

THE IMPACT OF TECHNOLOGICAL CHANGES ON PROJECT MANAGEMENT AT A COMPANY OPERATING IN THE CONSTRUCTION INDUSTRY

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Abstract

This study investigated the impact that technological changes have on the construction industry. In recent years, the construction industry has been forced to investigate ways to improve the delivery of projects. Construction projects are becoming more and more complex and clients are demanding improved products and services. The construction industry experiences inefficiency problems that are caused by the dispersed nature of the organisations in the industry. This leads to poor communication and insufficient transfer of information when it is needed. This has challenged the construction industry to be more efficient, innovative and to implement and use Information and Communication Technology (ICT) tools to facilitate the improvements required. However, due to the dynamic changes in technology, many organisations have implemented ICT solutions that do not meet their needs. Project managers are expected to integrate the work of all the companies involved in a project. As a result, there is a constant need for information throughout the lifecycle of a project. Therefore, communication of project information a project is critical.

Key Words: Technological, Project Management, Construction Industry, Products, Services, Inefficiency, Integrate, Solutions, Communication

Introduction

There is an urgent need to ensure that the construction industry achieves coordination and synergies in projects that it embarks upon. The industry is very fragmented, with a wide range of industry participants including architects, consultants, contractors, technology providers, engineers, developers and owners (Ilozor and Kelly, 2011:24). The risk associated with a lack of

proper technological deployment in completing various projects engaged in by companies that operate in this industry often leads to collapse of many projects, ultimately resulting in a decline in productivity in the industry. Eventually, this may lead to slow economic growth and a lack of job opportunities.

Over the past 10 years, the East London Industrial Development Zone (ELIDZ) has acquired a number of ICT tools in an attempt to improve project delivery within the organization. Very few of these tools are being utilized effectively, and a number of them have never been used. Some of the reasons for these issues include:

- New systems not interfacing with existing systems,
- No adequate training of the end-user,
- Some systems require a large number of people to administer them, which the organization had not budgeted for,
- An unwillingness from employees to change working methods and resistance to change, and
- Inadequate technical support from the system developer.

A project management system that the organization acquired a number of years ago was found to be deficient in a variety of functional areas the organization requires. The facilities management software that was purchased from the United States of America works perfectly for Eskom, but ELIDZ cannot get it to be as effective. It requires too many human resources to operate it and does not interface well with the financial system that is currently used.

A gap has been identified in the existing research and more research needs to be done about the impact of technology on project management in South Africa and how to deploy technology in project management in order to enable firms in the construction industry to achieve coordination and synergies in various projects. Smith, Mossman and Emmitt (2011:14) have identified three areas for future research, including the environment, the organization and technology, which will help to develop a solid understanding of the effects of setting and surroundings on project success.

Objectives of the Study

The research objectives are:

- To determine whether communication exerts an influence on project management in the organization.
- To explore whether the use of inappropriate ICT in project management influences project delivery within the organization.
- To explore whether employees' attitudes influence the adoption of ICT within the organization.
- To develop conclusions and make recommendations to management regarding the adoption of appropriate ICT for construction project management.

Literature Review

The construction industry in South Africa is one of the pillars of the domestic economy. In the first quarter of 2012, the industry expanded by R4 billion to R34 billion, which translates to 0.13% of the total expansion in the economy. In 2012, employment in the industry fell to 981,000. Since 2010, the total investments in the industry per year have averaged 10% of the country's GDP (Statistics SA, 2012:441). This translates to \$34.83 billion. As these figures indicate, the construction industry is simply too important to be allowed to stagnate.

In the construction industry, the majority of the construction companies can be categorized as small and medium enterprises. The challenges facing the companies and the construction industry are extensive and include problems caused by the remoteness of the projects (Sidawi, 2011:14) and a highly fragmented industry with numerous design firms, consultants, contractors, subcontractors and suppliers involved in almost any project (Weipert and Kajewski, 2002:103). As mentioned by Bjornfot and Torjussen (2012:47), many companies are financially vulnerable as they depend mainly on few key customers and products. They are often managed in an informal way and end up in financial problems, recruitment problems and problems with development of organizational and economic management systems.

Ccommunication

Numerous definitions of communication have been suggested over the years. Eisenberg and Goodall (1993), cited in Bowden (2005:12), identify four major definitions of communication:

- Information transfer,
- Transactional process,
- Strategic control, and
- Balancing creativity and constraint.

According to the Harper (2013), communication is the activity of conveying information through the exchange of thoughts, messages, or information, by speech, visuals, signals, writing or behaviour. It is the meaningful exchange of information between two individuals or a group of living creatures. The PMBOK, cited in Burke (2007), defines project communication management as the process required to ensure timely and appropriate generation, collection, dissemination, storage, and, ultimately, disposal of project information. The process provides the critical links between people, ideas and information that are necessary for success. Ahuja, Yang and Shankar (2012:538) suggest that the effectiveness of a building project management information system (MIS) is measured by the effectiveness of all project team agencies to communicate with and provide feedback to the rest of the project team throughout the project life cycle.

A study by Chan et al. (2004:154) reveals that, for many years, different researchers have tried to determine the factors that contribute to a successful project, but the conclusions have been that there is no general agreement about these factors in the literature. The authors conducted a study to determine the critical success factors for project success by reviewing seven major journals in the construction industry. In their study, they identified 'adequate communication' as one of the variables necessary for project success.

Sidawi (2011:14) and Nitithamyong, Mirosław, and Skibniewski (2006:80), along with a number of other researchers (Egan, 1998; Guevara and Boyer, 1981; Latham, 1994; Murray and Thorpe, 1996, cited in Bowden, 2005:12), have identified communication as one of the most pressing problems that the construction industry faces. They list the major communication obstacles as the volume and feedback of the information. Sidawi (2011:14) suggests that traditional communications and information management systems cannot meet the project information and effective communication needs required by a project team. As mentioned by Nitithamyong et al. (2006:80), the fragmented nature of the construction industry has led to well-documented problems with communication. Chan and Leung (2004:935) support this view and add that coordination between various participants throughout the construction process can be a difficult task. The exchange of information between major players, such as project managers, architects, contractors and engineers, occur very frequently in the forms of letters, change orders, drawings and can create problems, which include:

- Over-loading, where more information is supplied than can be utilized,
- Gate-keeping, where information is intentionally held back, and
- Distorting, where the nature of the information is changed by adding or deleting information.

Bowden (2004:12) and Nitithamyong et al. (2006:80) conclude that effective on-site communication is retarded by a predominantly paper-based world. During the construction stage, effective communication between project participants on-site and those operating from their offices are necessary to ensure that no misunderstanding or lack of information causes delays in the completion of projects (Chan and Leung, 2004:935).

Nielsen (2008) proposes that even the best projects that deliver on time and within budget can still get a bad reputation and be perceived as a failure because the project manager did not do an adequate job of communicating project success to the stakeholders.

Motivation and Attitudes in Project Management

According to Quashie (n.d.:212) project management is defined as the discipline of planning, organising and managing resources to bring about the successful completion of specific project goals and objectives. Project management is also defined as the planning, delegation, monitoring and control of the project, and the motivation of those involved for achieving the project objectives within the expected performance targets of time, cost, quality, scope, benefits and risks (Prince, 2009:4). Brodie (1962), Nokes (2008), Dinsmore and Cooke-Davies (2005), Carpenter (1987), cited by Ko (2011:1), add that the arrangement is temporary, as is the nature of a project. This suggests that any system put in place for the duration of a project should accommodate that very nature. The construction industry, over the years, has deployed or used different tools for project management. Some of the studies in the literature review (for example, Dossick and Neff, 2010:459; Barley, 1986; Bechky, 2003, cited in Dossick and Neff, 2010:460; Ahuja et al., 2010:539) have shown how inadequate and ineffective these tools can be if they are not managed properly.

Research Methodology

Target Population

The target population included the employees from the East London Industrial Development Zone. In order to minimize bias, the survey was conducted across all the employees. The ELIDZ has 87 employees spread across the following 5 departments:

- The office of the CEO (Chief Executive Office) with 11 employees,
- Zone operations with 20 employees,
- Corporate Affairs with 25 employees,
- Zone Development with 15 employees, and
- Finance Department with 16 employees.

Sampling

Stratified sampling was used to get a sample of 20 employees from the target population to participate in the research. Names of the 87 employees were written on pieces of paper and put into a hat. Names were drawn out of the hat ensuring that the sample represented the population. Kothari (2005:152-183) proposes that sample size must fulfill the requirements of efficiency, representativeness, reliability and flexibility. Sample size is also governed by the data analysis technique to be adopted. The ideal sample was to have:

- 3 employees from the OCEO,
- 5 employees from ZO,
- 6 employees from ZD,
- 3 employees from CA, and
- 3 employees from Finance.

If a name was drawn that resulted in the numbers exceeding the requirements from a department, the name was put back in the hat and a different name drawn. This process was repeated until the ideal sample was achieved. This strategy was used because there was an accurate and easily accessible sampling frame that listed the whole population in the form of employees within the organisation included in the study. Random names also allowed for the selection of the sample without bias. In a positivistic study, it is vital to obtain a random sample to get some idea of variation and to build general conclusions (Collis and Hussey, 2009:209). Targeted respondents were the employees in the organisation.

Assembling the Data

All data were recorded using numerical codes that allowed for quick entry of the data with fewer errors. Coding of the data is shown in Appendix D. The data was then checked for illegitimate codes. Only certain numbers were allocated and other numbers, therefore, were errors. The data was also checked for illogical relationships. Tuckey's (1977) exploratory data analysis (EDA) approach was used to analyse the data. This approach emphasizes the use of diagrams to explore and understand the data, emphasizing the importance of using the data to guide the choice of analysis techniques (Saunders et al., 2012:487). The key aspects that were considered and were guided by the research questions and objectives included:

- Proportions, and
- Distributions.

Table 3.2 – Staff compliment per department.

Department	Staff compliment	%
Zone ops	20	23
Office of the CEO	11	13
Zone development	15	17
Finance	16	18
Corporate Affairs	25	29
Total	87	100

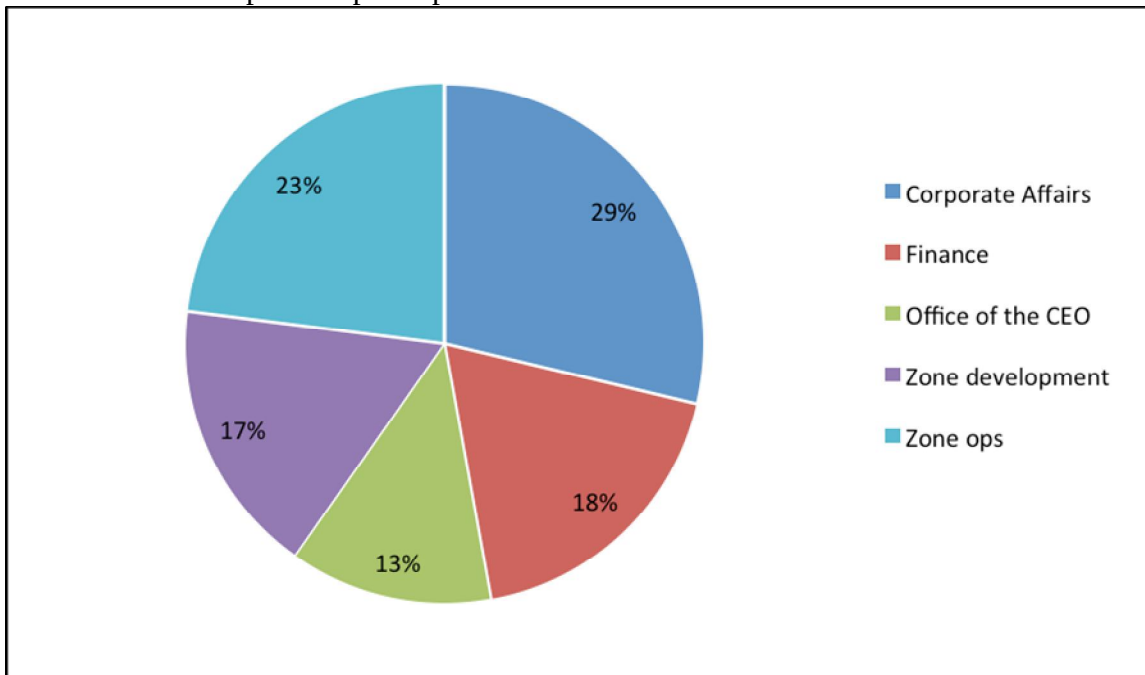
Limitations of the Research

As an internal or practitioner researcher, time constraints proved to be a limitation to the research. Combining two roles (employee and researcher) at work was very demanding, as it involved much data capturing after hours. Although this activity was not hidden from those who determined my workload, they did not appreciate the demands my researcher role made on me. For this reason, I needed to negotiate a portion of my work time to devote to my research. Not all the respondents completed the questionnaires, as 17 of the 20 distributed questionnaires were returned.

RESULTS, DISCUSSION AND INTERPRETATION OF FINDINGS

Data analysis of the questionnaires completed by the sample from ELIDZ is presented. The main objectives of this study was to assess the opinion of the ELIDZ employees with regards to the project management communication in the organization, the effectiveness of the current ICT in the organization and factors affecting the adoption of ICT in the organization.

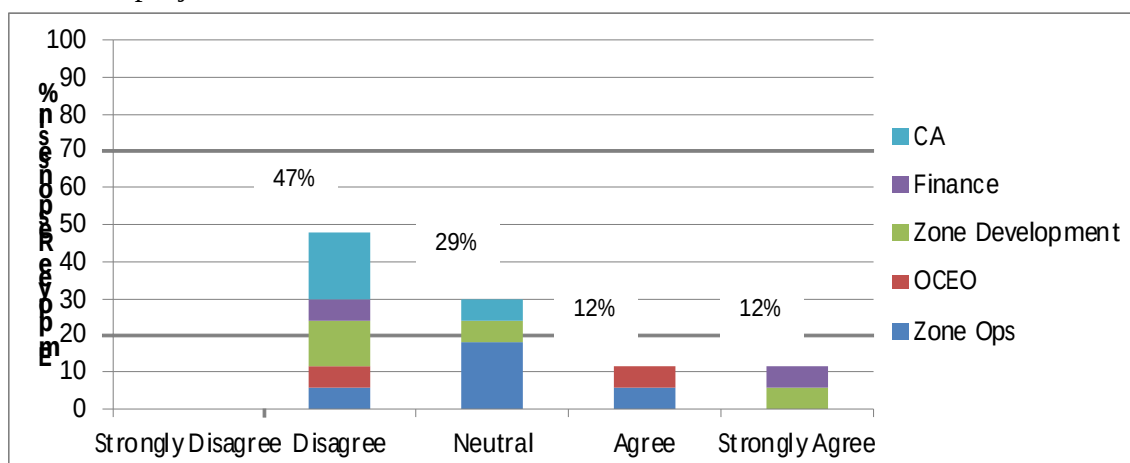
Figure 4.1 – Staff compliment per department.



Communication

The respondents' were requested to respond to 5 statements to determine whether communication exerts an influence on project management in the organization. The following 5 tables from the data analysis looked to what extent communication exerts an influence on project management in the organization.

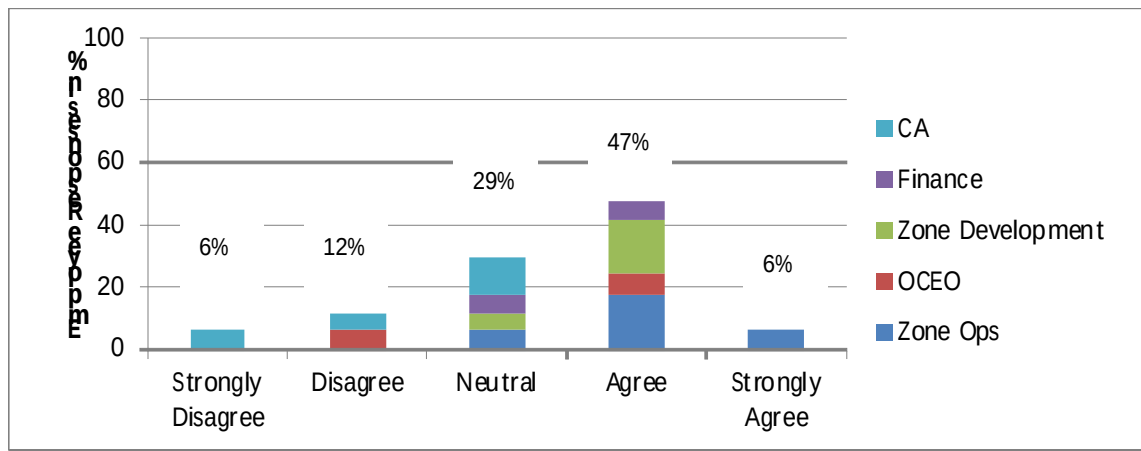
Figure 4.2 – Project management information process is effective in communicating project information to all project team members.



In Figure 4.2, above, it was found that 47% of the ELIDZ employees disagreed that the organization's project management information process is effective in communicating information to all team members. Also, 29% had no opinion, with 24% agreeing that the process

is effective. In chapter two, it was discussed that the information transfer process is critical in providing links between people, ideas and information that is necessary for project success. Figure 4.2 shows the distribution per department with most of the employees disagreeing. It is interesting to note the data also shows that most of the employees who believe the communication process to be ineffective were from the Corporate Affairs department. Corporate Affairs is the department that carries out most of the communication in the organization, as the public relations department is part of the CA department.

Figure 4.3 – Communication is a pressing problem during construction of a project.



In Figure 4.3, the data shows that 53% of the employees agreed that communication is a problem during a construction project, with only 18% disagreeing. Also, 29% of the employees had no opinion regarding the matter. The data support the Sidawi's (2011:14) and Nitithamyong, Miroslaw and Skibniewski (2006:80) findings, where they had identified communication as one of the most pressing problems the construction industry faces.

The data further shows that the distribution of the employees who agree with the statement is mostly from Zone Operations and Zone Development, the two departments responsible for carrying out construction projects. In the literature review in this study, the major communication obstacles were listed as volume and feedback of information. It was suggested that traditional communications and information management systems could not meet the need for project information and effective communication required by the project teams.

Figure 4.4 – The information management system meets the need of communicating project information to the project team.

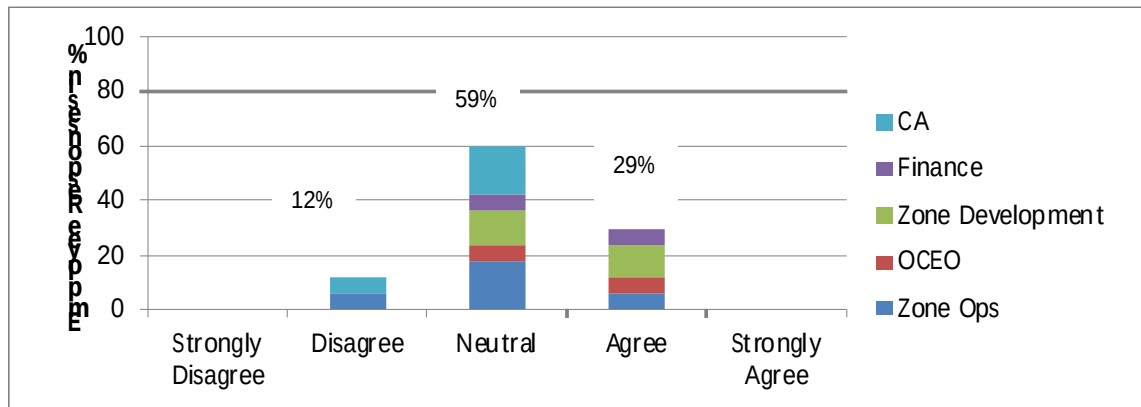


Figure 4.4 shows most of the employees (59%) were neutral regarding whether the information management system met the needs of communicating project information to the project team. Also, 29% agreed that the information management system met the requirements, with 12% disagreeing. Although the majority of the employees were neutral in this regard, more employees than not agreed that the information management system meets the needs of communicating information to the team. The difference in the opinions of the employees is explained by Guevara and Boyer (1981), who suggests that to function effectively, a construction company, must have communication systems of different types, including interpersonal, interdepartmental and interorganisational. This indicates that the information management system currently used works better for one department (Zone Operations) than it does for the other departments.

Figure 4.5 – Paper-based communication retards transfer of information within a project.

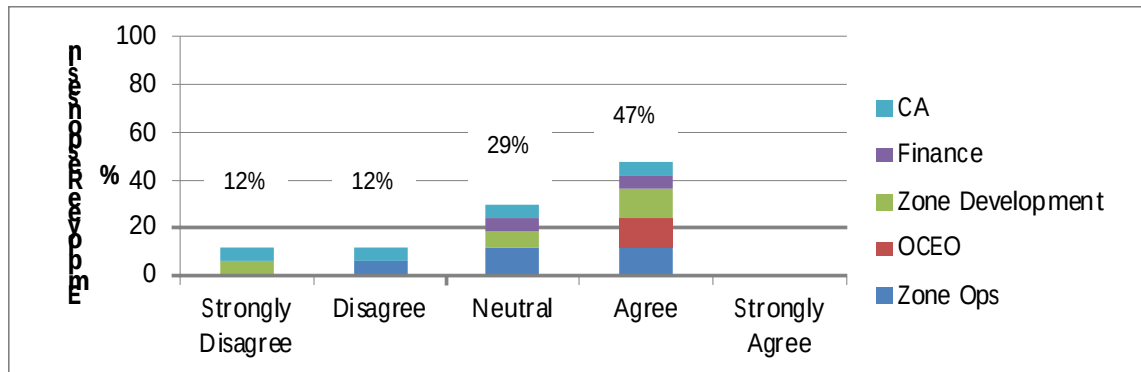
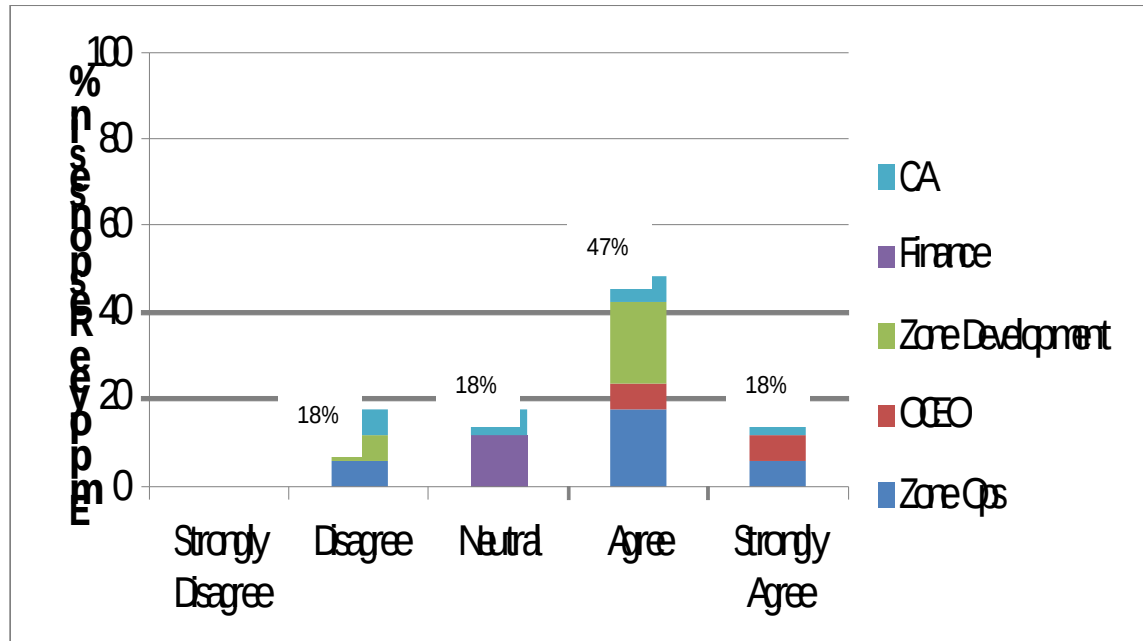


Figure 4.5 is an illustration of how most of the employees (47%) believed that paper-based communication hinders the transfer of information within a project. Also, 29% were neutral, with 12% disagreeing with the statement. The employees in the organization who agreed that the organization's paper-based communication hampers the transfer of information within a project support the studies carried out by Bowden (2004:12) and Nitithamyong et al. (2006:80), who concluded that effective on-site communication is hindered by a predominantly paper-based

world. The literature review indicated that, effective communication to occur; more effort needs to be devoted. Effective communication would assist to increase efficiencies and improve productivity and project delivery within the organization.

Figure 4.6 – Lack of information from consultants causes delays in delivering projects.



Most of the employees in the organization (65%) agree that lack of information from consultants causes delays in project delivery. It is interesting to note that 64% of those employees are in Zone Development and Zone Operations, the two departments that are directly responsible for project managing construction projects. Also, 18% of the employees disagreed with the other 18% being neutral.

Employees in Zone Operations and Zone Development, the two departments responsible for the delivery of construction projects, have the highest proportion of employees who believe that a lack of information from Architects, Engineers, Quantity Surveyors, Environmental Engineers, Mechanical Engineers and consultants, in general, causes delays in the delivery of projects.

In the context of communication, Jordaan and Jordaan (1989:42-51) state that it is important to understand a person's behaviour. Based on the literature review and this study, the importance of communication of meaningful information is very high. Communication, in the context of construction projects, is for expressing cognitive meaning through information and direction. In the same context, communication is the exchange of information or information transfer. This process starts with a sender whose responsibility it is to make sure that the information is clear, unambiguous, and completed in such a manner that the receiver will understand the intended meaning.

The dimensions of project communication, defined in chapter two, is the process required to ensure timely and appropriate generation, collection, dissemination, storage, and, ultimately, disposal of project information in a construction project are:

- Formal and informal,
- Within the project (internal) and to the customer or other stakeholders (external),
- Written and oral, listing and speaking,
- Up and down the organization (vertical) and with team members (horizontal), and
- Meeting management techniques – composing and agenda and conflict handling.

These communication factors, guidelines and techniques present solutions to the communication issues identified in the current study and related literature presented in chapter two. The communication process must be managed from the beginning of a project by informing all participants of their roles in the process and the impact of the communication breakdown in the project as a whole. According to the PMBOK (2000), it forms part of the communication plan that determines the communication and information needs of all the stakeholders, including information about who needs what information, when they need it and how it will be given to them.

Information and Communication Technology

The respondents were asked to respond to 5 statements to determine the extent to which inappropriate information and communication technology influenced project delivery within the organization.

Figure 4.7 – The introduction of Information and communication technology has improved project delivery.

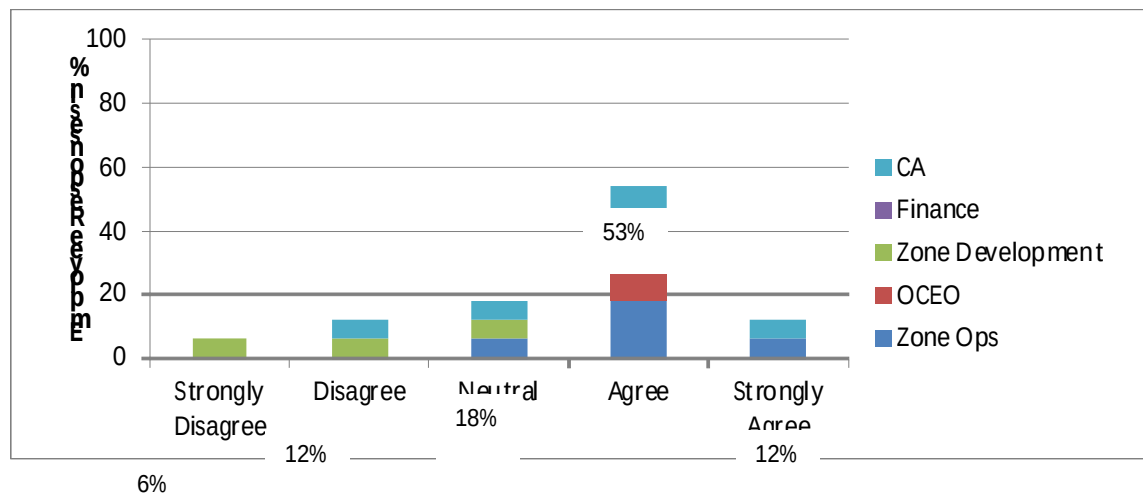
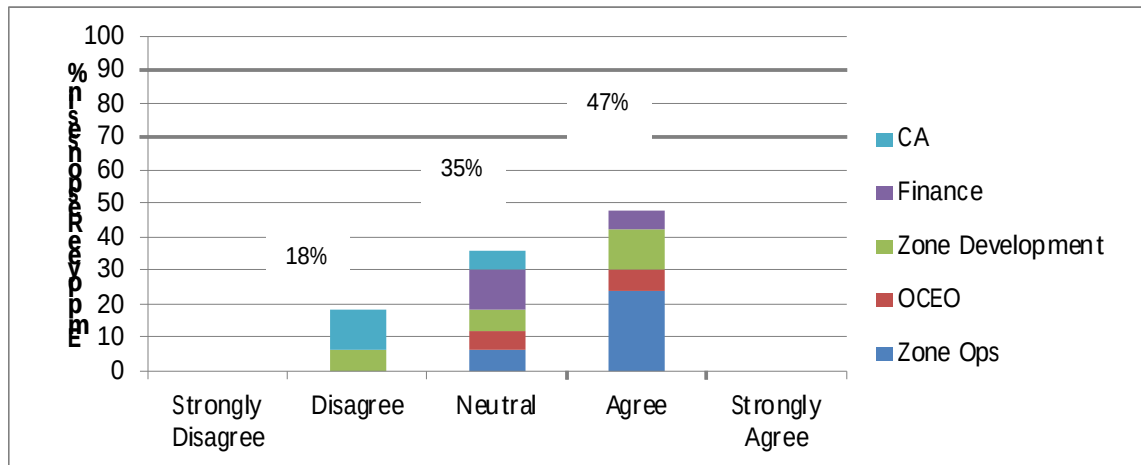


Figure 4.7 above shows that 65% of the employees agreed that the introduction of information and communication technology had improved project delivery, although 6% from Zone

Development strongly disagreed. With the introduction of information and communication technology, project members in the organization complete construction jobs on time or reduce the duration of projects. They have improved resource management and plant productivity and decreased the overall cost of projects. This has been achieved because the project managers had good access to timely and accurate information.

Figure 4.8 – The use of Information Technology in projects has improved coordination and collaboration amongst firms participating in construction projects.



In Figure 4.8 above, 18% of the employees did not agree that the use of information technology in projects has improved coordination and collaboration amongst firms participating in construction projects. This is attributed to system compatibility. The capabilities and functionality of an ICT tool must be compatible with other ICT products and ICPM systems used in the industry. A lot of employees were neutral (35%), with 47% agreeing.

This is an indication that even though implementing new ICT tools or systems can be problematic, using CPMS can solve a lot of the problems the construction industry experiences. These systems possess the ability to improve communication between project team members and to reduce some of the problems generated by fragmentation. Once again, the highest proportions of employees that agree with the statement are the two departments that undertake construction project management for the organization. The data supports the observation by Rojas and Songer (1999), who stated that the use of IT improves coordination and collaboration among firms participating in a construction project, leading to better communication practices. However, it does not agree with the study by Carrie et al. (2010:459), who found that although BIM makes connections among project members visible, it does not foster closer collaboration across different companies.

Figure 4.9 – Re-work in a project is due to insufficient and conflicting information.

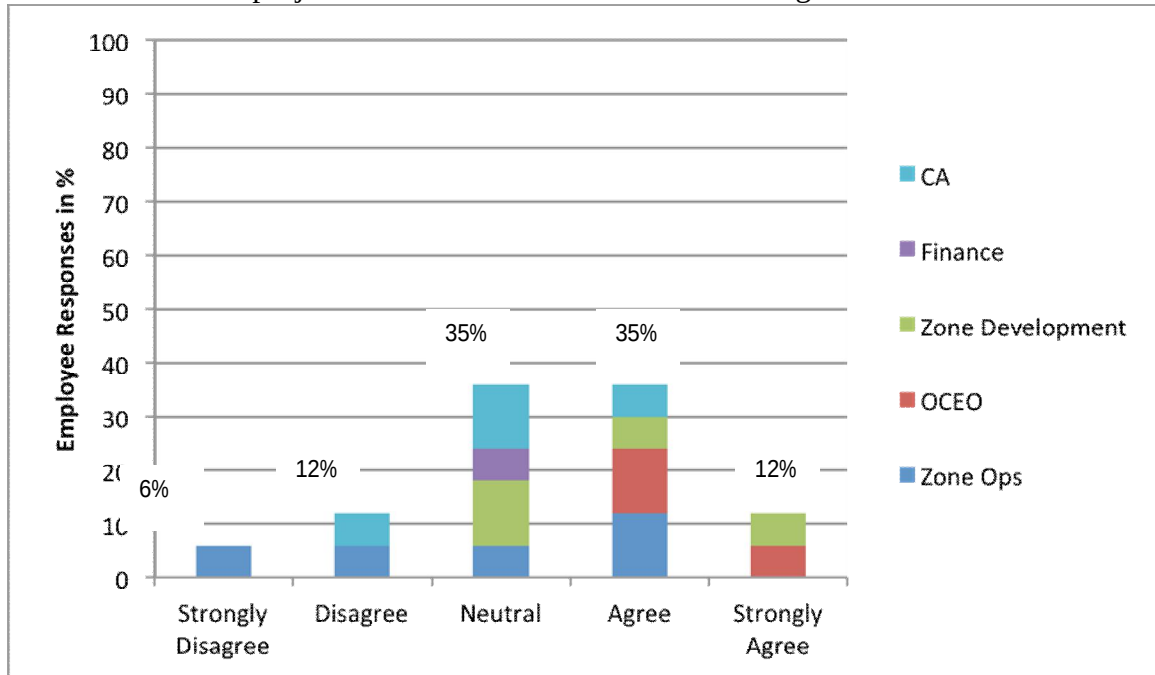
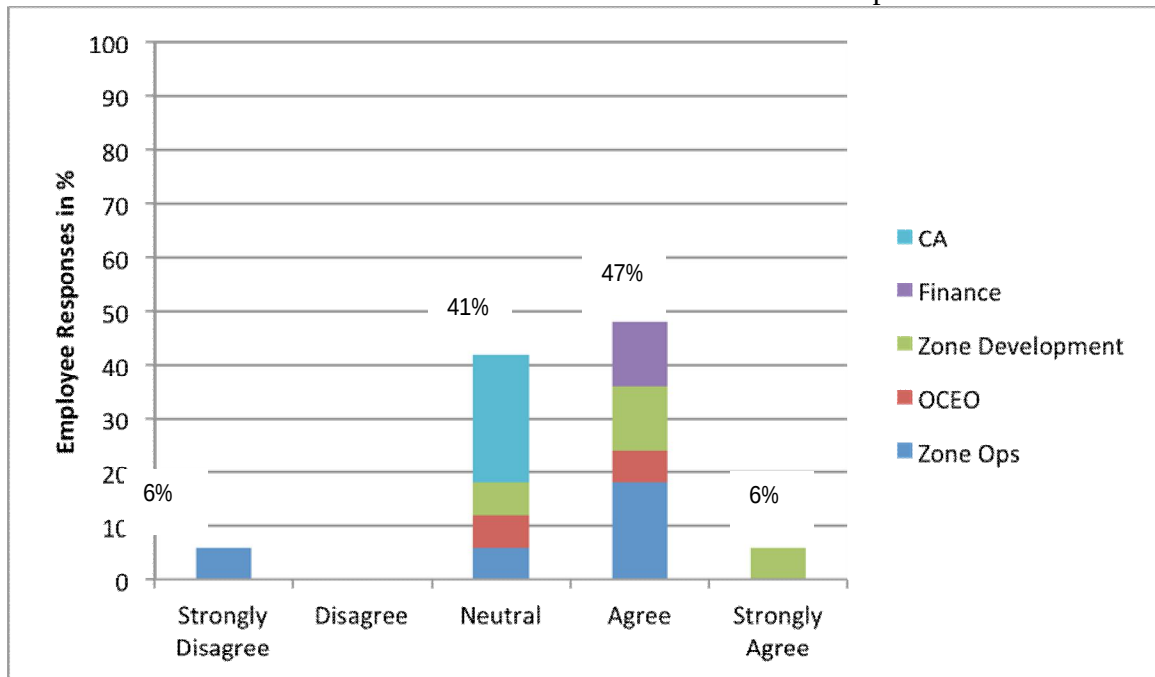


Figure 4.9 shows that 47% of the employees believed that re-work in construction projects is due to insufficient and conflicting information. Also, 35% had no opinion, with 18% disagreeing. The data supports the findings of several studies (for example, Sidawi, 2011; Baldwin et al., 1996), which found that 6% to 7% of contract expenses are attributed to failures. A study by Gallaher et al. (2004) in the United States of America estimated the time spent ensuring that the information accurately represents what is set in place is estimated at \$4.8 billion. The data show that 12% of the 47% agreed very strongly that conflicting information causes re-work.

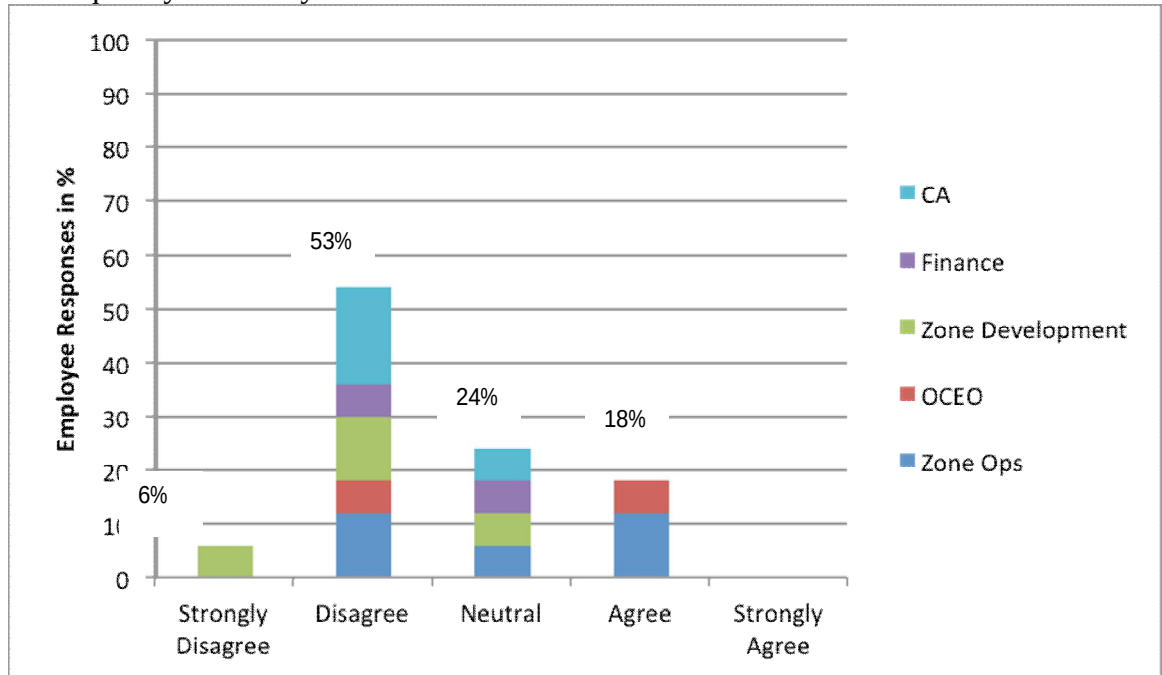
Figure 4.10 – Information retrieval and information transfer needs to be improved.



The majority of the employees was either neutral (41%) or agreed (53%) that information retrieval and information transfer needed to be improved in the organization. Only 6% felt that no improvement was required (Figure 4.10). The data suggests that even though the information is available, finding and retrieving the correct information is not always easy. There are many problems with document-based information systems, which include:

- Information overload due to ease of retrieval and downloading. The relevant information is difficult to locate, as it is buried in the midst of irrelevant information. This results in a waste of time, as decisions cannot be made timeously without the relevant information.
- Data incompatibility is another problem where drawings are drawn using different formats or software that is not compatible with the user. As a result, the user has to run different specialized applications and switch between applications to access the fragmented information.

Figure 4.11 – The existing information and communication system enables employees to share information quickly and easily.



In Figure 4.11 above, 59% did not agree that the existing information and communication system enables employees to share information quickly and easily. Also, 18% agreed with 24% expressing no opinion.

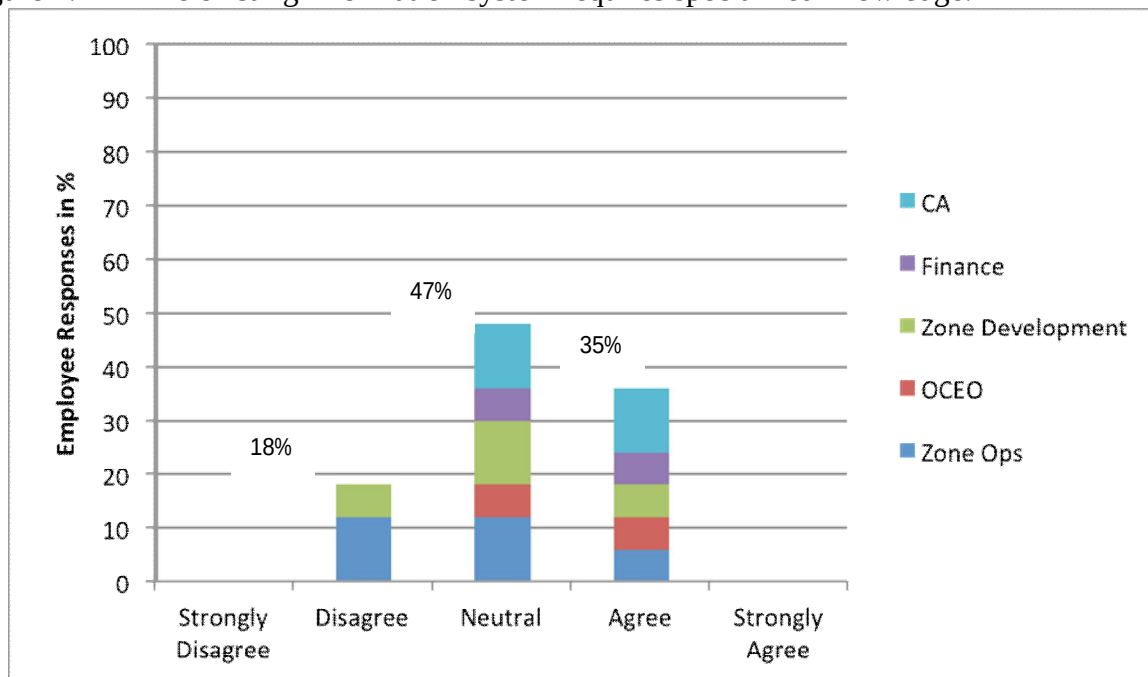
In chapter two, it was found that construction projects are becoming more and more specialized, complex and the current technology is insufficient to minimize wasteful practices. Construction companies need to do more to use ICT to solve some of these problems. The following factors are critical in helping ensure the successful implementation of ICT tools:

- Project participants want to learn to use one ICT tool for ease of understanding its capabilities,
- The capabilities and functionality have to be compatible with most other ICT systems used in the industry, with the results being saving implementation time, cost and errors,
- Ease of data entry, and
- Piloting an ICT system that has not had exposure to the construction industry should be treated as a special case and should be fully resourced with proper backing, support, and experience from developers, making sure all aspects are covered during the early stages of implementation.

Attitudes

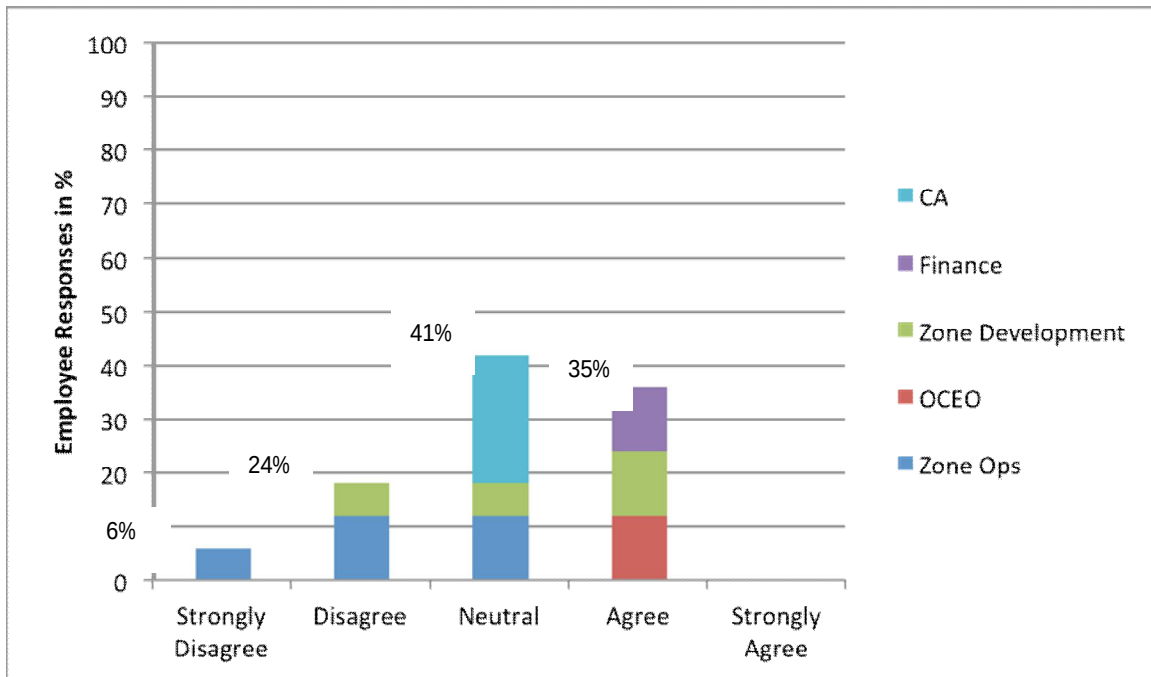
The respondents were asked to respond to 5 statements to determine to what extent employee attitudes influenced the adoption of information and communication technology.

Figure 4.12 – The existing information system requires specialized knowledge.



In Figure 4.12, 35% of the employees agreed that the existing information systems required specialized knowledge. Also, 47% were neutral and only 18% did not agree that the system requires specialized knowledge. The data seem to agree with the Technology Acceptance Model discussed in chapter two, which suggests that attitude is the deciding factor of the intention to adopt ICT.

Figure 4.13 – Employees are consulted when new information and communication technology is implemented.



In Figure 4.13, 24% of the employees disagreed that they were consulted when new ICT were implemented in the organization. More employees (35%) agreed that they were consulted than those who disagreed. The data supports a success factor identified in a study by Weipert et al. (2002:114), which was:

- Designed for the construction industry by the construction industry: Whilst developing a new ICT product or ICPM system, the end-users must be involved from the beginning to ensure a greater chance of successful ICT uptake.

Figure 4.14 – Adequate training is provided after the introduction of new information and communication technology.

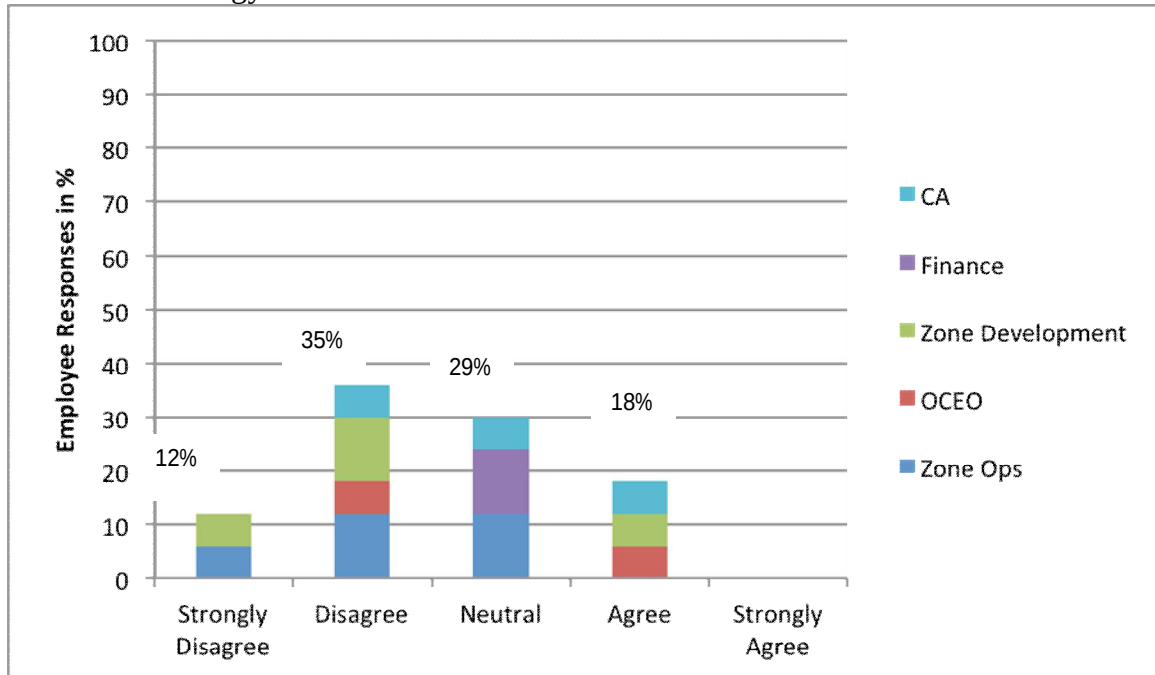
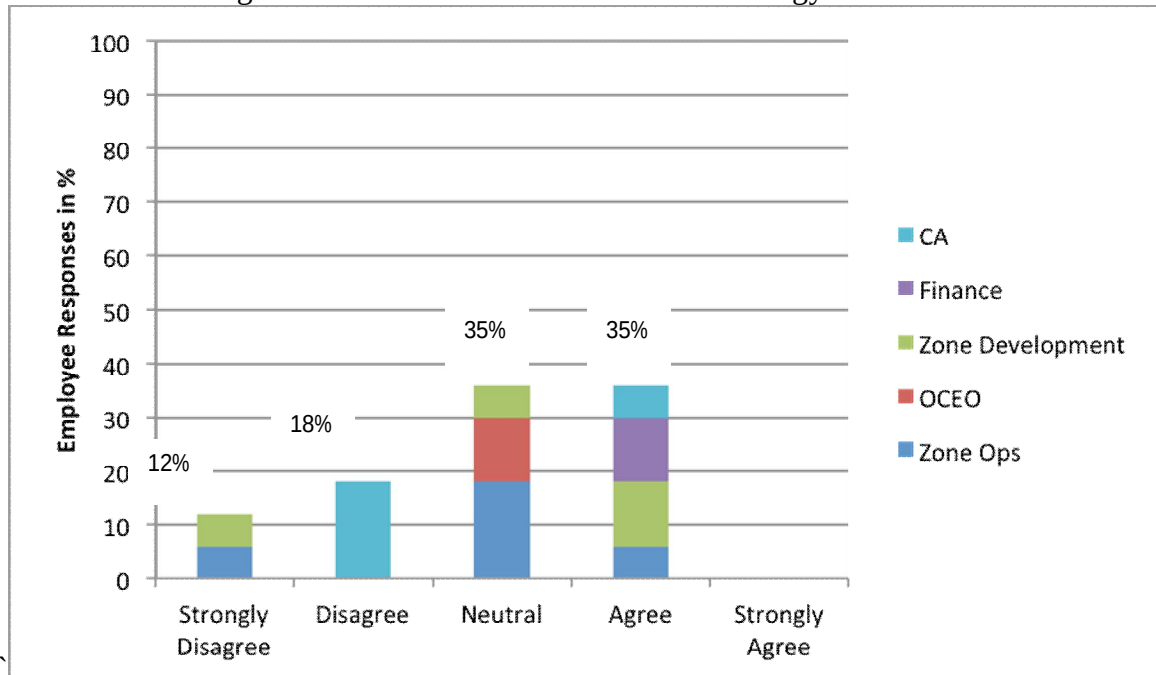


Figure 4.14 above illustrates how most employees (47%) felt that adequate training is not provided after the introduction of new ICT. 18% agreed that adequate training is provided. The data received indicated that the employees felt that not enough adequate training is received after implementation of a new system.

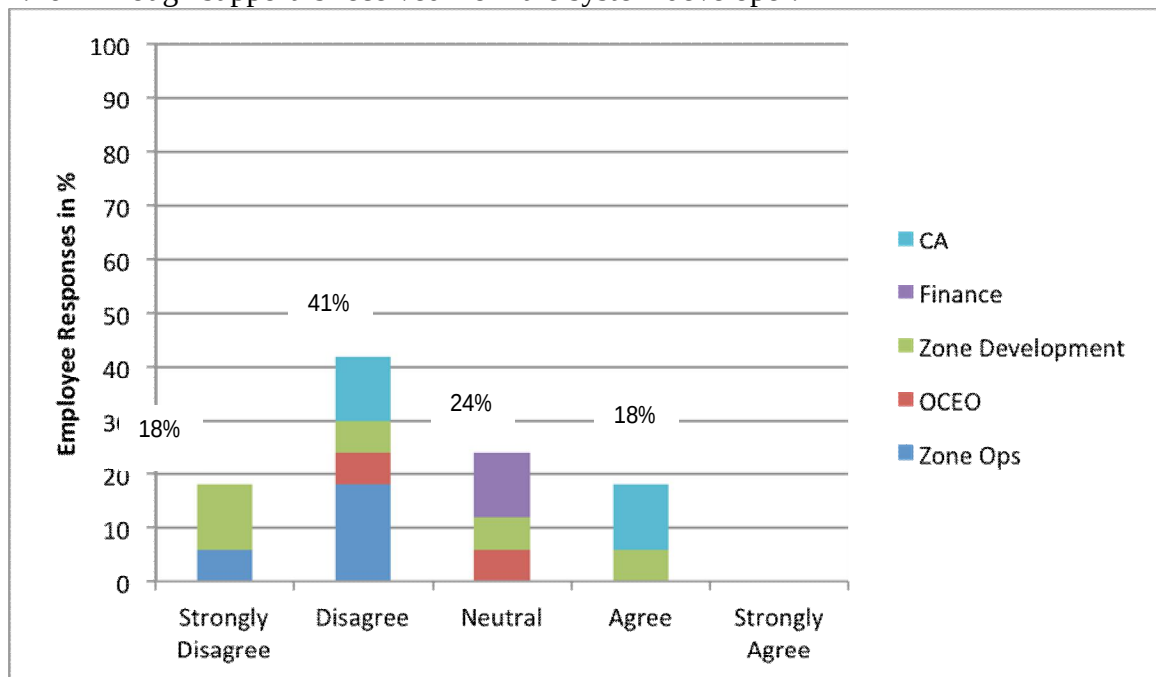
Figure 4.15 – The existing information and communication technology is relevant and reliable.



In Figure 4.15, more employees agreed (35%) that the organization's ICT is relevant and reliable than those who did not agree (30%). However, a vast number chose to be neutral. The data indicates that the organization's ICT meets one of the critical success factors, which were identified in the study by Weipert et al. (2002:114):

- Trust: Implementing a new ICT product or Internet-based construction project management (ICPM) communication system must create a feeling of trust (reliability, relevance and need) for potential users.

Figure 4.16 – Enough support is received from the system developer.



In Figure 4.16 above, a large number of employees (59%) felt that there is not enough support from the system developer, with only 18% agreeing that enough support was provided. In chapter two, it was discussed that the end-user is a key factor in adopting a new ICPM system. End-user needs, expectations, requirements, recommendations and comments must be a prime focus. From the data, it is clear that technology alone is not enough to guarantee improved quality and accuracy of project related communications.

Training in the use of the new ICT system is essential. This includes continuous access to a telephonic or on-line help desk, regular on-site demonstrations and refresher training sessions to ensure continuous learning and understanding of what the system is capable of, as well as recognizing its limitations. Steyn and Leonard (2012:27) mention strategic planning and skills availability within an organization as the two most important aspects when an organization begins to investigate the adoption of ICT.

All participants and stakeholders need to be fully committed to using the new ICPM communication system or ICT tool, with buy-in and collaboration at the highest level within participating companies, thereby reassuring and guaranteeing potential users of a corporate commitment.

The implementation of a new ICT tool or system should have a driver, have encouragement, support and its application and usage should be monitored throughout all phases of a project. By identifying ways to overcome the industry challenges and barriers, improving current technical limitations, encouraging the use of innovative ICT's and modifying traditional work habits will

help increase ICT knowledge, awareness and the skills of all industry stakeholders, resulting in a major impact and integrating the construction industry in a manner not yet seen.

In Section C, the participants were asked to assess whether inappropriate ICT has an influence on project delivery. The results showed that the introduction of information and communication technology had improved project delivery and improved the coordination amongst the firms participating in the construction projects, but information retrieval and information transfer still needed to be improved in the organization and the information and communication system does not allow information sharing to be quick and easy. As a result, the insufficient and conflicting information resulted in re-work.

In Section D, the questionnaire assessed whether employee attitudes influenced the adoption of ICT in the organization. The results indicated that the majority of the employees were not sure if the existing system required specialized knowledge. The employees were divided with regards to being consulted when a new ICT was being implemented. The results showed that adequate training was not provided after the introduction of new ICT and the system developer provided not enough support after implementation.

CONCLUSIONS AND RECOMMENDATIONS

Findings from the Study

Findings from the Literature Review

The research presented in this dissertation concerns an investigation of the impact of technological changes on project management at a company operating in the construction industry. The literature review showed that the majority of construction companies are SME's. It emerged that the challenges facing the companies and the construction industry include problems caused by remoteness of the projects (Sidawi, 2011:14) and a highly fragmented industry with numerous design firms, consultants, contractors, subcontractors, and suppliers involved in almost any project (Weipert and Kajewski, 2002:103). According to Bjornfot and Torjussen (2012:47), many companies are often managed in an informal way and end up in financial problems, recruitment problems and problems with the development of organizational and economic management systems.

It was also indicated that the four major definitions of communication identified by Eisenberg and Goodall (1993), cited in Bowden (2005:12), and are information transfer, transactional process, strategic control and balancing creativity and constraint. According to the Harper (2013), communication is the activity of conveying information through the exchange of thoughts, messages, or information, by speech, visuals, signals, writing or behaviour. It is the meaningful exchange of information between two or more living creatures. Project communication management is the process required to ensure timely and appropriate generation, collection, dissemination, storage, and, ultimately, the disposal of project information. The process provides the critical links between people, ideas and information that are necessary for success.

According to Ahuja, Yang, and Shankar (2012:538), the effectiveness of building project management information system (MIS) is measured by the effectiveness of all project team

agencies to communicate with and give feedback to the rest of the project team throughout the project life cycle. A study by Chan et al. (2004:154) identified 'adequate communication' as one of the variables necessary for project success.

Sidawi (2011:14) and Nitithamyong, Mirosław and Skibniewski (2006:80) identified communication as one of the most pressing problems that the construction industry faces. Sidawi (2011:14) suggests that traditional communications and information management systems cannot meet the need for project information and effective communication required by the project team. Bowden (2004:12) and Nitithamyong et al. (2006:80) concluded that effective on-site communication is hampered by a predominantly paper-based world.

In a study by Tenah (1986), it was outlined that information needs are linked to the responsibilities of construction personnel. The author's study looked at information needs of specific team members and concluded that managers with good access to timely accurate information complete projects on time or reduce the duration, improve resource management, improve plant productivity (equipment), and decrease overall project costs. Charoenngam, Ogunlana, Kang, and Dey Prasanta (2004), cited in Sidawi (2011:15), suggest that using CPMS can solve a lot of the problems experienced in the construction industry. These systems possess the ability to improve communications between project team members and enable teams to share information and quickly solve problems. They improve team members' ability to manage time and costs.

The use of IT in the construction industry as a tool to reduce some of the problems generated by fragmentation has been widely accepted, as these systems improve coordination and collaboration among firms participating in a construction project, leading to better communication practices (Rojas and Songer, 1999). A study conducted by Newton (1998), cited in Bowden (2005:14), found that more than 60% of re-work on-site is due to insufficient or conflicting information. Data collation, information retrieval and information transfer have been listed as areas of improvement and uncertainty about available information. This suggests that with improved information collation and retrieval, huge cost savings can be made.

Ilozor and Kelly (2011:23) suggest that a great deal of progress has been made over the past few years to improve delivery of construction projects to clients. They maintain that project management must evolve by redefining the perception of what project management is, as well as the procedures and devices utilized in project delivery. Chan et al. (2004:154) suggest "Motivating skills of the team leaders' is one of the human-related factors required for project success." In a study by Weipert et al. (2002:114), the Online Remote Construction Management (ORCM) critical success factors included the 'end-user' as a key factor in gaining advantage from an ICPM system. The adoption of ICT in an organization is primarily initiated by top management and is expected to filter down to the end-user. Their needs, expectations, requirements, recommendations and comments must be included as a prime focus.

The quality and accuracy of any project-related communication or information (electronic or paper-based) is directly dependent on the user or creator of that piece of information or correspondence, with or without an ICT tool. Technology alone is not enough to guarantee

improved quality and accuracy of project-related communications. Implementing a new ICT product or communication system must create a feeling of trust (reliability, relevance and need) for potential users.

In developing a new ICT product or ICPM system, the end-users must be involved from the beginning to ensure a greater chance of successful ICT uptake. Training in the use of new ICPM systems is essential. This includes continuous access to telephonic or on-line 'help desk', regular on-site demonstrations and 'refresher' training sessions to ensure continuous learning and understanding of what the systems are capable of, as well as recognizing and accepting their limitations.

All project participants and stakeholders need to be fully committed to using the new ICT tools, with 'buy-in' and collaboration at the highest level within participating companies, thereby reassuring and guaranteeing potential users of a 'corporate commitment'. Effective ICT adoption is also dependent on project managers who have the main responsibility of managing the projects (Peansupap and Walker, cited in Ahuja, 2007:4). Sidawi (2011:15) and a number of researchers (for example, Becerik, 2005; Zou and Roslan, 2005) anticipate that WPMS will replace traditional project management methods and these methods are drivers of WPMS adoption.

Findings from the Primary Research

This section presents a summary of the findings with regards to the fulfillment of the research objectives. Three research objectives were identified for fulfilling the research aim of investigating the impact of information and communication technologies on project management in a construction company operating in South Africa. The following section presents the research questions for reference and discusses the study in relation to the research questions.

Data collection with a sample of participants was undertaken to study the factors identified in relation to the research objectives. The units of analysis for the questionnaire were the employees working in the company. To have a true representation of the population, a sample was taken from the different departments in the company. The specific research questions of the study were:

- Does communication exert an influence on project management within the company?
- To what extent does the use of inappropriate ICT in project management influence project delivery within the organization?
- To what extent do employees' attitudes affect the adoption of ICT within the organization?

Research Question One

- Does communication exert an influence on project management within the company?

From the survey data analysis, it emerged that communication does exert an influence on project management within the organization. The project management information process is not effective in communicating the project information to all the project team members. Communication is a pressing problem within the organization, as paper-based communication

hinders the transfer of information in a project. Lack of information and insufficient information from consultants causes delays in the delivery of the projects.

Research Question Two

- To what extent does the use of inappropriate ICT in project management influence project delivery within the organization?

The survey data analysis showed that the introduction of information and communication technology has improved project delivery within the organization. It has improved the coordination and collaboration amongst the individuals participating in the construction projects. However, information retrieval and transfer still needs to be improved, as it does not allow for information sharing being quick and easy.

Research Question Three

- To what extent do employees' attitudes affect the adoption of ICT within the organization?

It was found that, in general, employees are consulted when a new ICT is being implemented. It also came out that the existing ICT may not be relevant and reliable to some departments. Even though the employees are consulted when new ICT is implemented, the system manufacturer does not give enough support and inadequate training is provided.

The literature review indicated that communication of information plays a critical role in enhancing project delivery. Thus, it is important to study the extent to which communication exerts an influence on project management. It emerged that the effectiveness of a project management information system (MIS) is measured by the effectiveness of all project team stakeholders to communicate with and provide feedback to the rest of the project team throughout the project life cycle. The data analysis showed that at ELIDZ, the management information system is not effective in communicating project information to all the team members. The reasons identified for this is that there is inadequate communication between the different companies participating in the projects. However, 'adequate communication' is identified as one of the critical success factors for a successful project. The data showed that 47% agreed and 6% strongly agreed that communication is a problem during the construction of a project.

An observation was made in the literature that paper-based communication hinders the transfer of information within a project. The exchanges of paper-based information in the form of drawings, operating and maintenance manuals, and deviations from the original design can create problems. The reasons identified include:

- More information is supplied than can be utilized,
- Information is intentionally held back, and
- Adding or deleting information changes the nature of the information.

The data strongly supported these observations, with 47% of the employees agreeing that paper-based information hinders the transfer of information in a project. Another observation from the literature strongly supported by the data is that a lack of information from consultants results in delays in project delivery. The data showed that 65% of the employees agreed that some of the

delays in project delivery are caused by lack of information from consultants. This highlights the need for companies to tackle this problem by implementing different types of communication systems for interpersonal communication, for interdepartmental communication, and for interorganisational communication. Communication methods employed by the organization may not be suited for communicating with the companies doing business with the organization.

It was also observed that the two departments responsible for project management of construction projects in the organization – Zone Operations and Zone Development – comprised almost half the employees of the organization (46%). It is these two departments who feel that communication is a problem. They also indicated the negative effects of a paper-based communication system more strongly than the other departments.

The literature review outlined that the use of IT improves coordination and collaboration among firms participating in a construction project, leading to better communication practices and improving project delivery. Thus, it is important to study to what extent the use of IT or inappropriate IT influences project delivery. Based on the literature review, CPMS can solve a lot of the problems experienced in the construction industry. These systems possess the ability to improve communications between project team members and enable teams to share information and quickly solve problems. They improve team members' ability to manage time and costs.

This view is greatly supported by the data in this study, which showed that 65% of the employees felt that the introduction of information and communication technology within the organization greatly improved project delivery. Information technology (IT) is now extensively used in the construction industry as a tool to reduce some of the problems generated by fragmentation. The literature also showed that it is mostly the larger construction companies that have adopted a higher level of ICT uptake, hiring more ICT practitioners, using ICT more to support innovation, and spending more on ICT than SME's.

The data supported this finding only amongst the larger companies. It showed that 47% of the employees agreed that the introduction of IT in construction projects improves coordination and collaboration amongst the companies participating in the projects. This view is not supported when it comes to SME's. It is the larger companies that have the financial power to introduce more advanced ICT solutions, such as:

- E-procurement systems,
- Collaborative design systems, and
- Collaborative document sharing systems.

The data further supported the findings from the literature indicating that insufficient and conflicting information leads to re-work in a construction project. These functions are hindered because most project information is stored on paper, which is difficult to access and time-consuming to retrieve. This problem can be tackled by improving information retrieval and information transfer. The data showed that even though the introduction of information and communication technology has improved project delivery, coordination and collaboration, there

are still areas where the information and communication system is lacking in that it does not allow information sharing to be quick and easy.

Although the use of ICT can be beneficial to a company, new technologies have the power to disrupt shared frames of reference, such as standards of practice, legal arrangements, and industry norms by making explicit power struggles. There is still a 'digital divide' between the CI and the weighted averages of all sectors. This is attributed to the dominance of small firms in the construction industry. The literature revealed that leadership, motivation and other interpersonal skills are listed as immensely important in project management. The 'end-user' is listed as a key factor in gaining advantage from an ICPM system. Thus, it is important to study to what extent employee attitudes influence the adoption of ICT. In the literature, it was shown that taking only the type or potential advantages or capabilities of a newly developed ICT tool or ICPM communication system into consideration is not enough during implementation. End-user needs, expectations, requirements, recommendations and comments must be included as a prime focus. The study showed that the 35% of the employees felt that they were consulted when a new ICT is being implemented. However, 30% were opposed to that feeling that there is not enough consultation.

It also came out that training in the use of new ICPM systems is essential. This includes continuous access to telephonic or on-line 'help desk,' regular on-site demonstrations and 'refresher' training sessions to ensure continuous learning and understanding of what the systems are capable of, as well as recognizing and accepting their limitations.

The data analysis showed that the organization does not meet the above requirement; with 47% of the employees' reporting that inadequate training is provided.

In the TAM, the information systems theory models how users come to accept and use a technology, 'Perceived ease-of-use' is one of the factors identified as a requirement that influences users to accept and use a technology. The ease of use of a system is the degree to which a person believes that using a particular system would be free from effort. In this study, it emerged that more or less the same number of employees felt that the organization's ICT is easy to use, relevant and reliable. However, it emerged that not enough support is received from the system developer.

Conclusions

The importance of effective communication for the successful delivery of a project has been highlighted. The need for efficient information transfer in project environment was also indicated. The need for organizations to move away from using out-dated business practices and adopt methods that will help move the industry forward into the future was also outlined. Continuous improvement of the ICT tools deployed is necessary for sustainable and successful project delivery.

Conclusively, the use of ICT solutions and products in the construction industry is on the rise, as benefits of these far out-weigh the problems they present. However, it is not enough to decide on implementing a system without doing proper research around the needs of an organization. All support structures and functions need to be in place in order to reap the benefits.

Recommendations

It has been shown that communication exerts an influence on project delivery. Therefore, it is important to identify the users of the ICT within a project environment and also determine the stakeholders, the participants, and all the people interfacing with the project and the project team. It is very important to ensure that only meaningful information is communicated. To achieve effective communication, the following communication techniques have been identified as very useful:

- Multiple communication channels must be established,
- Communicating at the proper time,
- Obtaining feedback,
- Reinforcing words with actions,
- Using face-to-face communication,
- Using a simple language,
- Determining how sensitive a listener is to your communications, and
- Using redundancy where possible.

Factors to be considered in the communication process, which are supported by the communication techniques and are crucial for effective communication include:

- Writing style – active or passive voice,
- Presentation techniques – visual aids,
- Sender –receiver models – feedback loops and barriers to communication, and
- Choice of media – written or verbal communication; informal memo or written report (Kerzner, 2003).

To achieve successful implementation of a new technology, it is important:

- To have a senior manager at executive level to drive the process,
- That the senior executive needs to champion the new technology,
- That the end-users must be involved at the early stages of the process,
- To provide sufficient training during implementation and ‘refresher’ training sessions to ensure continuous learning and understanding of what the systems are capable of, as well as recognizing and accepting their limitations, and
- To ensure adequate support from the system manufacture is available with continuous access to telephonic or on-line ‘help desk’, and regular on-site demonstrations.

It is also recommended that the organization amend its ICT and communication policies to ensure that ICT accommodates and enables the requirements needed for successful implementation.

Areas for Further Research

Studies should be conducted to investigate the use or the impact of mobile IT in the construction industry. This would provide information about new methods of managing remote construction projects. A study on the impact of cultural differences and language barriers in the

implementation of IT in construction projects, where the project team is sourced from different countries, should be conducted. This is because, in IT projects where nationalities are different, it has been found that language becomes a big barrier. A study on the factors that influence the successful development of solutions that meet an organization's needs or project management companies that operate in the construction industry should also be done.

Conclusion

There are many software solutions and ICT tools that have been developed in an effort to solve the problems that plague the construction industry. It emerged that most of the information required by construction personnel can be satisfied with currently available technologies. Including the front-line workers in the electronic flow of information and enhancing their training and support can provide many of the solutions needed in the industry. Organizations in the industry need to conduct research on the ICT solution they need prior to purchasing and implementing a new system. The benefits of acquiring adequate ICT solutions results in positive return on investments being achieved in a very short space of time, as adequate solutions improve the sufficiency of data capture, access to data and data integrity.

This study is expected to contribute towards improving policies around the implementation of ICT solution. This, in turn, will result in improved communication processes within the organization

NOTE: The entire bibliography is cited in this edited version of the study for ease of reference. The study was edited by Professor Anis Mahomed Karodia and supervised by Richard Cowden.

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