	☐
Flexibility improvement	☐	☐	☐	☐	☐
Delivery time reduction	☐	☐	☐	☐	☐
Time reduction	☐	☐	☐	☐	☐
Customers and	☐	☐	☐	☐	☐

suppliers' relation
improvement

Quality improvement ☐	☐	☐	☐	☐
Employees' experience ☐ exchange	☐	☐	☐	☐

3. Does your company recognize knowledge as a strategic asset?

☐ Yes

☐ No

4. Are you personally aware of any situation in your organization in which costly errors or mistakes were made because of insufficient knowledge?

☐ Yes

☐ No
If you have answered Yes, were they caused by the following reasons?

Insufficient technological knowledge	☐ Yes ☐ No
Loss of knowledge of vital importance	☐ Yes ☐ No
Insufficient knowledge about competitors	☐ Yes ☐ No
Insufficient knowledge about customers	☐ Yes ☐ No
Insufficient knowledge about processes	☐ Yes ☐ No
Employees cannot interpret or use available information	☐ Yes ☐ No
Knowledge unavailable when needed	☐ Yes ☐ No
Repetition of previous errors	☐ Yes ☐ No

5. Do you believe you may be currently missing out on business opportunities by failing to successfully exploit available knowledge?

☐ Yes

☐ No

6. What are the obstacles to developing a KM system?

☐ Change of mentality needed to use these systems.

☐ Time needed and high cost of implementing a KM system.

☐ Low involvement of top management.

☐ people's fear of sharing what they know.

☐ Lack of an incentive system.

☐ Lack of the technological infrastructure needed for its implementation.

Section C. Introduction to Knowledge management strategies

7. Is there any kind of knowledge management system available in your organization?

☐ Yes. There is a KM system available.

☐ There is no KM system available at the moment. But we are working on one.

☐ No. but we are considering the possibility.

☐ We have no KM system and are not planning to have one.

8. What is the frequency of group meetings for mutual knowledge sharing in your firm?

☐Weekly

☐Monthly

☐Quarterly

☐Such meeting are not held in our firm

9. How important are people, processes and technology within your organization in their contribution to a KM system?

	Extremely Beneficial	Very beneficial	Quite beneficial	Not very beneficial	Not at all beneficial
People	☐	☐	☐	☐	☐
Technology	☐	☐	☐	☐	☐
Processes	☐	☐	☐	☐	☐

Section D. Introduction to Tools used for knowledge management

10. How effective are these tools within your organization?

	Very effective	Effective	Not very effective	Ineffective beneficial	Not Used
E-mail	☐	☐	☐	☐	☐
Intranet	☐	☐	☐	☐	☐
Internet	☐	☐	☐	☐	☐
Communities of practice	☐	☐	☐	☐	☐
Video-conferencing	☐	☐	☐	☐	☐
Databases	☐	☐	☐	☐	☐
Decision-making tools	☐	☐	☐	☐	☐
Brainstorming sessions	☐	☐	☐	☐	☐
Small group meetings (2–4 people)	☐	☐	☐	☐	☐
Training and education plans	☐	☐	☐	☐	☐
Consultancy	☐	☐	☐	☐	☐
Monitoring of projects/ services by clients	☐	☐	☐	☐	☐

11. Who is overall responsible for knowledge management activities in your company?

☐ Top management

☐ Department manager

☐ Others. Please state:_____

12. Is Knowledge Manager designated in your company?

☐ Yes

☐ No

☐ Some are working for knowledge management in addition to their other duties officials

Appendix III

(Case Study Questionnaire)

1.0   General Information

1.1   Job Title: _____

1.2   In your work, are you generally based:

On-site   ☐   In head office   ☐   Between both   ☐

1. 3   What is your age range?

18-25   ☐   36-45   ☐   56-65   ☐
26-35   ☐   46-55   ☐   65+   ☐

1.4   How many years have you been working:

For PJ Hegarty   _____yrs   In Construction   _____ yrs

1. 5   What educational qualifications do you hold?

None   ☐   Secondary Level   ☐
Trade Qualification   ☐   Certificate   ☐
Diploma   ☐   Degree   ☐
Post Graduate   ☐   Other   ☐

If Other, please state: _____

_____

2.0   COMPANY SEMINARS

2.1   On average, how many in-house seminars would you attend in a year (i.e. those run and presented by staff)?

None   ☐   1-4   ☐
5-9   ☐   10+   ☐

2.2   What factors do you think make these seminars worth attending? Please rank in order of importance from 1 to 5, with I being the most important, 5 being the least important.

Its's a good way to meet colleagues   ☐
You get to see the experiences of others   ☐
There's always good discussion and interaction   ☐
The content is always interesting   ☐
They allow me to improve in my own work   ☐

3.0   PERSONAL DEVELOPMENT

3.1   Upon joining the company, did you attend a company induction?

Yes   ☐   No   ☐

3.2   Do you have a mentor within the company?

Yes   ☐   No   ☐

If yes, what is their position?   _____

3.3   Are you a mentor to anyone within the company?

                     Yes   ☐   No   ☐

If yes, what is their position?   _____

3.4   Please indicate the areas you have received training in, and whether the training was in-house (by the company) or external (e.g FAS, college, training company, supplier, etc.). please tick all the apply.

	In-House	External
Health & Safety	☐	☐
First Aid	☐	☐
Quality Management	☐	☐
Environmental Management	☐	☐
Communication Skills	☐	☐
Project Management	☐	☐
Materials Management	☐	☐
Surveying/Setting Out	☐	☐
Computer Skills	☐	☐
Technical Training	☐	☐
People Skills	☐	☐
Other	☐	☐

If Other, please state: _____

_____

3.5   Other than financial incentive, how important are the following in motivating you in your work?
(Tick the box under the initial that applies.   VI=   Very Important;   I = Important; NI =   Not Important).

	VI	I	NI
Job Security	☐	☐	☐
Good training and development programme	☐	☐	☐
Personal contact with Directors	☐	☐	☐
Responsibility to work on you own initiative	☐	☐	☐
Being part of a team	☐	☐	☐
Recognition of you skills and talents	☐	☐	☐
Other	☐	☐	☐

If Other, please state: _____

_____

4.0   COMMUNICATIONS

4.1   Please rank the following communication tools in order of effectiveness in the various situations (i.e your workplace, other sites and head and regional office), with I being most effective and 5 being least effective.

	Phone	Chat	Email	Fax	Meeting
Example	2	5	1	4	3
Your Workplace					
Other sites					
Head Office					
Regional offices					

4.2   In relation to computers and technology, do you think that:

	Yes	No
Too much information is being sent by email?	☐	☐
Computers and used effective in the company?	☐	☐
You are sufficiently trained to use computers?	☐	☐
Systems are developed without your input?	☐	☐

5.0   Lessons Learned

5.1   Do you think that the lessons learned database is of benefit to you **in your current position?**

Yes ☐   No ☐

5.2   How often do you refer to the lessons learned database? Please tick all that apply.

Never	☐
Very rarely	☐
When a new subcontract package starts	☐
When I have a problem	☐
When I have a specific question	☐
Quite often, I like to keep up to date	☐
Other	☐

If Other, please state: _____

_____

5.3   Do you Think that the lessons learned database:

	Yes	No
Is up to date	☐	☐
Is easy to access	☐	☐
Contains relevant information	☐	☐
Indentifies the key people	☐	☐
Well organized and laid out	☐	☐
Can be searched quickly	☐	☐
Is overloaded with information	☐	☐

6.0   COMPANY KNOWLEDGE

6.1   Do you meet with others in similar positions in the company, to discuss issues, problems, solutions etc?

Yes ☐   No ☐

If yes, complete parts A to C   If No. complete part D

(A)   If yes, how often do you meet?

Monthly	☐	3-4 times a years	☐
Twice a year	☐	Once a year	☐
Other	☐		

If Other, please state: _____

_____

(B)   If yes, how often do you meet?

New work methods	☐	New technologies	☐
Technical issues	☐	Recurring problems	☐
Company news	☐	Other	☐

If Other, please state: _____

_____

C) If yes, do you find it of benefit to you in your day to day work?

Yes ☐   No ☐

D) If no, would you like to have a forum to meet other people in similar positions?

Yes ☐   No ☐

6.2   If you are having a particular problem that requires the expertise of another employees, do you think that it is easy to identify these people?

	Yes	No
In your own workplace	☐	☐
On other sites	☐	☐
In head office	☐	☐
In the other regions	☐	☐

6.3   Have you ever visited another site to look at specific construction methods, new systems etc?

Yes ☐   No ☐

_____

Many thanks for taking the time to complete this questionnaire. I would be very grateful if you could return it by email at Khalid_engg2000@yahoo.com

Appendix IV

(Case Study Interview Questions)

1.0   GENERAL INFORMATION

1. 1   Maybe you could tell me about yourself, your experience in the construction industry, and some background to your current role?

1.2   In general terms, what do you think of Case Study as a company, what are they like to work for?

2.0   PERSONAL DEVELOPMENT

2. 1   Do you think that there is adequate training to support in your current position?

-     Are there any areas where you feel you could get more/better training?
-     Do you think that you're training experience and skills are fully utilized in your current role?

2.2   In meeting with one of the company directors, do you think that the annual appraisals are a worthwhile exercise?

-     Is there a need to meet with a Director?
-     How does the appraisal help you in your work?
-     Do you feel that you can have an honest and open discussion with a Director or do you find it one-sided\intimidating?

3.0   INFORMATION & COMMUNICATIONS TECHNOLOGIES

3. 1   How do you use computers in your day to day work?

-     What works well, what doesn't how could it be improved?
-     How much experience do you have of using computers?
-     What software packages can you use? (MS Office, P6, MS Project)
-     What type of training have you received in the use of computers?

3.2   Can you describe what you use email for, how often etc.?

4.0   LESSONS LEARNED DATABASE (LLDB)

4.1 Can you describe the LLDB?

-     Layout, use of photos, contacts information etc.
-     Give an example of a time when you used it?

4.2   What do you think of the LLDB?

-     Could it be improved?
-     Does it accurately reflect projects that you worked on?

4.3   How effective do you think the lessons learned seminars are?

4.4   Have you ever followed up on a lesson learned by contacting someone that was involved in a particular project?

4.5   Do you think that the LLDB actually prevents people from repeating the same mistakes?

5.0   KNOWLEDGE SHARING ACTIVITIES

5. 1   In terms of sharing knowledge and experiences, how effective do you think the following are utilized within the company?

-	Weekly site meetings	-	Site visits
-	Project reviews	-	Mentoring
-	External seminars	-	Company induction
-	Project reports	-	Other informal activities

5.2   Do you think that there's enough time given to activities like the above?
- Would you like more?
- When would be the best time to have them?

5.3   How much do you know about what is going on in other projects throughout the company? How do you find out about it?

5.4   Would you like to see an online tool to identify other within the company (other regions), based on their experience, qualifications and interests?

5.5   Do you think that others within the company are willing to share their knowledge with you?

5.6   Do you meet with others in similar positions within the company?
- Yes, how often, where, what is discussed, who organizes it?
- No, would you like to? How often? To discuss what?

6.0   PROJECT KNOWLEDGE

6. 1   In your current position, do you think that you are well informed as to how your job is progressing, in terms of cost, program and any other relevant issues?

6.2   Are there enough mechanisms in place for effective communications within the project team?

6.3   Do you think that there's enough communication with head office departments?

6.4   If you see something as being inefficient on site, are you encouraged to change the way you're doing something?

- Is there a platform or mechanism there to do that?
- Getting the job done vs. time to reflect\explore\be creative?

6.5   Do you think that there's enough time given at the end of a project to reflect upon what happened, what went well, what didn't?

6.6   Are there any areas where the company could improve?

7.0   WRAP-UP

7.1   Based on our conversation, is there anything else that you would like to add?