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Designers' perspectives on early contractor involvement as a means to improve the safety performance on construction sites

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Title

Designers' perspectives on Early Contractor Involvement as a means to improve the safety performance on construction sites.

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A Research Report proposal submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Masters of Science (Building) Project Management in Construction.

Johannesburg 2015

DECLARATION

I declare that this Research Report is my own unaided work. It is being submitted to the Master of Science in Project Management in Construction (Building) to the University of the Witwatersrand, Johannesburg. It has not been presented in any other university for examination or any other purposes.

ETHICS CLEARANCE

This research is in accordance with the University of the Witwatersrand code of ethics for research on Human Subjects.

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DEDICATION

I thank the almighty God;

Only He who understands how far my east is from the west.

From His one hand to the other I have found the grace to accomplish this.

I thank Him too that I'm a product of my parents.

That they braced me with their intelligence and energy for life that has fuelled this milestone. For their sacrifice, their many needs and desires deferred to grant me this opportunity, I remain forever grateful.

For the rare blessing of a wonderful brother and sister I am humbled.

In their love and support, like rain on the roof, I have danced, triumphed and this achievement trickles to be very much theirs.

For the Macharia's, my sense of home away from home, I'm thankful.

It is not just their generosity nor kindness, but the family moments shared in these lonely foreign forays were always rejuvenating for my quest.

And finally,

To Kalel,

For always being there for me every step of the way,

For your strength, support, love and kindness,

This is for you.

INSPIRATION

"For those that have died constructing,

those that will die,

and those that we must prevent from dying"

Professor John Smallwood, 2015

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LIST OF ACRONYMNS

CIDB	Construction Industry Development Board
ECI	Early Contractor Involvement
GDP	Gross Domestic Product
ILO	International Labour Organization
OGC	Office of Government Commerce
OSHA	Occupational Safety and Health Administration

LIST OF ACTS AND REGULATIONS

Republic of South Africa (1941). "Factories Machinery and Building Works Act 22 of 1941." Government Gazette, No. 36525.

Republic of South Africa (1983). "Machinery and Occupational Safety Act 6 of 1983." Government Gazette, No. 34927.

Republic of South Africa (1993). "Occupational Safety and Health ACT, No. 85 of 1993." Government Gazette, No. 14918.

Republic of South Africa (2003). "Construction Regulations." Government Gazette , No. 25207.

Republic of South Africa (2014). "Construction Regulations." Government Gazette , No. 37305.

ABSTRACT

The construction industry is one of the major industries in the world and has one of the poorest records in Occupation Health and Safety. In developing countries with improved political and economic stability in recent years, infrastructure developments have significantly increased which has implications for the industry to deliver projects safely.

Many designers' in the construction industry in developed countries believe that contractors have knowledge to offer concerning safety as they have the experiences from different projects and can pin point potentially hazardous risks in the design phase of the project and consequently improve on the Health and Safety and Safety Performance of a project. This research aimed to discover what designers' in the South African construction industry perceived about the use of ECI in the industry and its effect on the safety performance on construction sites.

A review of the literature showed that the designers in the construction industry had various perceptions towards trust and commitment of the contractor towards safety and liability issues among other concerns. Twenty-nine questions were identified, which formed the basis of the quantitative analysis that was undertaken. Five hundred architects, engineers and project managers were identified from the Gauteng Province of South Africa and a questionnaire survey emailed to them. A census sample was used in this research and despite the low response rate (9%) from the participants; the data collected was seen as representative of the population.

Analysis of the data collected from this survey revealed that designers believe that the use of ECI in the construction industry may improve the safety performance of the project as well as including contractors earlier in the design phase may be beneficial in enhancing safety during construction. The research also revealed that the designers believe that contractors have knowledge to offer in designing for safety as well as identifying potentially hazardous risks that may elude the designers during the design phase.

From the data collected, a number of recommendations were developed to promote the use of ECI in developing countries including a review of policies and guidelines in the construction regulations so as to boost the use of ECI and consequently reduce the number of accidents

and fatalities in the industry and as well as improve the overall safety performance of construction sites in South Africa.

The overall finding of this research show that the designers in the South African construction industry have a positive attitude towards the use of ECI in the construction industry and are ready to implement it mainly due to the fact that it has a positive impact on the health and safety of workers as well as the overall safety performance of construction sites.

1.0 INTRODUCTION

The African Newsletter on Occupational Health and Safety (2013) states that the construction industry is believed to employ 10% of the world's entire workforce and contributes to more than a 10^{th} of the world's GDP. The global construction industry is noted as being one of the most hazardous environments in which to work (Spillane and Odeyele, 2013, Cheah, 2007). The ILO estimates 340 million work-related accidents and 160 million work related illness worldwide averagely per year. On the other hand, the South African construction industry contributes an average of 16% Gross Domestic Product (GDP). During the period of 2009/2011, a large amount of construction projects were initiated due to the 2010 World Cup event hosted by the country. This period saw 2.5 million people employed in the industry. The 2012/2013 period saw 1.5 million people employed in the construction industry in South Africa. Moreover, according to the South African Department of Labour there are many unreported injuries that are not documented. This figure is significantly higher than stated and is mainly attributed to the employment of illegal workers in the industry among other reasons.

Smallwood, (2004), states that the South African construction industry and the general construction industry worldwide, the construction process generates a disproportionate number of fatalities, injuries and disease, the direct and indirect cost of which contributes to the construction. Smallwood, (2004), further argues that designers directly influence Health and Safety through design, supervisory and administrative interventions as well as indirectly through the type of procurement system used, prequalification, project time, partnering and the facilitating of pre-planning. This statement tends to be true in that in the use of a traditional procurement method, the design is first carried out to completion for the construction works to start. Contractors are not consulted during the design phase thus the number of accidents and fatalities on construction sites tend to be higher in this type of procurement method.

The construction industry worldwide generally uses the traditional procurement method where the contractor and sub contractors are appointed only for the construction phase and this is due to its familiarity, simplicity, and economic, procedural and cultural factors (Mosey, 2009 and Edward, 2009). Mosey, (2009), states that such a procurement method is

unlikely to obtain the best contributions of all parties to a successful project as it excludes the main contractor and subcontractors from the early design and project planning which inhibits opportunities for innovative solutions, constructability, and health and safety planning into design.

According to Edward, (2009), the development of ECI was based on the premise that traditional methods create the team much too late in the project development and there is little scope for innovation and consideration of constructability. Thus, ECI involves a two stage procurement and contractual model, where the client appoints design and construction professionals early in the project development process through a non-price based selection on the basis of the contractor's track record and availability, understanding of the project and quality of new ideas (Laursen and Myers, 2009). These professionals assist in planning, assessing constructability and identifying the risk and managing it as well as developing an "open book" target cost in conjunction with client. The target cost is agreed before construction, and detailed arrangements for the distribution of potential extra costs or savings are determined (Mosey, 2009). In addition, clients can benefit by use of ECI through improved schedule, cost, health and safety, higher level of innovation, better risk management and quality performance (Song et al., 2009).

Studies of construction accidents and injuries suggest that a significant proportion of such events have their origins upstream from the building process itself and are connected to processes such as planning, scheduling and design (Whittington,1992, Suraji, 2001). The European Foundation, (1991) and the OGC, (2007) further argue that one such analysis contends that 60% of construction accidents could have been eliminated, reduced, or avoided with more thought at the design stage. Hinze et al., (2005) agrees and states that design aspects of a construction project are a contributing factor in the health and safety of construction workers and overall safety performance of construction sites. This is also supported by Manuele (1997), as he states that designing for safety as an intervention is supported by hierarchy of controls common to the health and safety professions which identifies designing to eliminate or avoid hazards as a preferred means of reducing risk.

In 1996, Smallwood carried out a survey linking the design for safety concept to construction fatalities and injuries. 50% of the general contractors in the South African construction community responded to the survey and identified the design as an aspect or factor that negatively affects health and safety and the safety performance of construction projects.

Smallwood believes that majority of the designers generally do not have the construction expertise and in-depth knowledge of the construction works and may not be aware of the Health and Safety risks that may arise from their designs**.**

Construction occupational fatalities, injuries result in considerable human suffering and affect not only the workers but also their families (Smallwood, 2004). Smallwood, (2004) further states that occupational fatalities, injuries and disease also contribute to variability of resources of resources which increase project risk through reduced productivity, non-conformance to quality standards and time over runs and ultimately in an increase in the cost of construction. The key players in the construction industry especially the clients and designers do not value much on the Health and Safety and safety performance of construction sites as the implementation and mitigation measures that should be taken to avoid or reduce accidents and fatalities on sites require a lot of money and they are willing to overlook it.

South African construction industry has the third highest number of fatalities per 100000 workers. Fishing and transport are first and second respectively while mining comes in forth according to the South African DoL Health and Safety Report of 2009. *Table 1* below shows the top five (5) industries per 100,000 workers, Health and Safety statistics in South Africa for the year 1999.

Table 1: Top five (5) industries, Health and Safety statistics in South Africa for the year 1999.

Source: Cidb Report (2009)

INDUSTRY	TEMPORARY DISABLEMENT/ 100000	PERMANENT DISABLEMENT/ 100000	FATALITIES/ 100000
Fishing	4 088	215	473,3
Transport	1 543	87	31,4
Building and Construction	**981**	**96**	**25,5**
Mining	1 746	269	23,5
Glass, bricks and tiles	1 298	154	14,9

The construction industry in the United Kingdom has the highest number of accidents and fatalities according to the Health and Safety Executive (HSE) report of 2014. The HSE report (2014) states that, on average there are 46 fatal incidences in the construction industry in the UK and about 76 000 total cases of work related injuries. *Figure 1.1* below shows the trend of fatal injuries in the 3 major industries in the UK from 1974 to 2014.

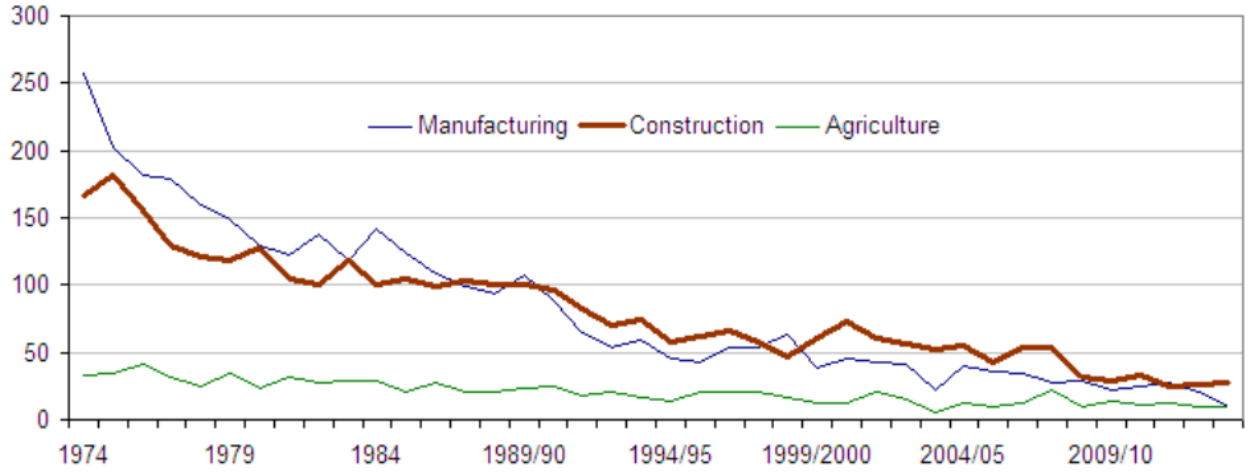


Figure 1.1 The trend of fatal injuries in the 3 major industries in the UK from 1974 to 2014

Source: Health and Safety Executive Report (2014)

The above trend in fatalities shows that accidents and fatalities in UK construction industry have been declining steadily and this is the same trend in the South African construction industry. This can be attributed to the new Health and Safety regulations imposed worldwide. The OSHA regulations adapted in most countries have generally improved the safety performance of construction sites.

As a result of the amount of work-related injuries that occur from construction works, the South African Government introduced the following regulations to help reduce the number of injuries. These Acts and Regulations include:

1. Factories Machinery and Building Works Act 22 of 1941.
2. Machinery and Occupational Safety Act 6 of 1983.
3. Occupational Health and Safety Act 85 of 1993.
    i. Construction Regulation 2003;
    ii. Draft amended Construction Regulation 2010;
    iii. Amended Construction Regulation of 2014.

As much as Construction Regulations have been enforced by the South African government, there is yet a visible impact in the industry. Agumba and Haupt, 2009 argue that despite being reports of improvement, there is very little commitment to comply with the basic requirements, let alone promote a culture of Health and Safety and safety promotion in the construction industry. The construction industry still has the "making it work" mentality as opposed to following the law. This mentality contributes to the accidents that occur in construction sites.

Designers in the construction industry have been seen to keep off health and safety matters as well as safety performance of construction sites and transfer the liability to contractors or their clients. As much as the involvement of contractors earlier in the design phase may reduce the number of accidents and fatalities as well as improve the safety performance on the construction sites, many of the designers in the industry fear the liability of handling issues concerning health and safety and safety performance. It may be this perception among others from the designers in the construction industry that may possibly prevent the incorporation of ECI in the construction industry.

Studies conducted in developed countries on the various perceptions the designers may have towards the use of ECI in construction sites have revealed a number of concerns that the designers have towards this type of project delivery. Some of their main concerns include:

- The designers trust levels towards the use of ECI as a project delivery strategy;
- The commitment of contractors towards safety promotion on construction sites;
- Whether accidents be reduced or prevented by the use of ECI;
- Communication friction between the designers and contractors during the design phase of the project:
- Whether contractors have the knowledge to offer in terms of safety and risk management when brought in at the design phase of the project and,
- Whether the benefits of using ECI in construction project outweigh the barriers of ECI.

The overall perception of designers from the studies conducted in the developed countries such as one conducted by Love et al., (2014) in Australia and Dulaimi et al. (n.d) in Dubai

revealed that designers are willing to adopt ECI as a project delivery strategy mostly because of improved health and safety and safety performance of construction sites among other reasons. On the other hand, Love et al. (2014), reveals that the contractors are not yet willing to embrace the use of ECI as a construction project delivery strategy as they preferred the use of traditional lump-sum method.

Some of the accidents on construction site may be attributed to lack of competent people performing Health and Safety risk analysis from the design, construction and handing over phases of the project. Lack of management and supervision of health and safety in construction work may also contribute to the accidents that occur. According to Maphaha, (2013), lack of including the project contractor and other relevant stakeholders at an initial stage and through the lifespan of the project regarding all matters of Health and Safety contributes majorly to the number of accidents in construction sites and consequently lowers the safety performance of the construction sites in general.

1.1 RESEARCH BACKGROUND

A study conducted according to the African Newsletter (2013) states that the cost of accidents in South Africa is estimated to be approximately 5% of the total cost of the construction project. The study further states that the cost of implementing Health and Safety is estimated to be between 0.5% and 3% of the total cost of the project at completion. This estimate could even be lower if Health and Safety was considered at an earlier stage such as the design phase as opposed to the construction phase.

The concept of designing for safety has been adopted in the European countries and Australia as a means of reducing accident and fatalities during the construction phase. Designers are required to identify health hazards that arise from their designs as early as the design stage and mitigate these hazards before the commencement of the construction phase. A study conducted by Gambetese et al. (2005) states that many designers may not have the knowledge to implement the designing for safety concept as well as the confidence to implement it. Furthermore, most designers especially in developing countries are advised by their legal practitioners to avoid liability in case of accidents and fatalities of construction workers during the construction phase and thus shy away from issues regarding safety.

The majority of architects and engineers especially in developing countries such as South Africa rarely design for safety and the consequences are felt during the construction phase where accidents and fatalities are prone and the general safety performance of the construction site is lowered. According to Mills and Ku (2011), there is lack of responsive tools and resources to assist designers in designing for safety thus making it harder for designers to implement the concept in addition to their lack of required knowledge. The few architects and engineers that actually incorporate design for safety may not have the required knowledge to achieve the required results and lower accidents and fatalities during the construction phase. Contractors are responsible for the actual construction and thus may have the know-how on how design influences the number of accidents and fatalities during construction as well as its effect on the safety performance of the construction project. It can be considered that, if contractors are brought in during the design phase, they can identify these safety hazards and resolve them prior to construction thereby improving the health and safety and safety performance during the construction phase of the project.

The designers in the construction industry may not believe Early Contractor Involvement can be of benefit in improving the safety performance in construction and therefore they do not implement it. This research will investigate the perception of designers on Early Contractor Involvement as a means to reduce accidents and fatalities as well as improve safety performance on construction sites.

The benefits and barriers of ECI have been identified in developed countries; but little research has been done in developing countries. The research aims to investigate some of these benefits and barriers are applicable in developing countries; in the case of South Africa.

1.2 PROBLEM STATEMENT

The research problem can be stated as:

A lack of knowledge regarding the designers' perspective on Early Contractor Involvement as a means to improve the safety performance on construction sites.

South Africa like many other countries uses the traditional procurement method in conducting construction projects. As stated earlier, the traditional procurement method splits the design and construction phases and treats them as completely separate entities. Due to this, a number of unforeseen problems arise during the construction phase of the project.

It is said that the traditional procurement method as a procurement strategy used by the clients and designers may be the highest contributor of accidents in construction sites in that, clients and designers make decisions with inaccurate information regarding the available technologies in the market as well as new/ modern equipment and potential innovative solutions. Contractors are brought at the feasibility stage after all the decisions have been made. Furthermore, the client allocates the tender to the lowest bidder and strives to even lower the price quoted by the contractor (IADC, Number 3, 2011). This in turn has an impact on the quality of the work as well as the Health and Safety of workers and overall safety performance of the site in that the contractor strives to save every penny in order to make a profit.

In addition, unforeseen incidences such as environmental issues, health and safety issues may arise from this type of procurement method during the construction works leading to

additional costs, wastage of time as well as waste of human resources. Thus, in the long run, the traditional procurement method does not offer the best value for money (VfM) for the client.

There have been widespread calls for the public sector to use of non-traditional delivery methods so as to obtain better value for money (VfM). ECI is one form of delivery approach that has begun to attract the attention of many construction companies worldwide. According to Love et al. (2014), the use of ECI as a procurement strategy allows a contractor to proactively participate in design development, risk management and the construction programming processes. Love et al. (2014) further states that, design and construction processes in ECI can also be integrated which, therefore, overcome the impediments and barriers that have conventionally existed between designers and contractor in other procurement strategies such as the traditional method.

1.3 RESEARCH QUESTIONS

1.3.1 RESEARCH QUESTION

The main research question is:

What is the attitude of designers' in the construction industry's towards the effects of Early Contractor Involvement on the safety performance on construction sites?

1.3.2 RESEARCH SUB QUESTIONS

The following research sub questions have been identified:

1. What is the trust level of designers in construction regarding Early Contractor Involvement?
2. How committed are the contractors towards safety promotion on construction sites?
3. Do designers believe that accidents can be reduced/ prevented by Early Contractor Involvement?

4. How do the designers find the communication with the contractors during the design phase to be?
5. Are the designers concerned about the liability that comes with contractors being involved earlier in the design phase of the construction project?
6. Do designers believe the contractor feel powerless/ constrained when not included in the design phase of the project when it comes to the safety performance during construction?
7. Do the designers believe the contractor have knowledge to offer in safety when included earlier in the design phase of the project?
8. Do the designers believe the contractors are aware of potentially hazardous risk in construction?
9. What are the possible benefits and barriers of ECI in respect to safety performance?

1.3.3 RESEARCH SCOPE

The findings of this research are restricted to the perception of the designers' in the South African construction industry may have towards the use of ECI as a means to improve the safety performance on construction sites. The study also looked at the benefits of ECI in relation to safety only.

The setting for this research was Gauteng Province, South Africa. The main reason for choosing this region in South Africa was that it leads in the highest number of construction accidents and fatalities in the country which can be attributed to the many large scale construction projects going on in this particular region as compared to the rest of the country.

The target population for this research is the designers' in the construction industry, that is, Architects, Civil/ Structural Engineers and Project Managers. The region selected for this research, that is, Gauteng Region, is characterized by large scale construction projects which attract international designers who work with the local designers in South Africa. Thus, the local designers in construction can give insight on the use of ECI as a practice; the benefits of the use of ECI in South Africa, its effect on the construction safety performance on site as well as their attitude towards ECI.

1.3.4 RESEARCH DELINEATION

The following are questions that this research did not look at. They include:

1. No emphasis was made on other potential benefits of ECI in the construction industry.
2. The barriers of ECI that might exist that could limit its implementation in the industry.

1.3.5 RESEARCH ASSUMPTIONS

There are various assumptions that will be used in the formulation of this research. They include:

- The study assumes that there is a link between ECI and safety performance in construction.
- The study assumes ECI can improve the safety performance of construction sites.

1.4 RESEARCH OBJECTIVES

The main objective of this study is to determine the designers' in the construction industry's attitude on the effects of Early Contractor Involvement on the safety performance on South African (Gauteng Region) construction sites.

The *literature objectives* of this research study include the following:

- Assess the designers' awareness/ familiarity with the concept of ECI.
- Explore ECI's relationship to design and site safety.
- Identify the possible effects of ECI on safety performance.
- The various attitudes the designers may have towards ECI and Safety Performance.
- Assess the designers' level of knowledge on the barriers and benefits of ECI.

The *empirical objectives* of this research study include the following:

- Identify the trust relationship between designers and contractors;
- Explore the designers beliefs regarding ECI as a way of increasing the safety performance on construction sites;
- Explore how the designers feel about ECI and liability issues due to introducing the contractor earlier in the design process;
- Explore whether the designers' believe contractors feel powerless for not being included in design phase;
- Explore the designers' beliefs on the communication barrier between designers and contractors and
- Explore the designers' beliefs on the commitment of contractors towards safety promotion and improving safety performance of their construction sites.

A detailed research design to achieve these objectives will be discussed further in the research methodology chapter.

1.5 RESEARCH HYPOTHESIS

1.5.1 ALTERNATIVE HYPOTHESIS (H_A)

Designers' in the South African construction industry have a positive attitude towards the effects of Early Contractor Involvement on the safety performance on construction sites.

1.5.2 NULL HYPOTHESIS (H_O)

Designers' in the South African construction industry do not have a positive attitude towards the effects of Early Contractor Involvement on the safety performance on construction sites.

1.6 RESEARCH MOTIVATION

The construction industry generates a high number of accidents and fatalities compared to other industries worldwide and this has an impact on the overall safety performance of the construction project. This is attributed to a number of challenges in the industry including the separation of design and construction phase, multi stakeholder influences, fragmented contributions, unique project teams, exposure to the element and a transient and contract workforce (African Newsletter 2013).

According to the Global Construction Perspective and Oxford Economics 2025 Report (2013) states that the construction output will grow by more than 70% to $15 Trillion by 2025. Clearly the construction industry plays a great role in the economic development of any country. Certain procedures have been developed to ascertain the safety of construction workers during construction as well as throughout the project by the users of the space after project completion. One of the major procedures adopted by stakeholders is the measuring of the contractor's safety performance so as to improve the Health and Safety of the workers at the construction level. This is considered during the tendering level after completion of the design phase by the designers. This procedure though it is effective to some extent, does not identify and eliminate the hazards and risks prior to commencement of construction.

There has been limited discussion on the impact of Early Contractor Involvement on Health and Safety and Safety Performance in the construction industry especially in the developing countries that have a lot of construction project going on currently due to improved infrastructure in the recent years. This research is going to focus upon why some of the designers in the construction industry have not embraced Early Contractor Involvement as a means to improve the safety performance on construction sites.

As stated by Song et al. 2009, limited research has been carried out to determine the benefits and barriers of ECI in respect to safety performance and demystify the concept for wider acceptance. The goal of this research is to contribute to the existing literature and fill in the gaps that may have been ignored especially on issues concerning Health and Safety and safety performance in construction sites of developing countries, the case of South Africa.

1.7 STUDY ORGANIZATION

The study organization adopted for this research is illustrated in *Figure 1.2* below.



Figure 1.2 Study organization chart

1.8 CONCLUSION

This research adopted a positivist approach that saw the conduct of an exploratory study to help determine and understand the designers' perspective on the use of Early Contractor Involvement as a means to improve the safety performance on construction sites in a South African context. A large scale quantitative survey was adopted for this research. The researcher identified 500 designers' in construction, mainly architects and engineers in South Africa at random and emailed a questionnaire survey to them.

A theoretical framework was developed from the literature that guided the deductive logic of this research. The findings from this study aimed to investigate the interaction between the designers in construction and safety performance and their attitudes towards ECI, that is, whether the designers' believed if ECI could potentially improve the safety performance on construction sites in South Africa.

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

The objective of this chapter is to find out if there is a link between Early Contractor Involvement and Safety performance from the Body of Knowledge (BOK), that is, previous research papers currently available. The various attitudes that the designers in the construction industry worldwide have towards ECI and Safety Performance have been explored as well as the current local and global construction health and safety statistics.

The topics discussed in this chapter are:

- The role of professionals in construction design;
- Health and Safety in construction;
- Early Contractor Involvement;
- Designing for Safety;
- Global research on safety performance of construction sites and
- Measuring attitudes.

There is limited Body of Knowledge (BOK) in the various attitudes the designers may have towards ECI and the Safety Performance of construction sites especially in developing countries such as South Africa. This research strives to note the gaps existing in the literature and previous studies and contribute in adding knowledge in the area to the already existing Body of Knowledge.

2.2 THE ROLES OF PROFESSIONALS IN CONSTRUCTION DESIGN AND HEALTH AND SAFETY

Design has an influence on Health and Safety and Safety performance of construction sites. According to Jeffrey and Douglas (1994) it has to be accepted that in terms of causation there is a link between design decisions and safe construction. This is based on research carried out by the European Foundation or the Improvement of Living and Working conditions, which concluded, that of site fatalities, 35% were caused by falls, which could have been reduced through design decisions. According to Smallwood et al. (2014), Health and Safety is not as important to architectural practices as it is to project management, quantity surveying, and consulting engineering practices.

Hinze, (1992), states that the principal parties involved in the development of a project include the client, designer and the contractor. These professionals play different roles during the design phase of the construction project and thus have certain influence and impact on the Health and Safety of the construction workers during the construction phase as well as the safety performance of the project. Behm (2005) and Hinze et al. (2006) stress the importance of clients' Health and Safety leadership, particularly decisions made at the early project-planning phase through the appointment of the design team, contractors, selection of professional advisors, and procurement methods (Smallwood, 2014).

These professionals of construction design include:

2.2.1 THE CLIENT

The client can be defined as a person or company from whom a construction project is carried out and thus has the controlling interest in the project. The client produces the design brief to the design team of professionals and is also the project financier. The client appoints the design team as well as the as the project manager to handle the project on his behalf. The client has various roles on a construction project. These roles include:

- Checks competence and appoints all designers, contractors and sub-contractors that will be involved in the project,

- Provides the designers with a brief on the construction project,
- Provides a reasonable time frame to carry out the project,
- Provides all resources required timeously and;
- Provides a Health and Safety file prior to the commencement of the project.

There are other professionals that are involved in the design phase indirectly and are employed by the client depending on the scope of the work. They include the project manager, land surveyor, EIA Expert, landscape architect and quantity surveyor.

A study conducted by the Health and Safety Authority in 2009 showed that 45% of the sites analysed where construction accidents and fatalities occurred were as a result of the client's negligence to appoint a project supervisor at the design phase of the project. The study further states that 25% of the construction accidents and fatalities were as a result of the client's failure to address the importance of Health and Safety on the construction site prior to the commencement of the construction phase.

Smallwood et al. (2009) state that striving for a better Safety Performance will remain elusive if the client is not actively involved in the Health and Safety implementation, especially in Southern Africa. Huang and Hinze (2006) further argue that the involvement of clients is an essential requirement for the zero injuries objective.

Suraji et al. (2001) argue in their journal on accident causation that construction accidents are caused by inappropriate responses to certain constraints and the environment. Suraji et al. (2001) observed, for instance, that the client responses are the actions or omissions in response to constraints that emerge during the development of the project scope. According to them, these include reducing the project budget, adding new project criteria, changing project objectives, and accelerating the design or construction efforts of the project. All these factors impact negatively on Health and Safety and the Safety Performance of construction sites. Smallwood et al. (2009) and Lingard et al. (2009) state that construction Health and Safety and Safety Performance can successfully be influenced by clients.

In the past, clients' were reluctant in becoming involved in matters concerning the construction of the project as they feared added liability exposure (Hinze and Huang 2006, Sikes et al. 2000). In the recent years, this has changed as shown by a number of studies

conducted on the issue. This change is attributed to a number of issues as listed by a study conducted by Huang and Hinze (2006):

- The cost of health care and worker compensation are reflected in the overall cost of their project and thus safety cannot be ignored by the owners (Gambese 2000, Huang and Hinze 2006).
- Litigation involving owners has escalated in the last three decades pertaining lawsuits from construction accidents thus owners have realized reducing construction accidents and incidents and improving the safety performance of the project is prudent in reducing their potential liability for construction worker safety (Levitt and Samelson 1993; Huang and Hinze 2006).

Under the amended Construction Regulations (2014), the client is obligated to provide the relevant Health and Safety information, for example, buried or overhead service lines, natural occurrences such as weather, information regarding what lies beneath the ground etc. to the designers and the contractor prior to the commencement of the project and this information can be assessed accordingly to determine the level of safety risk and offer possible mitigation measures prior to construction. Smallwood (2014) argues that accidents are caused by inappropriate responses to certain constraints and the environment. Smallwood (2014) further states that regardless of the argument of uncertainty in predicting the future, clients' provision of adequate Health and Safety information to the design team has a significant impact on project Safety Performance and the level of non-compliance with this important role by some clients suggests poor leadership and a lack of commitment to project Safety Performance.

In addition, the South African Construction Regulations (2014) require that clients appoint competent professional designers, quantity surveyors and contractors. According to Smallwood (2014), clients' lack of visible leadership in the appointment of competent professionals often leads to awarding contracts to contractors without adequate Health and Safety records. He further explains that unethical behaviour and non-adherence to the procurement process in clients' organisations have been noted as major factors contributing to poor safety performance.

According to Smallwood et al. (2009) and Huang and Hinze (2006), Clients' attitude can be deduced from the extent to which they are involved in the management of Health and Safety and Safety Performance. Huang and Hinze (2006) and Smallwood et al. (1998) outline a

number of responsibilities that clients could do to improve Health and Safety and the Safety Performance in construction sites. These responsibilities include:

- Provide financial support;
- Include Health and Safety as a prequalification criteria;
- Schedule Health and Safety requirements prior to bidding process;
- Structure contract documentation to allow for Health and Safety, and
- Conduct audits in Health and Safety.

The client has the responsibility to appoint a contractor according to their safety performance scores, qualification, training and experience so as to ensure the health and safety of the workers on the construction site during construction as well as safety of the building after construction. Smallwood (2014) states that pre-qualification is an effective means of identifying which contractors meet the client's requirements to perform the work in the most effective and efficient manner as it enables clients to assess relevant information with respect to contractors' Health and Safety management systems such as Health and Safety historical and performance records, insurance records, workers' Health and Safety training, and employees' competencies. Clients evaluate the information against pre-established criteria to determine whether the contractor is qualified to bid for the work and, if not, client organisations can exclude unsafe contractors from client lists.

The client should also emphasize the above when also selecting the design team and other construction professionals. This will improve the construction project's general safety performance score and overall image of the client as well as the professionals involved in the construction.

The client can also consider the use of risk management techniques such as Early Contractor Involvement to assess the Health and safety risk in the design phase to ensure the hazards detected are mitigated prior to the construction phase.

2.2.2 THE DESIGNERS IN CONSTRUCTION

Designers in construction are referred to as the people or companies that are engaged in work related to design of a construction project such as the preparation of drawings, specifications and bill of quantities (HSA, 2009). The main designers in the construction industry include the following but they can vary from project to project depending with the scope of work as well as contracts selection.

- Architects
- Engineers
- Surveyors

The designers in construction are appointed by the client. Designers are the initial people engaged to design the project and thus have the greatest influence on reducing the risk and improving the overall safety performance of the project during the construction phase and after occupancy. Identifying and mitigating the risk at the design phase can drastically reduce financial impact as opposed to rectifying the risks during the construction phase when construction is on-going. Thus, it is prudent the client identifies competent designers who consider the Health and Safety implications that may arise from their proposed designs.

Designers have various roles in construction, these roles include but not limited to the following:

- Advise and design according to the client's requirements,
- Notify the client on their role and responsibility in the project,
- Identifying and mitigating the hazards that may arise from their designs during the design phase,
- Ensure the Health and Safety of the construction workers during the construction phase as well as of the users of the space after project completion including the maintenance, repairs and demolition of the project,
- Adhere to the general principles of prevention,
- Notify the contractor on the design assumptions, control measures and the remaining hazards,
- Coordinate and cooperate with other designers and
- Plan, schedule and inspect the construction project during the construction phase.

Designers influence Health and Safety and Safety Performance directly through design specific, supervisory and administrative interventions. Design specific interventions may include general design, selection of type of structural frame and specification of materials and finishes.
Supervisory and administrative interventions may include requiring of Health and Safety reporting by contractors and reference to Health and Safety during site visits, inspections and upon site handover.

Designers also influence construction Health and Safety and Safety Performance indirectly through type of procurement system used, prequalification, project time, partnering and the facilitating of pre-planning (Smallwood, 2000). Smallwood (2000) states that a further role identified for designers is that of optimal interaction with clients, particularly at the design brief stage. Smallwood (2000) states that deviations from the initial design at a later stage resulting in variation orders can be a catalyst that triggers a series of events from designer through to workers that culminates in an accident on site. Smallwood (2000) argues that the design phase is the most crucial phase for the successful, and healthy and safe completion of any project.

Smallwood (2000) states that out of all project stakeholders, that is, the client, designers, project managers and contractor, designers are uniquely positioned to integrate Health and Safety in all aspects of the design and construction processes.

2.2.3 THE CONTRACTOR

The contractor in construction can be identified as the company that bridges the finished design and the finished project, ready for the client's use (Hinze, 1992). Procurement is the process of clients selecting or appointing the most economically viable or competent contractor to carry out construction projects (Smallwood, 2014). In the mostly used procurement method which is the traditional procurement method, the contractor is brought in after the design is complete to construct the development.

With the three primary parties involved in the development of a project, the contractor is deemed responsible for the Health and Safety of the construction workers on site as well as the safety of the users after the project is completed.

Contractor can be identified as designers depending with the project requirement, for example, Build Operate Transfer (BOT), Build Own Operate Transfer (BOOT), Design and Built or Develop and Build thus the contractor has the full control on safety performance of the project from the start of the project. For projects that only require the contractor to construct the project, the clients should consider bringing in the contractor earlier during the design phase so that the contractor can familiarize themselves with design requirements and also identify possible hazards that may arise from the design as well as offer mitigation measures prior to construction.

Hinze (1992), carried out a survey of contractors and what they consider designers should bear in mind when designing a development. Some of these considerations included:

- Grouping of the floor and roof penetrations such that they reduce the number of falls,
- Locating the valve and fittings at a safe and convenient location,
- Relocating overhead power lines prior to construction to minimize shocks,
- Designing of higher parapet walls or an integrated guardrail system along all roof systems and
- Laying out piping and mechanical systems so that workers have more than one escape route in case of emergencies.

The contractor is undoubtedly the pivotal party in controlling construction safety in the development of a project according to Hinze and Huang (2006). Hinze and Huang (2006), further state that the sub-contractors safety performance on site is highly influenced by the main contractor.

2.3 HEALTH AND SAFETY IN CONSTRUCTION

Occupation Health and Safety refers to safety in health of all employees working in the construction industry and other industries in general. A safe working environment improves the quality of work as well as production. According to the ILO, in the long run, providing a safe working environment generally tends to be cheaper that an inadequate working environment in that a poor working environment results in an increase of hazard pay to injured employees as well as compensation costs for accidents and injured employees not to mention loss of production and decrease in quality of the work.

According to the International Labour Organisation (ILO, 2011), the risk of injuries and fatalities in construction is 7-10 times more than that in other industries. Despite the promulgation and implications of the Construction Regulations, the traditional project parameters in the form of cost, quality, and time are still perceived to be substantially more important than Health and Safety and Safety Performance (Smallwood, 2014). According to Smallwood (2014), Health and safety and the environment are being increasingly identified as parameters which should be used along with the traditional parameters: cost, quality and schedule, to measure the success of projects. Hinze (2006) and Smallwood (2014) states that outstanding projects are: ahead of or on schedule, within budget and reflect exemplary health and safety.

Construction industry in the recent years has increased and this growth has been brought about by increased economic growth, improved infrastructure, urbanization, population growth and in Sub Saharan Africa, political stability. In 1988 the International Labour Organization (ILO) adopted the Safety and Health in Construction Convention (No. 167), and Recommendation (No. 175) with a view of reducing the number of accidents and fatalities that occur in the construction industry. These occupation health and safety instruments are essential points of reference to develop national standards of health and safety. In 1992 the ILO published the code of practice, Safety and Health in Construction, containing technical guidance, recommendations and know-how for all those who have responsibility for OSH within the construction sector (ILO 2005, Africa Newsletter, 2013).

According to the Cidb Report (2009), globally, 60,000 fatal accidents occur every 10 minutes in the construction industry and this translates to one in every six fatalities occur in the construction industry. In developed countries, more than 25% to 40% of work related

fatalities occur in construction sites despite the construction industry only employing about 6% to 10% of the total work force (CIDB 2009, ILO 2005). In a developing country such as South Africa, the building and construction industry has the 3rd highest number of accidents and fatalities of 25.5 per 100 000 workers (CIDB, 2009). The fishing industry and the transport industry take the 1st and 2nd place in the number of work related accidents and fatalities in South Africa. *Table 2* shows the South African construction industry's accidents and fatalities statistics between the year 2008 and 2012.

Table 2: The South African construction industry's accidents and fatalities statistics between the year 2008 and 2012.

Source: FEMA and MBA Report (2014)

Construction Health and Safety Statistics in South Africa

	Accident Frequency	Number of Employees	Number of Accidents	Fatal Accidents	Permanent Disabilities not Resulting in Pensions	Permanent Disabilities Resulting in Pensions	Average cost per Accident
2008	3.86	282 743	10 925	65	429	49	12 585
2009	3.59	288 736	10 380	73	443	54	13 993
2010	3.30	277 764	9 174	95	502	42	18 069
2011	2.83	282 285	7 991	51	568	23	17 492
2012	2.65	311 815	8 277	71	629	29	21 761

The comparison between construction health and safety in developed countries and developing countries is huge. Developing areas such as Sub Saharan Africa and Asia have an accident rate and fatality rate of 16 012 per 100 000 and 21, 16 434 per 100 000 and 21.5 respectively while the Established Market Economies have an accident rate of 3240 per 100 000 and a fatality rate of 4.2 (CIDB, 2009).

In comparison with developed countries, construction sites in developing countries are ten times more dangerous than in developed countries (Hamalainen et al. 2006; Agumba and Haupt, 2009). This is a clear indication that Health and Safety and overall safety performance are not in fact taken into concern during design and construction phases in construction sites of developing countries. Improving the Health and Safety and safety performance in

construction sites may be one of the links to improving the country's economy through improved productivity. Improving the Health and Safety performance in the construction sector is one of the ways to enhance the productivity of the construction sector in South Africa (Ntsika, 2001; Agumba and Haupt, 2009). *Table 3* below shows the South African Construction Health and Safety Claims and Fatalities between the year 2006 and 2007.

Table 3: South African Construction Health and Safety Claims and Fatalities between the year 2006 and 2007.

Source: FEMA and CIDB Report 2009

Construction Health and Safety Claims and Fatalities				
	2006		2007	
Province	Number of Claims	Number of Fatalities	Number of Claims	Number of Fatalities
Gauteng	4257	32	5143	30
KwaZulu-Natal	1207	13	1311	10
Eastern Cape	943	7	929	7
Boland	1577	12	1629	6
Western Cape	827	3	814	1
Kimberly and Northern Cape	28	0	43	0
Free State	345	7	362	6
South Africa	**9184**	**74**	**10231**	**60**

Various studies conducted by Peckitt et al. (2004), Gibb and Bust (2006) and Agumba and Haupt, (2009) suggest that Health and Safety management in construction in developing countries provide ample evidence of lapses in the management of health and safety at construction sites. Health and Safety management is hierarchical and should start from the top most authority i.e. the client and it should trickle down to the workers on the construction site but this is not the case in most construction sites in South Africa. The Health and Safety and safety performance matter is mostly left to the contractor to deal with.

There are various legal frameworks introduced in South Africa to deal with workplace Health and Safety; The Occupational Health and Safety Act 85 of 1993 and the Construction

Regulations of 2003. Despite the legal frameworks being established, Health and Safety should be seen as a value and not driven by the legal framework (Agumba and Haupt, 2009).

The promulgation of the South African construction regulations in 2003 realized that the clients, designers and quantity surveyors have a responsibility for Health and safety and safety promotion on construction sites. Previously, the role of Health and Safety and safety performance on construction sites was left to the contractor. The Construction Regulations, (2003) state that the client has to provide the Principle Contractor with a Health and Safety specification and ensure they have made allowance for the proper implementation of Health and Safety requirements on site (Smallwood and Haupt, 2005). This means that the client has to allocate a provision for Health and Safety in the tendering of projects.

Agumba and Haupt, (2009) further argue that despite being reports of improvement due to the implementation of the 2003 Construction Regulations, there is very little commitment to by the clients to comply with the basic requirements, due to the extra cost of implementing the safety requirements. The CIDB (2004), states that other than the direct compensation and medical costs associated with accidents in construction sites, the underlying costs are immense and may include rework, lost time, delays, damages, disruption, productivity loss and loss to skills to the economy. In addition, accidents and fatalities lower the safety performance of the construction project and may have an impact on the reputation of the client, designers involved as well as the contractor handling the project.

Some workers are equally to blame when it comes to their Health and Safety. Their employers provide them with Personal Protective Equipment (PPE's) and they choose not to use them so as to get injured and get compensated instead. This is a major problem for the South African employers in the construction industry. This problem also affects the South African mining industry as well. This problem contributes to lowering the safety performance of projects. This problem may be attributed to the poverty levels in the country. Majority of the construction companies, especially the small and medium enterprises (SME'S), may not have the man-power in terms of hiring the required number of safety officers described in the OHS regulations and thus, they may not be able to supervise all the construction workers. This provides the construction workers with an opportunity purposely get injured on site.

The construction industry attracts a lot of people to secure employment. The construction industry poses an inherent risk to the health and safety of employees and subcontractors. A threat to employees can negatively impact employee morale and results in a loss in

productivity and reputational risk. Despite an improvement in the health and safety statistics over the last few years, the industry still needs to go further and embed the desired culture (PWC, 2013).

The Cidb Act no. 38 of (2000) mandates the establishment of the best practice that promotes, amongst others, positive safety, health and environmental outcomes. It also mandates the establishment of a best practice contractor. There is a risk of non-compliance given the myriad local legislation and regulation relating to corporate governance, labor, taxes, health and safety, the environment, performance and specific contract requirements (PWC, 2013).

The South African construction industry predominantly uses the traditional procurement method where the design and construction are separated. Research shows that this type of procurement method has a higher probability of accidents and fatalities during construction as the contractor is brought in during the construction phase. Smallwood (2014) discusses the various procurement methods and their effect on Health and Safety and Safety Performance on construction sites.

Pre-qualification is a procurement related intervention, the purpose in the health and safety sense being to provide a standardised method for selecting contractors on the basis of demonstrated safe work records, health and safety commitment and knowledge and the ability to work in a healthy and safe manner (Smallwood, 2014).

Partnering is another procurement system related process which brings the various stakeholders involved in a construction project, that is, the client, designers, main contractor, subcontractors and suppliers together so as to develop mutual goals and mechanisms for solving problems, which effectively complements health and safety (Smallwood, 2014). According to Smallwood (2014), the main reasons for partnering complementing health and safety and they include the all round improvement in project relations as a result of health and safety performance being identified as a project specific goal. Smallwood (2014) further states that project duration can influence health and safety as a shortened project period invariably results in an increase in the number of workers; the number of hours worked per worker, or even a combination of the two; the amount of plant and equipment, and the number of subcontractors simultaneously undertaking work per period of time. He states that this intensification increases the possibility of incidents.

Constructability management is another procurement method for achieving optimum integration of construction knowledge and experience in planning, engineering, procurement and site operations, and the balancing of various project and environment constraints to achieve overall project objectives (Smallwood, 2014). One of the principles of constructability is designing for safe construction which directly influences Health and Safety and Safety Performance in construction sites.

The designers are expected to liaise with the client and inform them on all relevant information about the design, which will affect the tendering of the work; the client then informs the contractor of the known or anticipated dangers (Smallwood and Haupt, 2005). The inclusion of health and safety in the construction regulation affects the pricing of the works as the contractor has to adhere to the health and safety regulations as required by the law.

2.3.1 ACCIDENTS ON CONSTRUCTION SITES

An accident can be defined as an unplanned event which may or may not result in an injury (OSHA Regulations). Accidents are caused by unsafe physical conditions as well as unsafe acts on the construction site. Exposure to various hazards when working at heights, under water and/or with hazardous chemical substances forms part of daily work routines on construction sites (CIDB, 2009). The discovery that construction workers are often at risk of an accident, ill health and fatality at work when compared to other industrial sectors is cause for concern for individuals, stakeholders, and governments (Smallwood et al. 2014).

The unsafe physical conditions are addressed in the OSHA Regulations while the unsafe acts can be minimized by supervisory and management influence on construction sites.

The OSHA regulations have coded construction accidents into 5 and they include;

1. **Falls:** the most common fatalities include off roof, in scaffolding collapse, off scaffolding, in structure collapse, through floor openings, off ladder, off structure, through roof opening, off edge of floor opening etc.

2. **Struck by Incidences** e.g. worker struck by falling object, worker run over by heavy equipment, worker struck by crane/ boom/ load, worker run over by private vehicle, worker struck in trench cave in etc.
3. **Caught in-between Incidences** e.g. trench cave in, worker caught in-between piece of heavy equipment, overturning of heavy equipment/ machinery, worker caught in between moving part of heavy equipment etc.
4. **Electric Shocks** e.g. direct contact with live wire, contact of crane boom with power line, contact of materials with the power line, contact of ladder with the power line etc.
5. **Others** e.g. drowning, fire, toxic gas, lack of oxygen etc.

Most of the accidents and fatalities that may happen during the construction phase of the project can be avoided during the design phase. For example, stuck-by incidences such as a worker struck by a crane can be identified as a potential hazardous risk during the design stage. Power lines can be identified during the design stage and relocated away from the areas that require the use of cranes to avoid struck-by incidences during the construction phase of the project.

Accidents on construction sites can be categorized into 3, that is, major accidents, minor accidents and near misses. It is estimated that for every major accident that occurs on a construction site, twenty-nine minor accidents have occurred and approximately three hundred near misses. The diagram below shows the ratio relationship between the 3 categories of accidents. *Figure 2.1* shows the ratio relationship and domino effect between the types of accidents on construction sites.

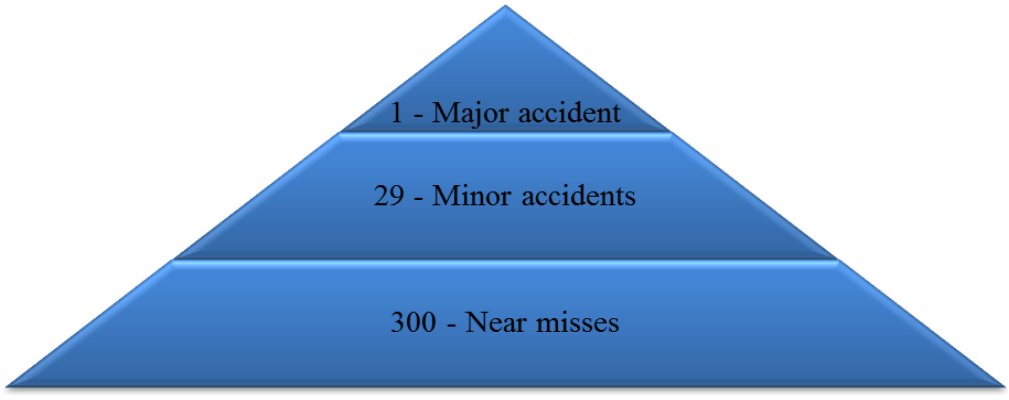


Figure 2.1: Bird's Safety Triangle (1969)

Source: Cited by Venkatachalam (2014)

Near misses in most cases go unreported on construction sites and only minor and major accidents are reported and recorded. The above figure shows the build-up on accidents from near misses to major accidents and their relationships and why near misses should be reported and recorded by the safety officers in charge of a construction site. *Table 4* below shows a summary of the types of construction accidents and fatalities and their statistics in South Africa.

Table 4: Summary of the types of construction accidents and fatalities and their statistics in South Africa.

Source: FEMA Report March 2014

	2014		2013		2012	
Description	**Number of Accidents**	**Number of Fatalities**	**Number of Accidents**	**Number of Fatalities**	**Number of Accidents**	**Number of Fatalities**
Accident type N.E.C	29	0	120	3	113	0
Striking against	120	0	756	1	876	1
Struck by	520	1	3 354	13	3 250	11
Caught in, on, between	85	0	551	3	529	3
Fall onto same level	61	0	323	0	354	1
Fall onto different levels	154	0	942	7	973	7
Slip or over exertion	116	0	820	0	715	0
Contact with temperature extremes	22	1	114	0	106	1
Inhalation, absorption, ingestion	22	0	118	0	79	0
Contact with electrical current	5	0	38	2	33	1

Unclassified/ Not sufficient data	31	0	21	0	5	1
Motor Vehicle Accident	129	3	1 026	42	958	25
South Africa	**1263**	**5**	**8 277**	**71**	**7 991**	**51**

From the table above, majority of the accidents that happen on site are stuck-by incidences, while majority of the fatalities that occur are due to motor vehicle accidents. It is believed that majority of these accidents and fatalities can be avoided through the incorporation of ECI in the industry. Lowering the number of accidents and fatalities during construction improves that overall safety performance of the project as well as the image of the people involved in the project.

2.3.1.1 MITIGATION OF ACCIDENTS ON CONSTRUCTION SITES

There are various mitigation measures that can be adopted to reduce the number of accidents and fatalities on construction sites. They include but not limited to:

- Job Hazard Analysis: This is the identification and control of unsafe physical conditions and possible acts as well as increase awareness of workplace hazards. This mitigation measure campaigns for project safety to begin prior to commencement construction works.
- Include contractors in the design process to address the safety issues of safety in the design prior to commencement of construction works.
- The architect and engineer should minimize the number of offsets or adjust the offsets and make them as large as they possibly can.
- The engineer should relocate or disconnect or bury any overhead power transmission lines offsite to allow mobility of the crane.
- Building components should be pre-fabricated at the assembly industry.
- The designer should create wide roadways that allow room for vehicles/ equipment and workers to access.

Majority of the mitigation measures listed above pertain identifying potentially hazardous risks prior to the construction phase. It is clear that contractors may be best suited to identify these potentially hazardous risks as they are the party that handles the construction phase of the project. Therefore, it would be practical if the contractors were included in the design phase so as to improve the overall safety performance of the project.

2.4 EARLY CONTRACTOR INVOLVEMENT

Early Contractor Involvement refers to the involvement of a contractor at an early stage of project development, to work together with the client and or design team, mainly to assist in planning and buildability (Rahman, 2012). According to IADC, Number 3, 2011, Early Contractor Involvement is instrumental in achieving the "Best Value Procurement" in that critical information required to make certain information is provided by the contractors. Early Contractor Involvement (ECI) as a practice in procurement allows the client as well as the project designers to gain greater certainty on price and risk outcomes for the project. Contractors should be brought in the design phase of the project so as to offer the technical know-how and innovative ideas to the client. Contractors help in addressing a more realistic and reliable operating schedule and cost estimates for a project (Lazuli, 2011).

ECI as a form of project delivery has been experimented with and evolved over decades (Mosey, 2009; Walker and Walker 2012). The concept of where the contractor collaborates with the client and the design team at an early stage of the project has had various terms to describe it over the years and varies geographically. Some of these terms include lean project delivery (Ballard, 2008), project alliancing (Jones, 2001; Ross, 2003), constructability (Sidwell, 1996; Cheetman and Lewis, 2001) and Early Contractor Involvement (Smallwood, 2004; Mosey, 2009; Walker and Walker, 2012).

Early Contractor Involvement can contribute to lower fatalities and injuries on construction sites which results in an improved safety performance score. This is attributed to contractors being included in the programming and design of the project and they are able to manage foreseeable accidents prior to commencement of construction works (Weinstein et al, 2004). The contractors when involved at an earlier stage of the design suggest design modifications which greatly impact the implementation and health and safety on the construction sites.

2.4.1 EARLY CONTRACTOR INVOLVEMENT VERSUS OTHER PROCUREMENT SYSTEMS

ISO 10845-1 (2010) defines procurement as the process which creates, manages, and fulfils contracts relating to the provision of goods, services and engineering and construction works or disposals or any other combination thereof. While the Joint contracts tribunal defines procurement as a term which describes the activities undertaken by the employer or client who Is seeking to bring about the construction or refurbishment of a building. Procurement systems and related issues are important as they affect, among other things, contractual relationships, the development of mutual goals and the allocation of risk, and ultimately provide the framework within which projects are executed (Love et al., 2014). Research indicates that procurement systems influence Health and Safety. Evidence gathered suggests incorrect choice and use of procurement systems has contributed to neglect of Health and Safety and Safety Performance by project stakeholders (Love et al., 2014).

According to Love et al., (2014), Design-build procurement systems complements Health and Safety as a result of the integration of the design and construction processes. Love et al., (2014) further states that the traditional construction procurement system which entails, the evolution of a design by designers, the preparation of bills of quantities and related documentation by quantity surveyors, the engagement of a contractor through competitive bidding, invariably on the basis of price, does not complement Health and Safety and Safety Performance on construction sites. Love et al., (2014) further adds that this may be due to the separation of the design and construction processes, the incompleteness of design upon both preparation of documentation and the commencement of construction, and the engagement of contractors on the basis of price.

Smallwood (1996), states that competitive tendering such as that in the traditional procurement marginalises Health and Safety and Safety Performance on construction sites. He further states that the market conditions in South Africa are such that contractors frequently find themselves in the iniquitous position that should they make the requisite allowances for Health and Safety, they run the risk of losing a tender or negotiations to a less committed competitor.

As previously discussed, the South African construction industry mainly uses the traditional procurement system. In traditional procurement method, the designer works closely with the

client and produces designs that are driven primarily by factors such as aesthetics, functionality and budget (Song et al, 2009). The designer and the client do not necessarily consider the Health and Safety repercussions that arise from the design during the construction phase.

Historically, Government and professional associations in South Africa have published a time based fee scale and percentage fee scale relating to commonly encountered scopes of work for professional services in respect of the various built environment disciplines. This has made appointments to be made to consultants on a prescribed fee basis without providing a scope of work. (CIDB, Procurement of professional services, 2007).

Traditionally, project success was attributed to the "iron triangle" of within cost, time and quality. Traditional method of procurement focuses on the delivery of a project once the design has been developed where the contractor is expected to deliver the project within the "iron triangle" constraints of specific time, cost and quality to deliver its fitness for purpose (Walker and Walker, 2012). The "iron triangle" has recently changed and addressed the issue of health and safety on construction sites.

The traditional procurement method had its advantages. Firstly, it is the mostly used procurement method in the construction industry and thus the most understood. Secondly, this procurement method provides a design certainty and a greater cost control than other procurement methods including ECI. Lastly, the procurement method poses an independent design and costing advice to the client through the use of a Bill of Quantity as opposed to other methods where the client is not really sure how much the overall project will cost.

Various disadvantages can be noted in the use of the traditional procurement method. Firstly, the procurement process is relatively long in that the design phase has to be finished first for the construction process to begin. Secondly, there is very limited time from the tendering process to the construction phase and this limits the contractor to make any improvements or take mitigation measures in the case of a Health and Safety risk on the construction site. Lastly, this type of approach brings a lot of law suits in that there is a distinct definition between the design and the construction works. If there happens to be say, a Health and Safety issue brought about by the design and the building happens to collapse during construction, the client may have to be forced to go to court to determine who is accountable for the incident.

Integrated project delivery has been described as a process that collaboratively harnesses the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste and maximize efficiency through all phases of design and construction (AIA California Council, 2007). One such method that enables project integration is the use of Early Contractor Involvement (ECI). According to Mosey (2009) and Love et al. (2014) consultants cannot solely develop a comprehensive design solution that is buildable and innovative.

ECI focuses on the conditional appointment of a contractor into the project team at the preconstruction stage. As a result, this enables the contractor to participate in design development, risk management and the construction programming processes (Mosey, 2009; Love et al., 2014). This process allows for stronger project relationships and the integration of the design and construction parties, which is not encouraged when a traditional design–bid– build procurement strategy is used (Song et al., 2009). According to Love et al. (2014), the use of ECI is a possible solution to addressing these shortcomings of infrastructure projects and can potentially provide the basis for developing a more realistic estimate of project costs.

Love et al. (2014) and Mosey (2009) state that to effectively incorporate a contractor into the pre-construction phase, a two-stage tender process is required. *Figure 2.2* below adopted from Mosey (2009) depicts these two stages. According to Love et al. (2014), this process enables a degree of competition for contractor selection to be maintained, as well as facilitates their early involvement. Love et al. (2014) and Mosey (2009) explain that the first stage of the selection process is typically based on a submission by the contractor in terms of profit margin, overheads, pre-construction stage fee, approach to risk pricing and any other cost components that can be priced accurately by the contractor, based on the contract information that is made available to them. Love et al. (2014) further explains that in addition to the price based criteria, the contractor is assessed against qualitative criteria such as the proposed construction method, ability to deal with unanticipated problems, ability to deliver similar-type projects on schedule, experience with similar project, Safety Performance Score and familiarity with local subcontractors and suppliers. Love et al. (2014) states that after a conditional appointment is made, the contractor actively contributes to the delivery process through design reviews, cost comparisons and development of the construction program and risk management analysis.

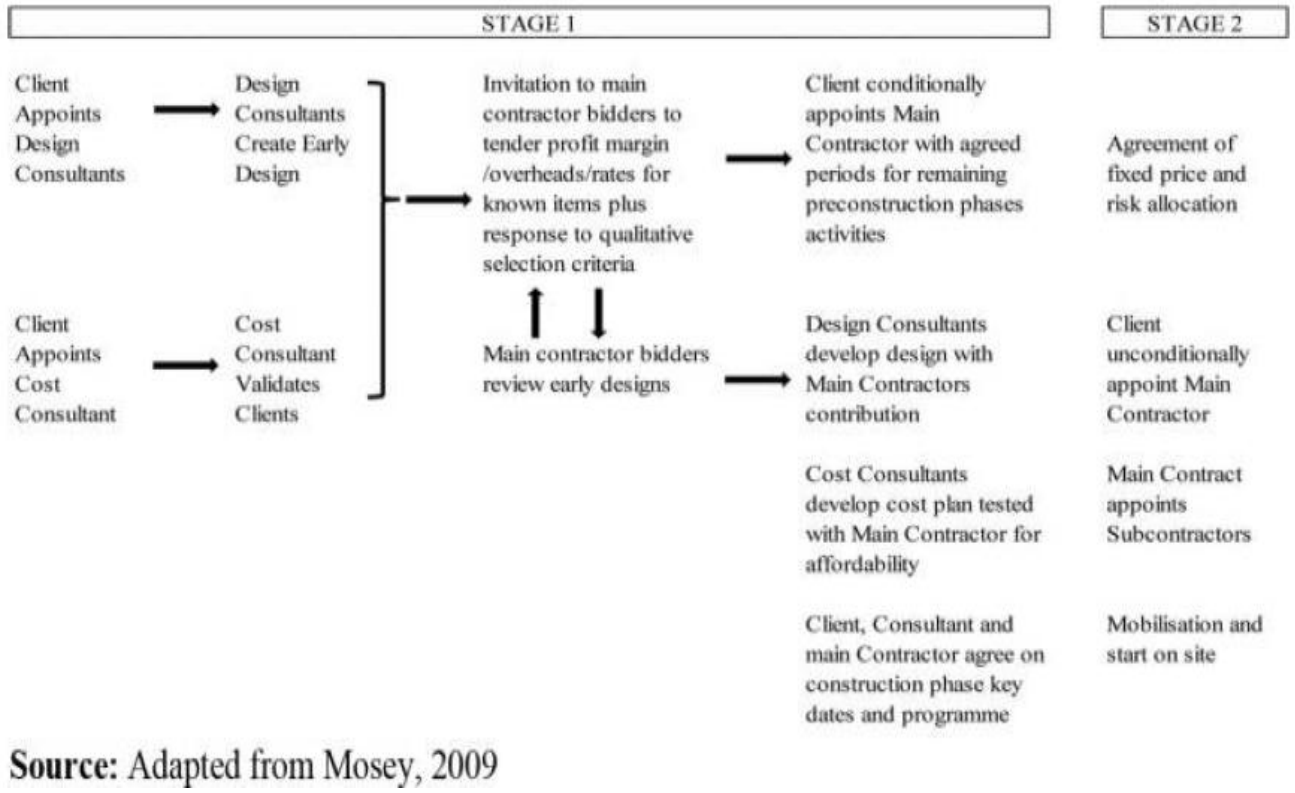


Figure 2.2: Stages of ECI Implementation.

Source: Adapted from Mosey, (2009); Cited by Love et al., (2014)

Love et al. (2014) states that the second stage is the unconditional appointment of the contractor where the contractor is required to provide a guaranteed maximum price (GMP) for the delivery of the project. Love et al. (2014) explains that the procurement process for the second stage can take numerous forms, as the contractor can be appointed using one of the following arrangements:

- *Traditional construct only contract*: In this instance, the client retains the responsibility to complete the detailed design and the contractor is required to undertake construction of the project.
- *Design and construct contract*: The contractors assumes responsibility for both the detailed design of the project as well as the construction of the project.
- *Novated design and construct contract*: Under this form of contract, the design team, engaged by the client for developing preliminary design documentation, is novated to the contractor for detailed design and construction phases of the project.

- *Managing contractor (at risk)*: In this case, the client appoints a contractor to manage the design and construction phase for a management fee. The term *at risk* is used where the contractor is required to provide a GMP for the construction prior to their engagement. Thus, the risk of cost overrun is transferred from the client to the contractor.

Love et al. (2014) states that the advantages of ECI two-stage process have been recognized by the Queensland State Government (2008). These advantages identified include:

- The first stage results in a more robust identification of risk and a realistic project schedule and price being defined as compared to the traditional design– bid– build procurement.
- The second stage is recognized for its ability to enable risk negotiation and the establishment of a GMP, which can reduce variation orders and excess project contingency fees that are associated which traditional design– bid– build procurement.

A study conducted by Love et al. (2014) in West Australia revealed that a significant proportion of contractors did not have the capability and experience to be involved within an ECI approach. Furthermore, their preference was the use of a traditional lump-sum method. Love et al. (2014) state that where there was limited scope for using competitive tendering, particularly on large complex projects, then ECI could be a preferred option for future projects.

2.4.2 BENEFITS OF EARLY CONTRACTOR INVOLVEMENT

African countries lag behind their peers in other parts of the world in terms of infrastructure development; furthermore, Sub-Saharan Africa ranks at the bottom of all developing regions (Yepes et al, 2008; Smallwood and Emuze, 2010). Smallwood (2010) and Foster (2008) further argue that the poor performance in the infrastructure development in Africa can be attributed to the poor project delivery and maintenance.

According to the CIBD Report, (2008), improving the construction industry performance requires the contribution of both the client and the contractors because clients and their procurement practices are the drivers of the industry behavior, performance and transformation. Smallwood, (2010) and Male (2002) further argue that contractors have the ability to influence the project participants and outcomes. Contractors over the years have acquired the vast knowledge in construction works and have encountered different obstacles in construction thus, have the know-how of dealing with different situations on site. If this knowledge is utilized at an earlier stage of the design process, the designers and client can be able to deal with the foreseen issues prior to construction including health and safety.

Song et al. (2009) identified various advantages of Early Contractor Involvement in the construction industry. The distinct advantages discussed include:

- Contractors have a higher expertise in construction compared to the designers and the clients thus are in the best position to provide specific information on the availability and limitation of resources as well as identify Health and Safety issues that may arise and offer ways to mitigate them.
- Contractors are responsible for the actual construction of the project and their input in the design process directly impacts their construction and safety performance.
- Contractors brought in at an earlier stage of the design project tend to improve collaboration between the designers, clients, engineers and the contractor. This reduces the number of lawsuits and builds a good reputation for all involved (Arditi et al. 2002).
- The contractor when engaged at an earlier stage of the project gives the contractor adequate time to plan for the project and in the long run cut project costs as well as

improve on the quality of the work. This especially benefits the client and the benefits include but not limited to improved schedule, cost, safety and quality performance.

- Contractors when engaged at an earlier stage of the design process helps them develop more knowledge and improve their performance on future projects.
- Jergeas G. and Van der Put J. (2001) further contribute that the use of construction sensitive schedules as well as the use of designs that facilitate construction efficiency can be added benefits of ECI.

In addition, Love et al. (2014) states that a contractor's input during the pre-construction process can significantly improve project design, specification and potentially stimulate innovation as well as significantly improve planning and scheduling and, therefore, reduce a project's construction period. Love et al. (2014) explains that this is achieved through the contractor's expertise with constructability input into the design phase. Love et al., (2014) and Wong et al., (2000) have suggested that constructability enables the:

- Economic use of contractor resources;
- Design requirements to be easily visualized and coordinated by site staff;
- Contractor to develop and adopt alternative construction details;
- Contractor to overcome restrictive site conditions;
- Incorporation of standardization and off-site manufacture;
- Simplification of construction details in case of non repetitive element and;
- Design to achieve safe construction sequences on site.

As discussed previously by Love et al., (2014), the tender process for the appointment of a contractor under the ECI model is not based purely on price. Love et al., (2014) and Mosey (2009) state that the ECI model and approach to tendering is beneficial for the contractor, as it allows them to differentiate themselves from competitors based upon their expertise, experience and capability and can contribute to reducing a contractor's bidding costs, as resource requirements for arbitrary tendering are reduced.

Though Love et al. (2014), Mosey (2009), Song et al. (2009) and Jergeas et al. (2001) have clearly outlined the benefits of Early Contractor Involvement; their study was carried out in Australia and the United States of America which are developed countries as compared to South Africa which is a developing country. The purpose of this research is to observe if the said benefits apply to developing countries, the case of South Africa and contribute on other benefits if they may arise during the investigation.

2.4.3 BARRIERS TO EARLY CONTRACTOR INVOLVEMENT AND THEIR IMPACT ON HEALTH AND SAFETY

The fact that ECI has not been adopted widely means there are challenges hindering this adoption in the construction industry. ECI represents a radical change from the traditional procurement process (Song et al. 2009).

Various barriers of ECI have been discussed by O'Connor and Miller, (1994) and Song et al. (2009). The distinctive barriers that are discussed include:

- Challenges in the contracting practice that is, alternative project delivery methods,
- Teamwork and partnering issues,
- Culture change brought about by lack of understanding of the concepts and its benefits,
- Ma et al. (2010) argue that both clients and contractors are reluctant to disclose too much information on the project before award of contracts,
- According to Tan and Lu, (1995); Fox et al. (2002) argue that in ECI, the client and contractor tend to focus on the construction works more than the design to accelerate the date of completion of the project. This tends to bring about issues of wastage and reworks as not enough attention was paid on the design and
- Mokhtar et al. (2000) debates that interrelated decisions between architects and engineers can be brought about by ECI in that the different changes brought about by the contractor can bring incompatibility issues and errors during construction.

Love et al., (2014) and Mosey (2009) state that to acquire the participation of a contractor in the pre-construction process, a level of remuneration is invariably required. They state that as a result, it is often perceived that additional money is being spent by a client that would not have been required under a traditional single-stage tender. Atkinson et al., (1997) states that despite this misconception, it has been reported that a cost saving of 10-20 times the actual remuneration paid for ECI can be attained. Mosey (2009) explains that ECI costs remain a risk to the client, as there are no guarantees that the contractor can provide a fixed price that is suitable after their appointment to construct the works. This can result in the client having

to seek an alternative procurement method, in which case, part of the value gained from the Early Contractor Involvement is lost (Love et al., (2014).

The traditional contracting practice of design, bid and build further prompts the separation of the design from the construction process (Song et al, 2009). Song et al (2009), further state that this separation also hinders the design and construction knowledge integration and diminishes the opportunity for contractors to influence design decisions.

The failure of design professionals to consider how a contractor will implement the design can result in scheduling problems, delays and disputes during the construction process and hence harm the overall project performance (Arditi et al. 2002, Song et al. 2009). It can also result in higher number of accidents and fatalities in construction sites.

The traditional procurement model has been recognized for its ability to facilitate competitive pricing through a single-stage tender and often results in tenders based on very low profit margins, therefore providing the lowest possible price for the client (Love et al., 2008). Love et al., (2008) further explains that the ECI model appoints a contractor to the construction phase through a negotiated process and thus, there is the perception that a lack of competition will inflate prices. Mosey (2009) explains that the opportunity of inflating prices is limited in the two-stage tender model as the contractor is required at the initial tender stage to disclose their profit margin and overheads.

In addition, Mosey (2009) states that in the first stage of the pre-construction phase, the contractor has no guarantees that they will be appointed to undertake the construction of the project and thus, the contractor may limit the amount of information and knowledge they are willing to divulge prior to the awarding of the construction contract. Furthermore, Love et al., (2014) adds that the methods of construction adapted in the design stage can be guided by a contractor so that it favours their selection; if the negotiation stage fails, and competitive tenders then take place, then the contractor can have an advantage over other competitors. Love et al., (2014) and Mosey (2009) state that in such a case, a contractor may seek to use this leverage to inflate their construction price and reduce their level of risk exposure.

Another foreseeable barrier to ECI is explained by the Government of Western Australia (2010), and they state that the ECI model provides no guarantee that during the design development, pricing and risk analysis will meet a client's needs in terms of their brief,

budget and time frame. They further add that his may result in the need to disengage the contractor and select another through an alternative form of procurement route. In this instance, time and cost increases may arise, with a significant portion of the project's cost or value established with the contractor being lost.

Love et al., (2014) explains that another barrier identified from previous research is the reluctance of architects and engineers to accept input from construction personnel. This may be seen as a problem as ECI requires project participants to work in a cooperative manner. Love et al., (2014) adds that the gap that exists between design and construction has been professionally institutionalized, so that people from different organizations have lost some of the respect for, and the ability to work cooperatively with one another.

The above outlined barriers of Early Contractor Involvement as discussed by O'Connor and Miller, (1994), Song et al, (2009), Mosey (2009) and Love et al., (2014) were discussed from a developed countries point of view. This research will discuss the barriers of ECI from a developing countries point of view, the case of South Africa. The research will strive to see if the same barriers apply in developing countries and contribute other barriers if they may arise during the investigation to further the literature in this area.

2.5 DESIGNING FOR SAFETY

Designing for Safety is defined as the consideration of construction site safety at the design stage of a construction project (Dulaimi, 2014). Various people are involved in the designing for safety in construction and they include the architect, the civil and structural engineer, mechanical engineer, electrical engineer and the interior designer.

Hinze, (1992), states that the problem with construction worker safety is that traditionally, it lies as the responsibility of the contractor whereas the designers' designs impact on construction worker safety. Designers have a moral, economic obligation to ensure that their designs are safe to build (Lam and Wong, 2009). According to studies done by OGC (2007), Lam and Wong (2009), an estimated 60% of fatal accidents were attributed to decisions and choices made before the work began. Dulaimi (2014) further states that in the last two decades the researchers and practitioners in the industry have started to shift the blame of

accidents and fatalities from the contractors to the designers as they should consider site safety as a design criteria.

Designing for construction safety in the recent years has been considered as the foremost method of eliminating hazards and reducing risk rather than controlling the hazard and protecting the construction workers from it (Dulaimi 2014, Gambetese and Behm 2008, Manuele 1997). As designing for safety may be the preferred method of dealing with Health and Safety issues on construction sites, many designers in the industry are yet to incorporate this in their designs as clients normally have a cost constraint. According to Dulaimi (2014), designing for safety influences the choice of construction methods and materials and this may increase the budget cost of the client.

With one of the major challenges experienced on construction sites being the use of a contract work force that are often unskilled, poses a higher risk of accidents and fatalities on site. Dulaimi (2014) states that developing an adequate safety strategy is complicated as projects in the construction industry are quite unique and vary from client to client with various time and cost constraints. With such constraints, health and safety and safety performance of the project tend to be side lined.

The consideration of safety requirements at the early design stages of construction and other industries has been widely recognized as a beneficial approach for safety management, since it is an effective way of either reducing or eliminating hazards at their sources (Saurin, 2008). Saurin further argues that when hazards are anticipated at an earlier stage, there will be more time available to plan for safe construction methods, which boosts the safety performance of the project.

With an increase in concern on construction Health and Safety especially in the developed areas such Europe, laws and regulations such as the Construction Design and Management Regulations have been enforced by the European Union which strive to enhance construction work safety as well as allocate certain safety duties to the designers including designing for construction site safety (Dulaimi 2014, Behm and Culvenor 2011). In developing countries such as South Africa, designers have not yet embraced designing for safety as it is not necessarily required by the law and designers tend to avoid utilizing this concept for fear of liability during construction. *Figure 2.3* below shows the Design for Safety concept, implementation factors and impacts.

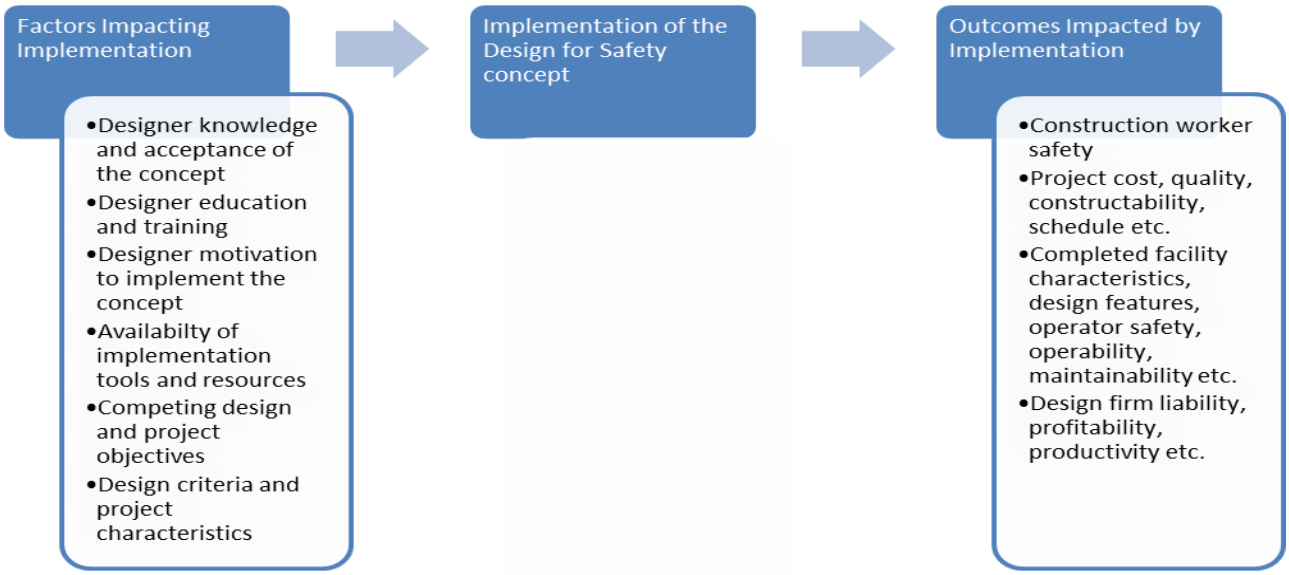


Figure 2.3: Design for Safety concept, implementation factors and impacts.

Source: Adapted from Gambatese et al. (2005)

Despite this knowledge being recognized by the clients, designers and contractors, there are various barriers prohibiting the design for safety concept in the construction industry. These barriers identified by Hecker (2006), Mackenzie et al, (2000), Hinze and Gambetese (1996) and discussed by Saurin (2008) include the following but not limited to:

- There are liability fears on the part of the architect and the engineers for becoming involved in construction site safety especially in the USA.
- The design for safety reviews may increase the professional fees.
- Tight project schedules established by the client may discourage thorough analysis of safety issues in favour of other design requirements.
- The lack of information and uncertainty, noticeably in early design stages.
- The limited education architects and engineering designers receive on construction safety.
- Limited availability of safety in design tools, guidelines and procedures.
- Limited pre-construction collaboration between the designer and the contractor due to the traditional contracting structure of the construction industry.
- The narrow specialization of the construction and design professionals, which may make it difficult their involvement in safety management.

Most construction projects address the issue of safety when the construction phase has begun. Designers tend to keep away from issues regarding safety in construction projects mostly to avoid litigation as well as liability for injuries that occur on construction sites as a result of their designs. In addition, the building codes and standards are a bit ambiguous on the matters of designers and safety on construction sites. *Figure 2.4* below shows the consideration of worker safety in designer selection of firms with large construction budgets.

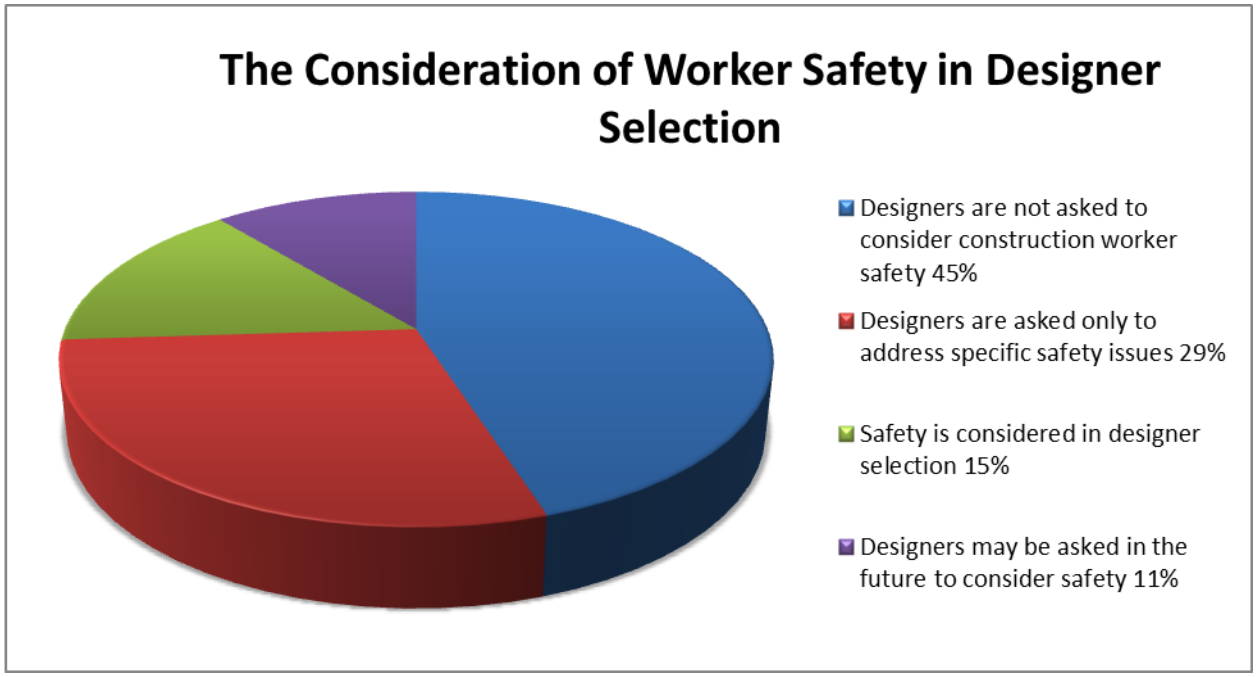


***Figure 2.4*:** The consideration of worker safety in designer selection of firms with large construction budgets.

Source: Venkatachalam (2014)

The direct involvement of the client can promote safety in both the design and construction phases. The owner can select the contractors based on their safety performance, Experience Modification Rate and Injury Incident Rate. The owner can also insist on the designers to design in safety and also include safety in contracts to the contractors.

2.6 GLOBAL RESEARCH ON THE SAFETY PERFORMANCE OF CONSTRUCTION SITES

A number of studies have been carried out globally about the effect of Early Contractor Involvement and Safety performance on construction sites and established a link between the two. Few of these studies touch on the various attitudes the designers' in the construction industry have towards Early Contractor Involvement and even fewer of these studies have been carried out in the African context. A review of the most important literature shows that most of the researches in attitude measurement used questionnaire surveys to conduct their researches. *Table 5* below summarizes the different research methodologies that have been used in similar studies such as this.

Table 5: Summary of the different research methodologies that have been used in similar studies such as this.

RESEARCHER	CONTEXT	RESEARCH METHODOLOGY
Behm M. (2005)	United States of America	Sampled Survey Questionnaires
Cheng E. et al. (2011)	Hong Kong	Sampled Survey Questionnaires
Christianson (2005)	United States of America	Sampled Survey Questionnaires
Dulaimi M. (n.d)	Dubai	Sampled Survey Questionnaires
Gambatese et al. (2005)	United States of America	Sampled Survey Questionnaires and Interviews
Gambatese J. et al. (2008)	United States of America	Sampled Survey Questionnaires and Interviews
Gangolellis M. et al. (2009)	Spain	Sampled Survey Questionnaires
Hale A. et al. (2003)	Norway	Sampled Survey Questionnaires
Haupt T. et al. (2003)	United States of America	Sampled Survey Questionnaires

		and Open-Ended Questions
Hinze J. et al. (2005)	United States of America	Interviews
Hinze J. et al. (2013)	United States of America	Sampled Survey Questionnaires and Interviews
Lingard H. et al. (2014)	Australia and New Zealand	Sampled Survey Questionnaires
Love et al. (2014)	Australia	Sampled Survey Questionnaires and Semi-structured Interviews
O'Donoghue D. et al. (2013)	Australia	Sampled Survey Questionnaires and Semi-structured Interviews
Rahman M. et al. (2012)	United Kingdom	Sampled Survey Questionnaires
Smallwood J. (1998)	South Africa	Sampled Survey Questionnaires
Smallwood et al. (2009)	Botswana	Sampled Survey Questionnaires
Smallwood et al. (2014)	South Africa	Sampled Survey Questionnaires and Semi-structured Interviews
Song L. et al. (2009)	United States of America	Case study and theoretical simulation analysis

Majority of the studies done, pertained the benefits and barriers of ECI and some looked into why ECI was not prevalent in the construction industry as well as the effects of ECI on safety performance of construction sites. A great number of the studies were carried out in developed countries.

Literature review was used to identify possible questions and develop the quantitative research for data collection *(Refer table 6 below).* The available literature had limited to no information on the various attitudes of the designers' in the South African construction industry towards the use of ECI as a means to improve safety performance on construction sites. For this reason, a quantitative approach was deemed necessary so as to collect the relevant data required for this research and provide a richer theoretical and empirical perspective of ECI and its relation to safety performance in South African construction industries than that which already exists in the literature.

Table 6: Summary of the different questions that have been used in similar studies such as this as well as their context and authors.

#	Research Question/ Statement	Researcher	Context	Outcome
1	Designers are committed to safety performance on construction sites.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Smallwood et al. (2009), Love et al. (2014)	Dubai, Norway, USA, Botswana, Australia,	Studies as well as literature review show that majority of the professionals in construction do not believe this to be true.
2	Contractors can contribute towards design for safety.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008), Love et al. (2014)	Dubai, Norway, USA, Australia,	Studies as well as literature review show that designers believe this to be true.
3	Contractors understand the implication of the various designs on safety.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008)	Dubai, Norway, USA,	Studies as well as literature review show that designers believe this to be true.
4	Contractors have the necessary knowledge to contribute towards designing for safety.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008)	Dubai, Norway, USA,	Studies as well as literature review show that designers believe this to be true.
5	Contractors are committed to safety promotion/ accident promotion on their construction sites.	Dulaimi M. (n.d), Hale A. et al. (2003), Gambatese J. et al. (2008)	Dubai, Norway,	Studies as well as literature review show that designers believe this to be true.
6	Accidents can be prevented by Early Contractor Involvement.	Gambatese J. et al. (2008), Song L. et al. (2009), Smallwood et al. (2009), Love et al. (2014)	USA, Botswana, Australia,	Studies as well as literature review show that designers believe this to be true.
7	Communication with the contractors during the design phase is effective.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005)	Dubai, Norway, USA,	Studies as well as literature review show that majority of the professionals in construction do not believe this to be true.

8	Contractors can assume liability for their involvement in the design process when involved earlier in the process.	Dulaimi M. (n.d), Hale A. et al. (2003)	Dubai, Norway,	Studies as well as literature review show that designers believe this to be true though this is regarded as contractual issue.
9	Contractors can take full liability for accidents and fatalities that occur on construction sites after Early Contractor Involvement	Dulaimi M. (n.d), Hale A. et al. (2003), Song L. et al. (2009)	Dubai, Norway, USA	Studies as well as literature review show that designers believe this to be true though this is regarded as contractual issue.
10	Designers will be held liable for accidents and fatalities that occur during the construction stage as a result of Early Contractor Involvement.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Song L. et al. (2009), Love et al. (2014)	Dubai, Norway, USA, Australia,	Studies as well as literature review show that designers believe this to be true.
11	Accidents and fatalities that happen on the construction site after Early Contractor Involvement will have an impact on your career and success/ credibility and reputation.	Hale A. et al. (2003), Behm M. (2005), Song L. et al. (2009)	Norway, USA	Studies as well as literature review show that designers believe that the use of ECI may have an impact on their careers in case an accident or fatality was to occur.
12	Contractors should have an influence in the design process.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008), Love et al. (2014)	Dubai, Norway, USA, Australia,	Studies as well as literature review show that designers agree with this statement.
13	Contractors experience safety performance constraints when not involved in the design process.	Dulaimi M. (n.d), Hale A. et al. (2003), Gambatese J. et al. (2008)	Dubai, Norway,	Studies as well as literature review show that designers believe this to be true.
14	The client's requirements can pose safety risks during construction.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008), Smallwood et al. (2009)	Dubai, Norway, USA, Botswana	Studies as well as literature review show that designers believe this to be true.

15	The involvement of the contractor earlier during the design stage may lengthen the design process.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005)	Dubai, Norway, USA,	Studies show that designers believe this to be true but the literature review revealed that in fact ECI may shorten the design process.
16	Contractors have knowledge to offer when involved earlier in the design process.	Dulaimi M. (n.d), Hale A. et al. (2003), Love et al. (2014)	Dubai, Norway, Australia,	Studies as well as literature review show that designers believe this to be true.
17	Designers have the required knowledge in design for safety.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008), Love et al. (2014)	Dubai, Norway, USA, Australia,	Studies as well as literature review show that designers believe this to be true.
18	Contractors are aware of potentially hazardous risks	Dulaimi M. (n.d), Hale A. et al. (2003), Gambatese J. et al. (2008)	Dubai, Norway, USA,	Studies as well as literature review show that designers believe this to be true.
19	Designers in construction believe they have more knowledge in identifying safety issues than the contractors.	Dulaimi M. (n.d), Hale A. et al. (2003), Behm M. (2005), Gambatese J. et al. (2008), Smallwood et al. (2009)	Dubai, Norway, USA, Botswana	Studies show that designers believe this to be true though the literature review reveals that contractors may in fact have more knowledge in identifying construction safety issues.
20	Early Contractor Involvement can improve the safety performance on a construction site.	Love et al. (2014), Song L. et al. (2009), Mosey (2009), Ma T et al. (2010), Jeargeas et al. (2001)	Australia, USA	Studies as well as literature review show that designers believe this to be true.
21	Early Contractor Involvement can reduce the number of variation claims on a construction site.	Love et al. (2014), Song L. et al. (2009), Mosey (2009), Ma T et al. (2010), Jeargeas et al. (2001)	Australia, USA	Studies as well as literature review show that designers believe this to be true.
22	Early Contractor Involvement can reduce disputes on a construction project.	Love et al. (2014), Song L. et al. (2009), Mosey (2009), Ma T et al. (2010), Jeargeas et al. (2001)	Australia, USA	Studies as well as literature review show that designers believe this to be true.

23	Early Contractor Involvement can improve the site safety on a construction site.	Love et al. (2014), Song L. et al. (2009), Mosey (2009), Ma T et al. (2010), Jeargeas et al. (2001)	Australia, USA	Studies as well as literature review show that designers believe this to be true.
24	Early Contractor Involvement can improve the constructability on a construction project.	Love et al. (2014), Song L. et al. (2009), Mosey (2009), Ma T et al. (2010), Jeargeas et al. (2001)	Australia, USA	Studies as well as literature review show that designers believe this to be true.
25	Early Contractor Involvement can improve the risk management on a construction project.	Love et al. (2014), Song L. et al. (2009), Mosey (2009), Ma T et al. (2010), Jeargeas et al. (2001)	Australia, USA	Studies as well as literature review show that designers believe this to be true.

2.7 MEASURING ATTITUDES

There are various studies that have been carried out on how to measure attitude. There are very limited studies however that have been done in regards to the various attitudes towards Early Contractor Involvement and the Safety Performance on construction sites. Studies conducted by Love et al. (2014), Mosey (2009), Smallwood et al. (2009), Gambatese (2005), Christianson (2005) and Dulaimi (n.d) on the various attitudes that designers may have towards designing for safety and enhancing construction worker safety were carried out by the use of a Likert scale as this was seen as the best method of capturing attitudes and perceptions. Various studies have been carried out and discussed in summary by Hale et al. (2003) and Dulaimi et al. (n.d) on the relationship between powerlessness, dissatisfaction, mistrust, reduced knowledge, anxiety and lack of job control coping.

A review of the literature identified 8 factors that may influence the perception of the designers in the construction industry towards the use of ECI in the industry. The factors include:

- Trust
- Commitment
- Fatalism concerning accident prevention
- Communication
- Personal worry and emotion
- Powerlessness
- Priorities of safety
- Contractor awareness

- **Trust and Commitment**

From a review of the literature, various concerns were clear that would influence the various attitudes the designers may have towards the use of ECI in the construction industry. One of the main concerns clear from the studies conducted by Hale et al. (2003) and Dulaimi et al. (n.d) was trust and commitment. The designers in the construction industry had trust issues regarding the contractors' commitment in improving the safety performance of their construction sites. The designers also had concerns on the contractors' level of commitment to designing for safety in construction. Nonetheless, from the literature review and studies

conducted, the designers in the construction industry believed that contractors were committed to safety improvement on their construction sites. Furthermore, the designers believed that the contractors could contribute to designing for safety.

- **Fatalism concerning accident prevention**

Another concern present in the literature review was whether accidents could be prevented by the use of ECI. The designers in the construction industry were keen to understand whether ECI could actually prevent accidents during construction or designing for safety was sufficient enough without the involvement the contractors earlier in the design phase of the project. From the literature and studies conducted regarding this matter, the outcome showed that majority of the designers in the construction industry believed that ECI can reduce the number of accidents and fatalities that may happen during the construction phase of the project.

- **Communication**

Communication between the designers and the contractors during the design phase of the project was another concern noted from studies conducted by Hale et al. (2003) and Dulaimi et al. (n.d). Designers believed contractors would cause friction between the design team and client if they were included in the design phase of the project. Designers believed that the inclusion of an extra person to the design team would lengthen the design process. Nonetheless, a study conducted by Love et al. (2014) revealed that bringing in the contractor at an earlier stage of the project may form better relationships with the rest of the project team which would be beneficial to the project in terms of reduced legal issues between parties.

- **Personal worry and emotion**

Another main concern established from the literature review was the designers' personal worry towards the use of ECI. Their main worry was in regards to the liability issue in case of accidents and fatalities occurred even after including the contractor earlier in the project. Designers believe they may be held liable for accidents and injuries that may happen during the construction phase of the project if the incorporated the use of ECI. Though, this may be seen as a contract issue, designers were concerned on taking liability of accidents and fatalities that may happen on site. The literature and various studies conducted regarding this

matter revealed that majority of the designers in the construction industry in developed countries believed that the contractor would assume all liability if accidents and fatalities would occur during the construction phase of the project if they were included in the design phase of the project.

- **Powerlessness**

A review of the literature revealed that contractors felt powerless and constrained when not involved in the design phase of the project. Contractors felt that they had little influence on the design and thus, were unable to make safety performance enhancements on the design so as to improve the safety performance on site. The literature review revealed that designers in developed countries believed that the contractors did experience safety performance constraints from not being included in the design phase of the project.

- **Priorities of safety and Contractor awareness**

Another main concern established from the literature view was whether contractors have any knowledge to offer if they are included earlier in the project. Designers were concerned whether contractors understood the concept of designing for safety and its implications. Designers were also concerned whether contractors would be able to identify potentially hazardous risk from the designs prior to construction. The literature revealed that indeed the designers believed that contractors would be able to identify potentially hazardous risks from the design phase of the project and thus, would be beneficial to the project if they were included earlier in the design phase of the project.

It should be noted that from the literature review, studies conducted by Love et al. (2014) and Mosey (2009) reveal that clients also had a concern with the implementation of ECI in terms of cost escalations due to employing of a contractor earlier in the project as well as trust issues in bring in the contractor earlier in the project as they would expose the project budget before the tendering process.

A five point *Likert Scale* rating that spreads from strongly agree to agree to neutral to disagree to strongly disagree has been identified by various scholars such as Saunders et al. (2012), as the best method to collect and measure attitudes or perceptions of something. This rating scale allows the respondent to feel indifferent about certain statements poised to them

by including the 'neutral' category on the rating scale. This rating scale has been adopted by various scholars including a research done by Hale et al. (2003) used this type of rating scale to conduct their researches. Dulaimi et al. (n.d) also adopted the use of a 7 point Likert scale to establish the designers' attitudes towards designing for construction safety.

2.8 CONCLUSION

The *literature objectives* of this research study included the following:

- Assess the designers' awareness/ familiarity with the concept of ECI.
- Explore ECI's relationship to design and site safety.
- Identify the possible effects of ECI on safety performance.
- The various attitudes the designers may have towards ECI and Safety Performance.
- Assess the designers' level of knowledge on the barriers and benefits of ECI.

A review of the literature revealed the following in regards to the above objectives;

- **Assess the designers' awareness/ familiarity with the concept of ECI.**

A review of the literature revealed that designers in the developed countries had some knowledge on ECI especially in the UK and Australia but only a few had practiced it. In the case of Australia, only the designers who had big projects with the government had practiced ECI. Regardless, the literature review shows that designers are aware of the concept of ECI in the industry.

- **Explore ECI's relationship to design and site safety.**

Studies carried out by renowned authors such as Smallwood and Haupt among others revealed that there is indeed a link between ECI and site safety. The introduction of a contractor earlier in the project has positive effects when it comes to site safety during the construction phase according to the various studies conducted on the matter.

- **Identify the possible effects of ECI on safety performance.**

A review of the literature revealed that majority of the studies conducted in regards to the effects of ECI on the safety performance of a site showed that ECI improves the general

safety performance of a construction site as well as the health and safety of construction workers during construction.

- **The various attitudes the designers may have towards ECI and Safety Performance.**

The literature review revealed that surveys done in developed countries regarding the attitude of designers' towards ECI and safety performance showed that majority of the designers believe that ECI has a positive impact towards improving the safety performance of a construction site.

- **Assess the designers' level of knowledge on the barriers and benefits of ECI.**

A review of the literature revealed that even though majority of the designers both internationally and locally have not practiced the use of ECI in their projects; they do have knowledge on the benefits and barriers of ECI. A list of benefits and barriers in respect to safety performance and construction safety carried out in previous studies done in the developed countries were consolidated and included in this research to find out if the designers in the South African construction industry had the same perception as well.

Toole, (2002), states that it is prudent that all the parties involved in the development of a project communicate their expectations concerning the site safety roles throughout the project. A study carried out by Toole, (2002) found out that effective communication and coordination between all stakeholders during the design stage improved the safety performance during construction especially if the contractor was involved during the design stage.

In conclusion, a review of the literature and studies carried out in developed countries regarding the designers' in the construction industry's perception towards the use of ECI and its impact on the safety performance on construction sites reveal that majority of the designers believe that the use of ECI could improve the safety performance in construction sites as well as reduce the number of accidents and fatalities on site.

3.0 RESEARCH METHODOLOGY

3.1 INTRODUCTION

There has been limited research done on the impact of Early Contractor Involvement on Health and Safety as well as the safety performance in the construction industry especially in the developing countries that have a lot of construction projects going on currently due to improved infrastructure in the recent years. From the literature, it has been noted that ECI improves on the Safety Performance of construction sites as well as has a general improvement on the Health and Safety of a project.

Though the literature in this topic is limited, there is enough literature to conduct a positivist collection instrument. A survey was done and a questionnaire developed from an analysis of the literature review and was used to determine the designers' attitude towards ECI and safety performance on construction sites.

3.2 RESEARCH OBJECTIVE

The main objective of this study was to determine the designers' in the construction industry's attitude on the effects of Early Contractor Involvement on the safety performance on South African (Gauteng Region) construction sites. The empirical objectives are:

- Identify the trust relationship between designers and contractors;
- Explore the designers beliefs regarding ECI as a way of increasing the safety performance on construction sites;
- Explore how the designers feel about ECI and liability issues due to introducing the contractor earlier in the design process;
- Explore whether the designers' believe contractors feel powerless for not being included in design phase;
- Explore the designers' beliefs on the communication barrier between designers and contractors and

- Explore the designers' beliefs on the commitment of contractors towards safety promotion and improving safety performance of their construction sites.

3.3 RESEARCH PHILOSOPHY

This research was done from a positivist epistemological perspective where the real world out there was made independent from the observer. The facts in a positivist epistemological perspective are value-free.

The research aims to determine the attitude or perception of the designers' in construction towards Early Contractor Involvement and its role on improving safety performance on construction sites. Thus, according to Saunders et al. (2012), the best suited philosophy for this research question was the *Positivist* philosophy. This is done by sending out a large scale survey using questionnaires to collect empirical data.

3.4 RESEARCH APPROACH

This research followed a *deductive* approach where the empirical data collected is used to test a theory. The literature provided guidance to developing an instrument for this research. The researcher collected the data from various construction professionals in the Gauteng Region of South Africa, so as to get a clear theoretical position on the attitude designers' may have towards the use of ECI in the South African construction industry as well as towards safety performance on construction sites.

According to Saunders et al. (2012), this type of approach is best suited for researches where the theory is developed from a review of the literature and suitable a research strategy is designed to test the theory.

3.5 RESEARCH DESIGN

The research followed an *descriptive* design where the researcher established a link between the lack of use of Early Contractor Involvement in South African Construction projects and the designers' in the construction industry's attitude towards it. A descriptive design as discussed by Saunders et al. (2012), strives to gain an accurate profile of situations or events. In this research, the researcher strived to find out what the designers in the South African construction industry thought about the use of ECI as a means to improve safety performance on construction sites.

3.6 RESEARCH STRATEGY AND TIME HORIZON

The research used a *survey* strategy. A questionnaire survey was developed based on the literature review. Saunders et al. (2012) states that this strategy allows for the collection of standardized data that can be easily analysed. This strategy was specifically chosen by the researcher as it is easy to generate findings that are representative of the whole population. This research was a *cross sectional* study as it strived to study and understand the designers' in the construction industry's attitudes towards ECI currently.

3.7 RESEARCH METHODS

The research method that was adopted for this research entailed initially the carrying out of a qualitative research in the various Body Of Knowledge (BOK) available and identifying the various attitudes the designers' in the construction industry may have towards the use of ECI as a means to improve the safety performance of construction sites in South Africa. The effect of the use of ECI on the safety performance and the various benefits and barriers of ECI were also researched qualitatively from the various bodies of knowledge available.

3.8 RESEARCH SCOPE

The setting for this research was Gauteng Province, South Africa. The main reason for choosing this region in South Africa was that it leads in the highest number of construction accidents and fatalities in the country which can be attributed to the many large scale construction projects going on in this particular region as compared to the rest of the country.

The target population for this research is the designers' in the construction industry, that is, Architects, Civil/ Structural Engineers and Project Managers. The region selected for this research, that is, Gauteng Region, is characterized by large scale construction projects which attract international designers who work with the local designers in South Africa. Thus, the local designers in construction can give insight on the use of ECI as a practice in procurement; the benefits and barriers of the use of ECI in South Africa, its effect on the construction safety performance on site as well as their attitude towards ECI.

3.9 TARGET POPULATION AND SAMPLING PROCEDURES

The target population of this research consisted of designers in the construction industry specifically architects and engineers. This research used a *census sampling procedure* as all the designers' in the Gauteng Region of South Africa identified by the researcher were emailed a link to the questionnaire survey. Architects and engineers were identified from different South African registration bodies' databases and the South African yellow pages directory. These databases included architects and engineers in the Gauteng Region of South Africa and not necessarily those who have practiced ECI. There were approximately 500 questionnaire surveys sent out but the number of professionals sampled could be higher as the architectural and engineering firms were requested to send out the questionnaire survey to their employees. This gives a wider view on the matter at hand as opposed to using only architects and engineers who have practiced ECI. Should this response rate to the survey not be sufficient, demographic data will be used to analyse whether the data collected can be seen as representative of the population.

3.10 DATA COLLECTION

The main data collection method that was utilized for this research was a self-completed questionnaire. Each participant targeted was asked to respond to a set of predetermined questions which were the same of all the participants involved in the research. This research took up a survey strategy and according to Saunders et al. (2012) the use of questionnaires is the most commonly used data collection method for the survey method as well as the most suitable for this type of research. Smallwood et al. (2009) states that, respondents find it easier to respond to questionnaires in privacy and in their spare time. Saunders et al. (2012) continues to state for a research that strives to determine the various attitudes or opinions of the participants can best be captured by the use of questionnaires as questionnaires are able to identify and describe the variability in different phenomena. Furthermore, previous research in this area as discussed in the Literature Review chapter, carried out their data collection using questionnaires.

3.11 RESEARCH PROTOCOL

The survey was electronically administered and a link to the survey was sent to all the identified companies that could have possible respondents in the target population. The email contained a brief introduction to the research and a more detailed information sheet was attached *(Refer Appendix A).* By using the link, a layer of anonymity was provided.

The researcher keyed in all the email addresses of the participants involved and sent the link to the self-completed questionnaires to them and after the questionnaire was fully completed, it was automatically sent back to the researcher for data analysis. Due to the time and cost constraints as well as the large sample number required for the survey, this method was deemed suitable for this research.

The email stated that the participants' responses would be anonymous and not linked to their email address and in addition, the information that they provide would only be reported in an aggregated format. The email and participant information document attached to the email also stated that the participant's participation in this research was voluntary and their refusal to participate would not be penalized as well as there would not be any loss of benefit for

non-participation. The participants in this research were also informed in the email and participant information sheet that all the information obtained from the questionnaire answered would be kept confidential but absolute confidentiality cannot be guaranteed.

3.12 RESEARCH INSTRUMENT

3.12.1 LIKERT- STYLE RATING SYSTEM

The questionnaire was based on a *Likert-style Rating System* where the participants were asked to rate their opinion in terms of how they strongly agreed or strongly disagreed with a series of statements. This particular questionnaire is based on a five point *Likert Scale* rating that spreads from strongly agree to agree to neutral to disagree to strongly disagree. This rating scale allowed the respondent to feel indifferent about certain statements poised to them by including the 'neutral' category on the rating scale. Saunders et al. (2012), states that this rating design is the most suitable method in collecting the respondent's attitude or opinion on something.

The questionnaire was delivered in three (3) sections which consist of the following *(Refer Appendix D):*

Section One

This part consisted of an information letter attached to the email address which explaining the purpose of the survey and the contact details of the researcher among other details of the research. The information letter outlined the steps that would be taken to offer anonymity of the participant as well as the steps that would be taken to guarantee confidentiality of the participant's responses if they chose to take part in the survey.

Section Two

This section, which is officially the first part of the questionnaire, contained the demographic information which entailed finding out the respondents work description and work experience as a designer in the construction industry as well as their level of education in their particular fields. It is believed that demographic data can be used to compile the data in the case where

the data received is insufficient as it can be generalized as representative of the population. The following demographic data was collected:

- The participant's role in design of construction projects;
- The participant's experience in the construction industry and;
- The participant's qualification/ education background.

This section consisted of the bulk of the questions which were mainly identified from the literature review chapter and a conceptual framework produced. A five-point *Likert scale rating system* was by the respondents to answer the questions and consequently measure their attitudes on the statements posed to them. This quantitative research can be categorized as Ranked (Ordinal) Data in that the 5 point Likert scale was used to depict the different attitudes and opinions the respondents had on the various questions given a scale and thus were ranked; in other words numerical values were used to denote the various attitudes the respondents had per question to aid in the data presentation. For example,

The 5 point Likert scale used by the researcher and their rankings were as follows;

- *Category One (1)* represents *Strongly Disagree*
- *Category Two (2)* represents *Disagree*
- *Category Three (3)* represents *Neutral*
- *Category Four (4)* represents *Agree*
- *Category Five (5)* represents *Strongly Agree*

The part of this section consisted of the benefits and barriers of Early Contractor Involvement in relation to Safety Performance in construction sites *(Refer 2.4.1 and 2.4.2).* These benefits and barriers of ECI were been identified from previous studies carried out in developed countries and this particular research strived to determine if the same benefits and barriers were applicable in developing countries such as South Africa and hopefully contribute to the limited literature available in this area.

Section Three

The third and last section of the questionnaire contained the email address of the researcher, where the respondents could enquire for further information and follow up on the outcome of this research if they wished to.

3.12.2 MEAN SCORE INDEX

The calculation of a mean score index was also done to establish the perception on the order of importance of Health and Safety and Safety Perception relative to other on a construction project. The mean score index was calculated by computing the total of all weighted responses and then relating it to the total responses on a particular aspect. The weights were assigned to each response ranging from one to five for the responses of *Strongly Disagree* to *Strongly Agree*. The weighting was allocated as presented in *Table 7*. The weighting was developed based on the *Likert scale* of 1 to 5.

Table 7: Opinion weighting on the level of importance

Opinion	Responses	Weighting
Strongly Agree	a_1	5
Agree	a_2	4
Neutral	a_3	3
Disagree	a_4	2
Strongly Disagree	a_5	1

Computation of the importance index was done with the following formula:

$$\textbf{Importance index} = \frac{5a_1 + 4a_2 + 3a_3 + 2a_4 + 1a_5}{\sum a}$$

Table 8 below was adapted from Jillson (2002), and it shows the outcome of responses in respect to the mean of a question. The mean score is then multiplied by the weighting and this shows where on the opinion scale it lays. This was the method adapted by the researcher for this analysis.

The coefficient of variation analysis scale as derived by Jillson (2002) and adapted for this research is as follows:

Table 8: Jillson (2002) Group scores and opinion rating

Group Score	Opinion
Greater than 4.20	Strongly Disagree
Greater than 3.40 but less than or equal to 4.20	Disagree
Greater than or equal to 2.60 but less than 3.40	Neutral
Greater than or equal to 1.80 but less than 2.60	Agree
Less than 1.80	Strongly Agree

3.12.3 THE COEFFICIENT OF VARIATION

The coefficient of variation which is also known as the relative standard deviation is a standardized measure of dispersion of a probability distribution or frequency distribution. CV is use to show the extent of variability in relation to the mean of the population. The coefficient of deviation is defined as the ratio of the standard σ to the mean μ.

$$CV = \frac{\sigma}{\mu}$$

The main advantage of using CV is that the actual value of CV is independent of the unit in which the measurement has been taken and thus, it is best suited for comparison between data sets with different units or widely different means.

The researcher used the CV analysis to identify the spread in responses. Jillson (2002) provided a scale in which the CV was translated into group scores so as to convert the nominal scale as interval data.

3.12.4 Z-SCORE TO PERCENTILE RANK

The Z-Score to percentile rank is a Six-Sigma technique that converts raw score to normal score. Sauro (2011), states that a reasonable benchmark to compare to the mean on a 5 point Likert scale is 4. Sauro (2011) provides 3 steps of calculating the Z-Score to Percentile Rank;

Step One: Subtract the benchmark, that is, 4, from the mean,

Step Two: Divide the difference by the standard deviation,

Step Three: Convert the Z-Score to percentile rank.

The researcher converted the Z-Score to percentile Rank using an online calculator provided by Sauro (2011). The Z-score to percentile rank was used to rank the responses and was compared to a top 2 box score as well as the mean score and the CV score. Sauro (2011) states that main reasons of using the Z-Score in an analysis is that it offers the most precision as it uses the mean and also that it tends to generate results in the middle of the others. Sauro (2011) adds that the Z-Score is the only metric that includes variability in the score.

3.13 DATA PRESENTATION AND DATA ANALYSIS

Data collected from the *Qualtrics Survey Software* ™ was presented using graphs, charts and tables for better analysis and interpretation of the data. The Microsoft Excel Spreadsheet ™ was also used to analyse the data and generate the graphs, charts and tables for better understanding of the data received.

- **Charts**

Bar charts were used to shows the frequency of occurrences of categories that cannot be easily be understood from the tables. Charts were used to show the most frequent attitude outcome from the survey through use of *Top 2 Box analysis.* Pie charts were used mostly to analyse the demographic data from the questionnaire.

- **Tables**

Tables were used to show each variable outcome on the ranked Likert scale so that each value can be easily read. The table summarized the frequency in each category. Saunders et al. (2012) states that tables are best used to depict such scenarios and provide data that can be easily read and understood.

The data analysis explored the relationship between the demographic information asked, that is, the work experience a respondent had and the education background they have to the outcome on the various attitudes they may have towards ECI and Safety Performance on construction sites.

3.14 DATA VALIDITY AND DATA RELIABILITY

Analysing data validity and reliability is necessary in establishing the relevance of the feedback information received in respect to answering the research question.

3.14.1 DATA VALIDITY

Validity aims to determine the truthfulness of the outcome of the data collected and analysed. Literature review was carried out and a conceptual framework developed which was used to construct the questionnaire survey. Questions were identified from previous studies and literature and formed the basis for the quantitative study. If the outcome of this research mirrors the theoretical concepts of the study, it therefore validates the data from this research. This ensured construct and content validity.

Both supervisors analysed the questionnaire survey to provide face validity. To ensure external validity, a census sample of a known population was used. Should the sampling process not yield sufficient data, demographic data would have been used as it is believed that the results would have been indicative of the population although the results would not be statistically generalized.

3.14.2 DATA RELIABILITY

Data reliability ensures that the data received is trustworthy and accurate and able to yield correct results. Clearly, articulated questions were included in the questionnaire survey for the respondents to better understand them and explanations were provided where needed. The instrument can be reused according to the research protocol to replicate this research.

3.15 CONTINGENCY PLAN

Questionnaire surveys tend to have a low response rate and thus a contingency plan is required to enable for a proper response rate to be achieved. The researcher sent out reminders every couple of weeks to the participants as well as made follow up telephone calls to companies so that they could distribute the questionnaire survey to their employees.

Should this response rate to the survey not be sufficient, demographic data will be used to analyse whether the data collected can be seen as representative of the population though this means that there will be no statistical generalization, the data collected can be deemed as representative of the population.

3.16 ETHICAL CONSIDERATIONS

The main ethical concern present in this research was ensuring confidentiality and anonymity of the participants' responses as matter of health and safety and safety performance can be regarded as sensitive. Due to health and safety in construction being a sensitive topic, people tend to shy away on reporting on the matter and thus, it may be attributed to the low response rate received in this research. Should this response rate to the survey not be sufficient, demographic data would be used to analyse whether the data collected can be seen as representative of the population. Such matters as these can lead to misrepresentation of the information provided by the participants and thus, proper mechanisms must be used to ensure that the information provided is valid and reliable. Some of the ethical mechanisms that were incorporated in this research include:

- Ensuring confidentiality of data and maintenance of anonymity of those taking part
- Informed consent of those taking part
- Responsibility in the analysis of the data and reporting of the findings
- Compliance in the management of data
- Integrity and objectivity in carrying out of the research

A participant information letter attached to the questionnaire was sent out via email detailing the purpose of the questionnaire survey and outlined the extent of the confidentiality of the data and anonymity that can be achieved by the researcher. The researcher also outlined that the research was voluntary but if the respondent chose to respond to the questionnaire, the respondent can be given pertinent information on the study while involved in the project and after the results are available *(Refer Appendix A).*

The information letter outlined that the data collected is merely for the purposes of this research and the data will be discarded after the completion of the research so as to ensure confidentiality and anonymity of the respondents is maintained. Furthermore, all reporting was done in an aggregated format.

3.17 CONCLUSION

The research design is positivist and a questionnaire was developed based on previous research studies and a review of the literature. Architects and engineers in the Gauteng Region of South Africa were identified though South African architectural and engineering council data bases as well as the South African yellow pages and emailed a link to the survey as well as the participant information sheet that outlines details of the research *(Refer Appendix A).* The questionnaire survey was administered electronically and the reporting was done in an aggregated manner. The analysis of the data obtained will be discussed in the next chapter.

4.0 DATA ANALYSIS

4.1 INTRODUCTION

The main purpose for this study was to find out designers' perceptions on Early Contractor Involvement as a means of improving the safety performance on construction sites. The empirical objectives that this research sorted to explore included:

- Identifying the trust relationship between designers and contractors;
- Exploring the designers beliefs regarding ECI as a way of increasing the safety performance on construction sites;
- Exploring how the designers feel about ECI and liability issues due to introducing the contractor earlier in the design process;
- Exploring whether the designers' believe contractors feel powerless for not being included in design phase;
- Exploring the designers' beliefs on the communication barrier between designers and contractors and
- Exploring the designers' beliefs on the commitment of contractors towards safety promotion and improving safety performance of their construction sites.

In order to successfully carry out this study, a review of the literature was conducted and a conceptual framework developed which gave rise to the questions which should be asked. A total of twenty-nine questions were asked in the questionnaire survey. The twenty–nine questions will be grouped and analysed in the following categories:

- Demographic Analysis
- Early Contractor Involvement Analysis
- Designers' Perspective
- Analysis of Designers' views on Contractors
- Risk and Safety Performance Analysis

4.2 RESPONSE RATE

In order to survey the professionals from the identified population, five-hundred architects and engineers who operate in the Gauteng Province of South Africa were purposely selected from different architectural councils in South Africa as well as the from the South African Yellow Pages directory. As discussed previously in the research methodology chapter, Gauteng Region was selected as it is characterized by large scale construction projects which attract international designers who work with the local designers in South Africa and thus, this sample group has a higher probability of having some experience of using ECI on construction projects.

The first few days after the questionnaire was sent out, there was a low response rate and thus a follow up email was sent out after two weeks of opening the questionnaire survey. This prompted additional responses from the identified population. After twenty-one days of running the survey, further email reminders were sent out as well as simultaneously following up with a few architects and engineers in the industry through telephone calls who sent out the questionnaire survey to their fellow architects, engineers and project managers email contact list.

Out of the five-hundred sample size selected to carry out the questionnaire survey, the researcher received a total of thirty-nine responses of which thirty-six responses were fully completed and three responses were partially completed. This represented a 9% response rate. The questionnaire survey was open for twenty-five days.

Figure 4.1 below shows that the majority of the respondents were architects with 41% followed by project managers with 30%. The questionnaire survey was also answered by one SHE Risk Manager.

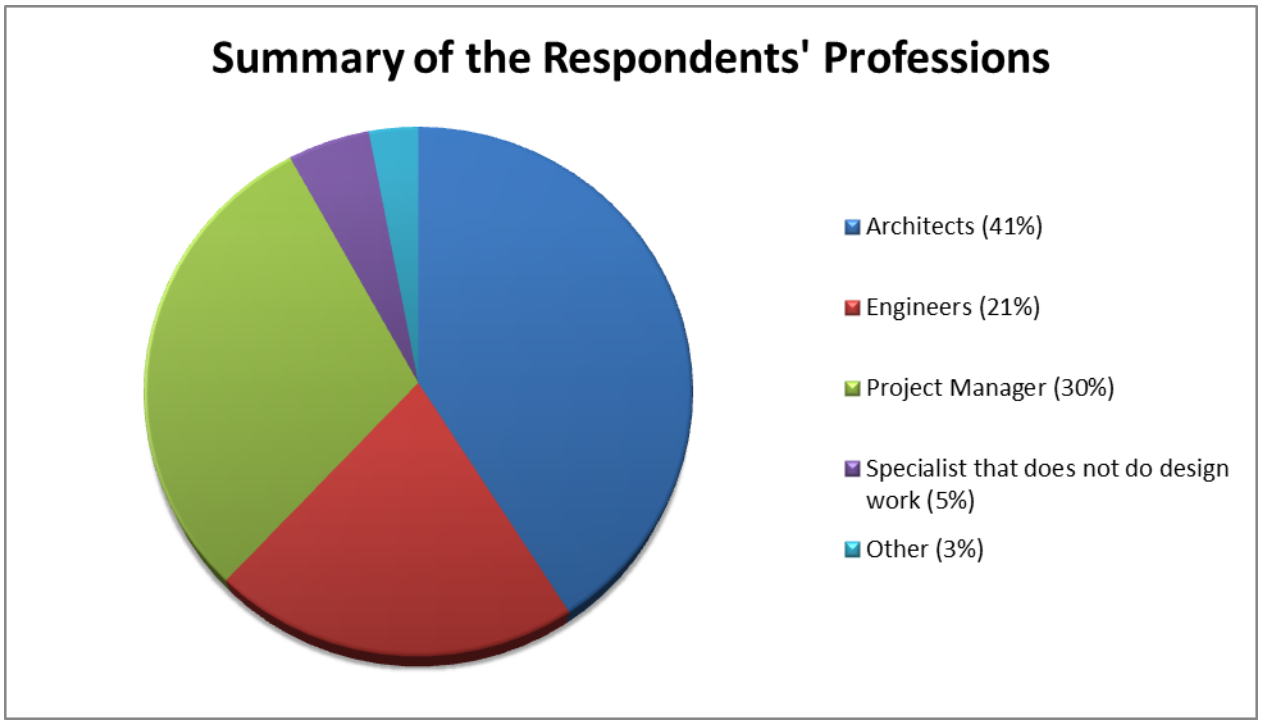


Figure 4.1: A summary of the respondents' professions

From the data result shown above, approximately 92% of the respondents have an influence on the design aspects of a project thus; their perceptions on ECI and the Safety Performance in construction sites can be considered valid.

4.3 DEMOGRAPHIC ANALYSIS

The questionnaire was sectioned into two parts; part one dealt with the demographic information of the respondent and consisted of four questions. The questions were carefully selected and the reasons will be discussed below.

Question one asked the respondents the following question;

"How would you describe your role in the design of construction projects?"

This question was specifically asked so as to find out what profession in the construction industry the respondent belonged to. This would aid the researcher in distinguishing the various attitudes the different designers' in construction professions may have towards ECI and Safety Performance in the industry. *Table Nine* below shows that the respondents had five options to choose from which included an architect, design engineer, project manager, a specialist in the field but does not do design work and other.

Table 9: A summary of the respondents' professions

How would you describe your role in the design of construction projects?				
#	Answer	Bar	Response	%
1	I am an architect		16	41%
2	I am a design engineer		8	21%
3	I am a project manager		12	30%
4	I am a specialist that does not really do design work		2	5%
5	Other		1	3%
	Total		**39**	**100%**

From the data shown above, majority of the survey participants are designers' in the construction industry thus their response can be indicative as a representative of the designers' population in the Gauteng Province of South Africa.

The second question was posed to design professionals whose profession was not listed on the four listed options. Only one design professions who answered 'Other' was a Safety, Health and Environment (SHE) Risk Manager.

The Safety, Health and Environment (SHE) Risk Manager's response is analysed separately to observe what view they may have on Safety Performance and ECI in the construction and will be compared and contrasted to the views of the designers' in the construction industry. There are two notable differences in opinion as answered by the SHE Risk Manager and compared to the rest of the participants. The SHE Risk Manager does not believe that

designers are committed to safety performance on construction sites as opposed to what the rest of the participants believe. As a Risk Manager in the construction industry, this opinion can be deemed true. The SHE Risk Manager also does not believe that designers would be held liable for accidents and fatalities that may occur during the construction stage as a result of ECI.

Question three asked the respondents the following question;

"How long have you been working in the construction industry?"

The main aim of asking this question was to find out how much experience the respondents had in the construction industry. The longer the respondents have been working in the industry, the more experience and interaction they may have with contractors and the use of ECI. This provides a more reliable set of data. *Table Ten* below shows a summary of the respondents' professional experience in the industry.

Table 10: Summary of the respondents' professional experience in the industry

How long have you been working in the construction industry?				
#	**Answer**	**Bar**	**Response**	**%**
1	1<5 Years		21	54%
2	6<10 Years		11	28%
3	More Than 10 Years		7	18%
	Total		**39**	**100%**

The majority of the respondents, 54%, have worked in the construction industry for less than 6 years, while 46% of the respondents have worked in the industry for longer than 5 years. Nearly half of the respondents have over 6 years of experience thus the information they may offer is based upon considerable project and industry experience.

Question four asked the respondents the following question;

"What is your qualification?"

The aim of this question was to find out the level of education the respondents had and if indeed they were professionals in the industry. *Table Eleven* below shows a summary of the

respondents' education qualification the industry. It was assumed that a person with a 4 year Honours Degree and above to be a professional. The ability to generalize the sampling frame and response rate does not make it possible a statistical analysis.

Table 11: Summary of the respondents' education background level

What is your qualification?				
#	**Answer**	**Bar**	**Response**	**%**
1	BTech		2	5%
2	Bsc 3 Years		2	5%
3	Honours or 4 year B degree		19	49%
4	Masters		13	33%
5	Other		3	8%
	Total		**39**	**100%**

The majority of the respondents, 82%, have an Honours Degree and above. The experience and qualification of the survey respondents provide a high degree of confidence in the reliability of the data they provide. The response representative population and an analysis of the demographic data show that the response can be seen as indicative of the populations' qualification thus an appropriate research can be conducted.

4.4 RANKING

The following 25 questions administered in the questionnaire survey were ranked according to their mean, Top 2 Box score, Coefficient of Variation and the Z-Score to Percentile rank *(Refer 3.12). Table 12* below shows a summary of responses from the questionnaire survey analyzed according to the mean score, Top 2 box score, Coefficient of Variation as well as Z-Score to Percentile Rank.

Using the Z-Score to Percentile Rank, designers in the South African construction industry had the highest opinion on *'Accidents can be prevented by ECI'* with a score of 73.6% and a Top two box score of 95% which was the 2nd highest in this research. The CV score for this question was 0.16 and this shows that there was consistency in the responses as the gap is not widely spread. In addition, the mean score analysis lies on *'Agree'* on the opinion scale. Thus, this analysis shows that designers in the South African construction industry have a positive perception on ECI in regards to it preventing accidents and they do believe it can reduce accidents and fatalities in construction.

The Z-Score to Percentile Rank revealed that *'Early contractor Involvement can improve the risk management on a construction project'* had the 2nd highest opinion with the designers in the South African construction industry with a score of 67.4%. This survey question had a top two box analysis of 95% and a mean of 4.24. The CV score for this question was 0.13 and this shows that there was consistency in the responses as the gap is tight. It is evident from this research and from the review of the literature that designers in the construction industry believe that ECI can improve the risk management on a construction site.

The survey question *'Early Contractor Involvement can improve constructability on a construction project'* had the 3rd highest Z-Score of 67% with the highest top two box score of 97%. In addition, the mean score for this question was 4.27 that lies on the scale of *'Agree'* on the opinion scale. A CV score of 0.14 was achieved for this question and this shows that there was consistency in the responses as the gap is not widely spread. Designers in the construction industry according to this research and literature review believe that ECI can improve constructability on a construction project.

Table 12: Summary of Mean Score, Top Two Box Score, Coefficient of Variation Analysis and Z-Score to Percentile Rank from the questionnaire survey

Survey Question	Mean	Top Two Box Score	Coefficient of Variation	Z-Score to Percentile Rank
Accidents can be prevented by Early Contractor Involvement.	4.37	95%	0.16	73.6%
Early Contractor Involvement can improve the risk management on a construction project.	4.24	95%	0.13	67.4%
Early Contractor Involvement can improve the constructability on a construction project.	4.27	97%	0.14	67%
Early Contractor Involvement can improve the safety performance on a site.	4.24	94%	0.15	64.8%
Contractors have knowledge to offer when involved earlier in the design process.	4.19	94%	0.15	62.2%
Accidents and fatalities that happen on the construction site after Early Contractor Involvement will have an impact on your career and success/ credibility and reputation.	4.11	87%	0.18	55.6%
Early Contractor Involvement can reduce the number of variation claims in a construction site.	4.08	84%	0.16	55.2%
Early Contractor Involvement can improve the site safety of a construction site.	4.08	92%	0.17	55%
Contractors are aware of potentially hazardous risks.	4.08	84%	0.18	54.4%
Early Contractor Involvement can reduce disputes on a construction site.	4.00	81%	0.22	50%
The client's requirements can pose safety risks during construction.	3.92	76%	0.26	47%
Contractors understand the implication of the various designs on safety.	3.79	76%	0.27	42%

Survey Question	Mean	Top Two Box Score	Coefficient of Variation	Z-Score to Percentile Rank
Designers will be held liable for accidents and fatalities that occur during the construction stage as a result of Early Contractor Involvement.	3.70	68%	0.29	39%
Contractors can take full liability for accidents and fatalities that occur in construction sites after Early Contractor Involvement.	3.66	61%	0.33	39%
Communication with the contractors during the design phase is effective.	3.68	63%	0.27	37.4%
Designers have the required knowledge in design for safety.	3.76	68%	0.20	37.4%
Contractors have the necessary knowledge to contribute towards designing for safety.	3.71	66%	0.23	37%
The involvement of the contractor earlier during the design stage may lengthen the design process.	3.67	67%	0.26	37%
Contractors should have an influence in the design process.	3.61	64%	0.27	34.1%
Contractors experience safety performance constraints when not involved in the design process.	3.62	70%	0.25	34.1%
Contractors assume liability for their involvement in the design process when involved earlier in the process.	3.46	57%	0.37	33.3%
Contractors can contribute towards design for safety.	3.50	57	0.31	32.3%
Contractors are committed to safety promotion/ accident promotion on their construction sites.	3.47	63%	0.33	32%
Designers are committed to safety performance on construction sites.	3.46	59%	0.31	30.5%
Designers in construction believe they have more knowledge in identifying safety issues than contractors.	3.30	49%	0.33	26%

The Z-Score to percentile rank revealed that *'Early Contractor Involvement can improve the safety performance on a construction site'* had the 4th highest perception by the South African designers in construction with a score of 64.8% and a top two box score of 94%. In addition, this question had a mean score of 4.24 which lies on *'neutral'* on the opinion scale and a CV score of 0.15 which shows that there was consistency in the responses as the gap is tight. This research and a review of the literature showed that designers in the construction industry do believe that ECI can positively impact the safety performance of a construction site. This survey question formed part of this research's hypothesis and revealed that designers in the South African construction industry do have a positive perception towards the use of ECI in improving the safety performance of construction sites.

According to the Z-Score to Percentile rank, the lowest score was 26% on the survey question of *'Designers in construction believe they have more knowledge in identifying safety issues than contractors'.* In addition, this question had a top two box score of 49%. This question had a mean score of 3.30 which lies on *'Disagree'* on the opinion scale. Furthermore, a CV score of 0.33 was achieved on this question and this shows that there was no consistency in the responses as the gap is widely spread. The outcome of this question shows that designers do not believe that they have more knowledge in identifying safety issues than contractors and thus contractors would be a valuable asset during the design phase of the project as they would be able to identify safety issues prior to construction.

4.5 EARLY CONTRACTOR INVOLVEMENT ANALYSIS

The participants in this study were asked a number of questions to help identify their various attitudes towards ECI and its impact on the Safety Performance on construction sites. These questions included:

- Accidents can be prevented by Early Contractor Involvement;
- Early Contractor Involvement can improve the site safety of a construction site;
- Accidents and fatalities that happen on the construction site after Early Contractor Involvement will have an impact on your career and success/ credibility and reputation;
- Early Contractor Involvement can improve the safety performance on a site;
- Early Contractor Involvement can reduce the number of variation claims in a construction site;
- Early Contractor Involvement can reduce disputes on a construction site and
- Early Contractor Involvement can improve the constructability on a construction project.

Table Thirteen below shows the various attitudes in which the participants had towards ECI in regards to accident prevention.

Table 13: Summary of responses from the question 'accidents can be prevented by ECI'.

Please rate the degree with which you agree or disagree with the following statement.				
'Accidents can be prevented by Early contractor Involvement'.				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		0	0%
3	Neutral		2	5%
4	Agree		20	53%
5	Strongly agree		16	42%
	Total		**38**	**100%**

The above data shows that 95% of the participants agree that accidents on construction sites can indeed be prevented by the use of ECI. This outcome from the study supports what the previous literature had stated, in that accidents can be prevented by the use of ECI on construction site. It should be noted that none of the participants disagreed with statement and only 5% of the participants were neutral on the matter. Though these previous studies had been conducted in more developed countries, this particular study asserts that this is potentially the same from a developing country's point of view.

This particular question can be seen to partially answer the research question of this study in that, it shows that over 95% the designers in the South African construction industry believe that accidents can be prevented by the incorporation of ECI .

Table Fourteen below shows the various attitudes in which the participants had towards ECI in regards to safety improvement on construction sites.

Table 14: Summary of responses from the question 'Early Contractor Involvement can improve safety on a construction site'

Please rate the degree with which you agree or disagree with the following statement.				
' Early Contractor Involvement can improve safety on a construction site'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		2	5%
3	Neutral		1	3%
4	Agree		26	70%
5	Strongly agree		8	22%
	Total		**37**	**100%**

The above question, '*Early Contractor Involvement can improve safety on a construction site',* which is similar to the question on *Table Thirteen*, '*Accidents can be prevented by Early contractor Involvement',* was purposely included in the questionnaire to show internal validity. The two questions, which were put far apart from each other on the questionnaire

survey, were used to test whether the participants believe ECI can truly prevent accidents on construction sites as well as improve the site safety of the construction sites.

The response from the previous table, that is, *Table Thirteen*, showed that over 95% of the participants believed that ECI can prevent accidents on construction sites. Similar results can be realized from *Table Fourteen* where, over 92% of the participants agree that ECI can indeed improve the site safety of a construction site. This shows that the statements made by the participants throughout the questionnaire survey can be believed and accepted as true.

Table Fifteen below shows the various attitudes in which the participants had towards ECI in regards to safety improvement on construction sites.

Table 15: Summary of responses from the question 'Accidents and fatalities that happen on the construction site after Early Contractor Involvement will have an impact on your career and success/ credibility and reputation'.

Please rate the degree with which you agree or disagree with the following statement.

'Accidents and fatalities that happen on the construction site after Early Contractor Involvement will have an impact on your career and success/ credibility and reputation'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		2	5%
3	Neutral		3	8%
4	Agree		22	58%
5	Strongly agree		11	29%
	Total		**38**	**100%**

A review of the literature showed that one of the main concerns the designers' in the construction industry had, was towards reputation in case of accidents and fatalities happening on site after incorporating ECI. From this study, it is clear that this is a main concern with the South African designers' in the construction industry as more than 87% agreeing with the statement. Only 5% of the respondents disagreed with the statement and 8% of the respondents were neutral towards the statement.

This can be assumed as one of the reasons why ECI has not been fully accepted by designers' in the South African construction industry. The designers' in this industry believe that their reputations may be tarnished if they included ECI in the design phase of the project and they are unable to prevent accidents and fatalities during the construction phase of the project. They believe that this may in turn impact the future success of their careers.

Similar studies on identifying the benefits and barriers of ECI have been carried out in the developed countries but there has been limited research carried out in developing countries. Some of the benefits and barriers of ECI relevant to this study were selected from the literature review and included in the questionnaire survey. The outcome of this study will be compared to the outcome of previous studies. This research study aimed to contribute to the limited information in this area and offer more insight about ECI in developing countries.

Table Sixteen below shows the various attitudes in which the participants had towards ECI in regards to safety performance improvement on construction sites.

Table 16: Summary of responses from the question 'Early Contractor Involvement can improve the safety performance on a site'

Please rate the degree with which you agree or disagree with the following statement.

'Early Contractor Involvement can improve the safety performance on a site'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		1	3%
3	Neutral		1	3%
4	Agree		23	62%
5	Strongly agree		12	32%
	Total		**37**	**100%**

The purpose of this question was to answer the research question of this study as well as discover additional benefits of ECI in the construction industry. Over 94% of the participants agreed that ECI can improve the safety performance on construction sites. Three percent of

the participants felt neutral on the matter and another 3% disagreed with the statement. This can be interpreted as one of the many benefits of using ECI by the designers' in the construction industry.

According to the data presented above, majority of the participants believe ECI has a positive impact on the Safety Performance on construction sites. The outcome from this research agrees with the literature that ECI can improve the safety performance of construction sites.

Table Seventeen below shows the various attitudes in which the participants had towards ECI in regards to variation claim on construction sites.

Table 17: Summary of responses from the question 'Early Contractor Involvement can reduce the number of variation claims in a construction site'

Please rate the degree with which you agree or disagree with the following statement.

'Early Contractor Involvement can reduce the number of variation claims in a construction site'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		0	0%
3	Neutral		6	16%
4	Agree		22	60%
5	Strongly agree		9	24%
	Total		**37**	**100%**

One of the benefits of ECI identified from the literature review included a reduction in the number of variation claims during construction. This was attributed mainly to the incorporation of the contractor in the design phase of the project and finalizing the final drawings of the project with the contractor before the construction phase begun.

Eighty-four percent of the participants in this study agreed that the inclusion of the contractor at the design stage of a project would reduce the overall number of variations of the project. It

should be noted that none of the participants in this research disagreed with this statement. This outcome is similar to the previous studies carried out in the developed countries.

Table Eighteen below shows the various attitudes in which the participants had towards ECI in regards to reduction of disputes in construction sites.

Table 18: Summary of responses from the question 'Early Contractor Involvement can reduce disputes on a construction'

Please rate the degree with which you agree or disagree with the following statement.				
'Early Contractor Involvement can reduce disputes on a construction site'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		1	3%
2	Disagree		1	3%
3	Neutral		5	14%
4	Agree		20	54%
5	Strongly agree		10	27%
	Total		**37**	**100%**

Another benefit of ECI identified from the literature review was that ECI can reduce the number of disputes on a construction site. Eighty-one percent of the participants in this study agreed with the above statement that indeed ECI can reduce the number of disputes in a construction site. This outcome is in agreement with the outcome from previous studies carried out in developed countries.

ECI is believed to reduce disputes by majority of the designers in the construction industry in that, during the construction phase, all the drawings and relevant documents have already been agreed upon by all relevant parties including the contractor before the construction phase.

Table Nineteen below shows the various attitudes in which the participants had towards ECI in regards to constructability improvement in construction sites.

Table 19: Summary of responses from the question 'Early Contractor Involvement can improve the constructability on a construction'

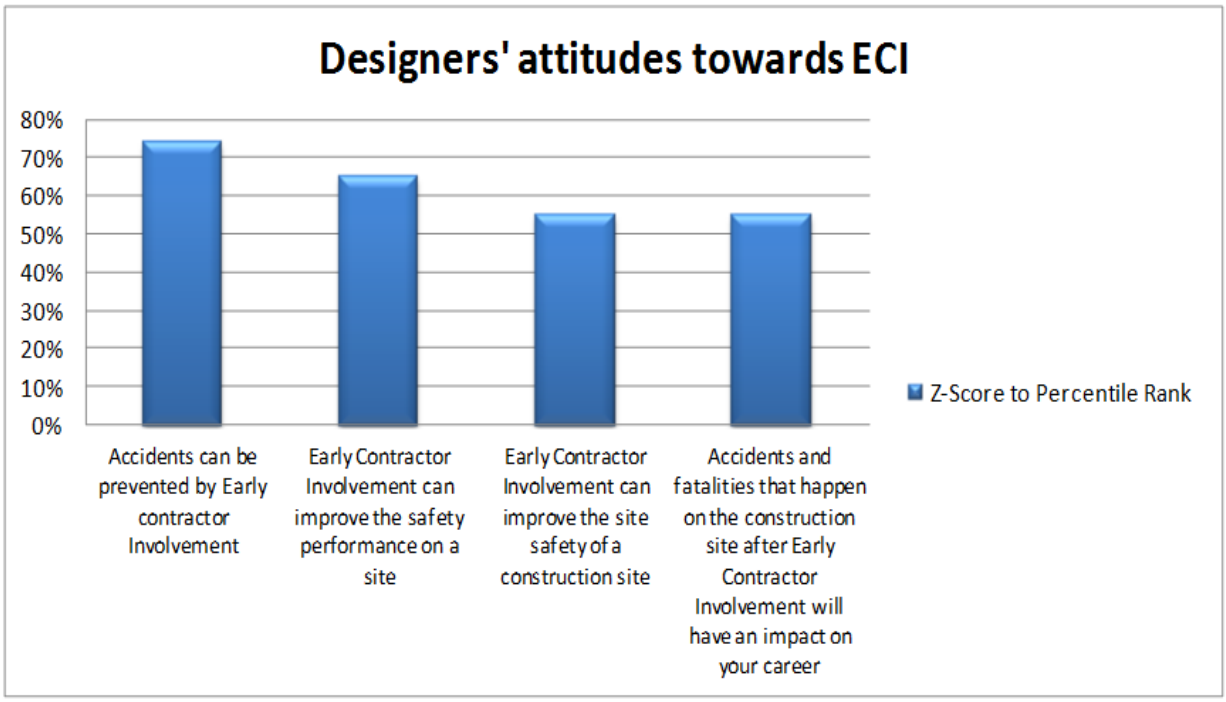
Please rate the degree with which you agree or disagree with the following statement.				
'Early Contractor Involvement can improve the constructability on a construction project'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		1	3%
3	Neutral		0	0%
4	Agree		24	65%
5	Strongly agree		12	32%
	Total		**37**	**100%**

A review of the literature revealed that ECI can improve the constructability on a construction project. Ninety-seven percent of the participants agreed with that statement and only one person disagreed with the statement. None of the respondents felt neutral on the matter. This particular question is in agreement with previous studies conducted in the developed world.

4.5.1 SOUTH AFRICAN DESIGNERS' ATTITUDE ON ECI

To understand better the outcome of what designers' in the South African construction industry thought about the use of ECI in the construction industry, the researcher analysed the above questions asked concerning their attitudes towards ECI in the construction industry using the Z-Score to Percentile Rank analysis.

The researcher ranked the questions according to the Z-Score to Percentile Rank so as to compare differences in attitudes from the questions asked. The outcome from this analysis is summarized on *Figure 4.2* below.



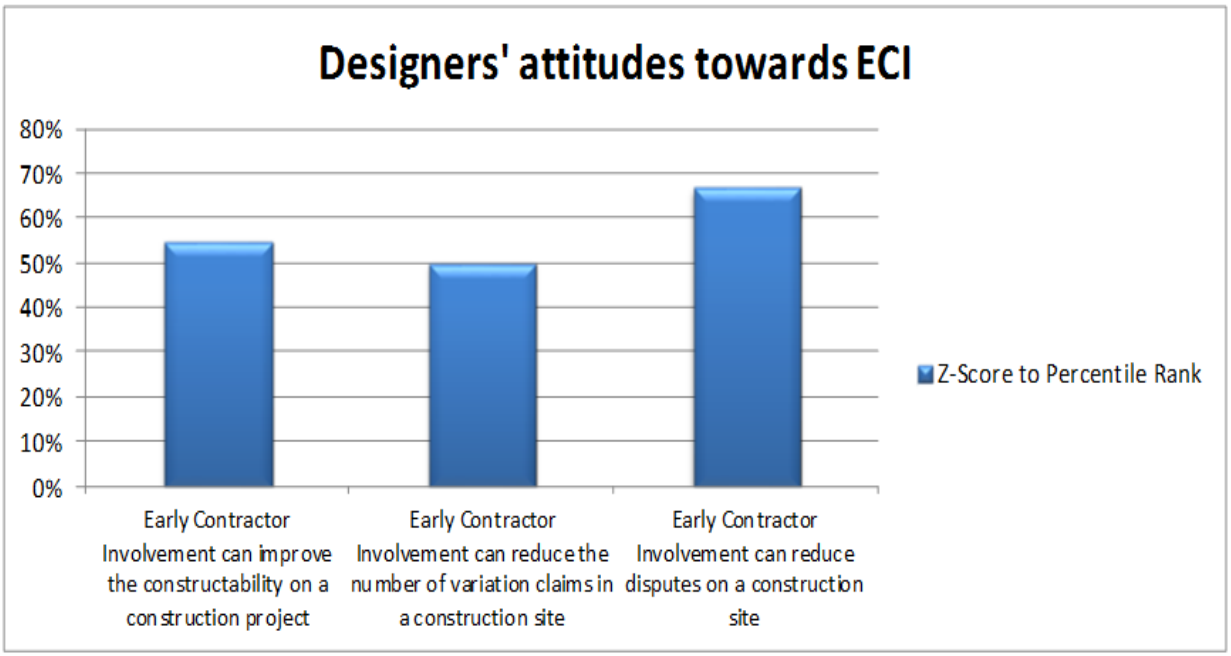


Figure 4.2: Z-Score to Percentile Rank Analysis of the various attitudes the designers in the construction industry have towards ECI.

From the Z-Score analysis above, it is clear that designers have a positive attitude towards the use of ECI in the South African construction industry. Responses from the seven questions asked about their attitude towards ECI range between 55% and 74%. The designers' in the South African especially believe that ECI can improve the constructability of a construction project and that accidents on a construction site can be prevented by the use of ECI.

It should be noted that none of the respondents from this research disagreed with the statement *'Early Contractor Involvement can reduce the number of variation claims in a construction site'.* Majority of the respondents believe that ECI can reduce the number of variation claims on a construction as the designers and the contractor agree on the final drawing before the construction phase.

It should also be noted that none of the respondents felt neutral about the statement *'Early Contractor Involvement can improve the constructability on a construction project'.* Majority of the respondents believe that ECI can indeed improve the constructability on a construction project.

A review of the literature and studies carried out in the developed countries show the same outcome in the designers' attitudes towards the use of ECI in the construction industry. Designers' in the construction industry are ready to embrace the use of ECI in the construction industry.

4.6 RISK MANAGEMENT ANALYSIS

The study also sought to analyse the designers' perceptions of ECI towards risk management in a construction project. A review of the literature showed that ECI can improve the risk management of a construction project in that it is linked to the overall safety performance of the construction project. Some of the questions included in the questionnaire survey that were used to assess risk management include the following:

- Early Contractor Involvement can improve the risk management on a construction project;
- The client's requirements can pose safety risks during construction and
- Contractors are aware of potentially hazardous risks.

Table Twenty below shows the various attitudes in which the participants had towards ECI in regards to risk management in construction sites.

Table 20: Summary of responses from the question 'Early Contractor Involvement can improve the risk management on a construction project'

Please rate the degree with which you agree or disagree with the following statement.

'Early Contractor Involvement can improve the risk management on a construction project'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		0	0%
3	Neutral		2	5%
4	Agree		24	65%
5	Strongly agree		11	30%
	Total		**37**	**100%**

Over 95% of the participants in this study believed that ECI can improve the risk management on a construction project. None of the respondents disagreed with this statement

and only 5% of the respondents felt neutral towards it. Improved risk management on a construction project can be interpreted as improved safety performance through the use of ECI in a construction project thus answering one of the empirical questions asked in this research regarding the designers' beliefs towards the matter. The outcome in this question is in agreement with that carried out in previous studies.

Table Twenty-One below shows the various attitudes in which the participants had towards a client's requirements posing safety risk on construction sites.

Table 21: Summary of responses from the question 'The client's requirements can pose safety risks during construction'

Please rate the degree with which you agree or disagree with the following statement.				
'The client's requirements can pose safety risks during construction'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		1	3%
2	Disagree		3	8%
3	Neutral		5	14%
4	Agree		17	46%
5	Strongly agree		11	30%
	Total		**37**	**100%**

From a review of the literature, it was noted that clients may have certain project requirements that may pose safety risks during and after construction of the project. Over 76% of the participants agree that this may be true. Only 11% of the participants disagreed with this statement.

If clients are poorly advised by the designers concerning their requirements and proceed to construct, this poses a great challenge to the contractor during construction and after completion of the project as accidents may occur and lower the safety performance of the project. If contractors are included earlier in the project, that is, during the design phase of the project, they may advise the client on the risks that may occur due to their project requirements and avert them before the commencement of the project.

Table Twenty-Two below shows the various attitudes in which the participants had towards ECI in regards to constructability improvement in construction sites.

Table 22: Summary of responses from the question 'Contractors are aware of potentially hazardous risks'

Please rate the degree with which you agree or disagree with the following statement.				
'Contractors are aware of potentially hazardous risks'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		1	3%
3	Neutral		5	14%
4	Agree		21	57%
5	Strongly agree		10	27%
	Total		**37**	**100%**

One of the main discussion points clear from the literature review conducted was whether contractors were aware of potentially hazardous risks in construction. One of the main concerns outlined in the literature review was whether contractors had any knowledge to offer concerning identifying of hazardous risk during the design process.

The outcome from previous studies conducted showed that majority of the designers in the construction industry in the developed countries believed that contractors do have knowledge to offer and are aware of potentially hazardous risks that may arise in the design phase of the project. This is synonymous with this study as 84% of the participants also agree that contractors are aware of potentially hazardous risks.

4.6.1 SOUTH AFRICAN DESIGNERS' ATTITUDE TOWARDS RISK MANAGEMENT

To understand better the outcome of what designers' in the South African construction industry thought about the use of ECI and its link to Risk Management Analysis in the construction industry, the researcher analysed the above questions asked concerning their attitudes towards Risk Management in the construction industry using the Z-Score to Percentile Rank analysis.

The researcher ranked the questions according to this so as to compare the outcome of attitudes from the questions asked. *Figure 4.3* below shows the Z-Score of the various attitudes the designers in the construction industry have towards the use of ECI in Risk Management.

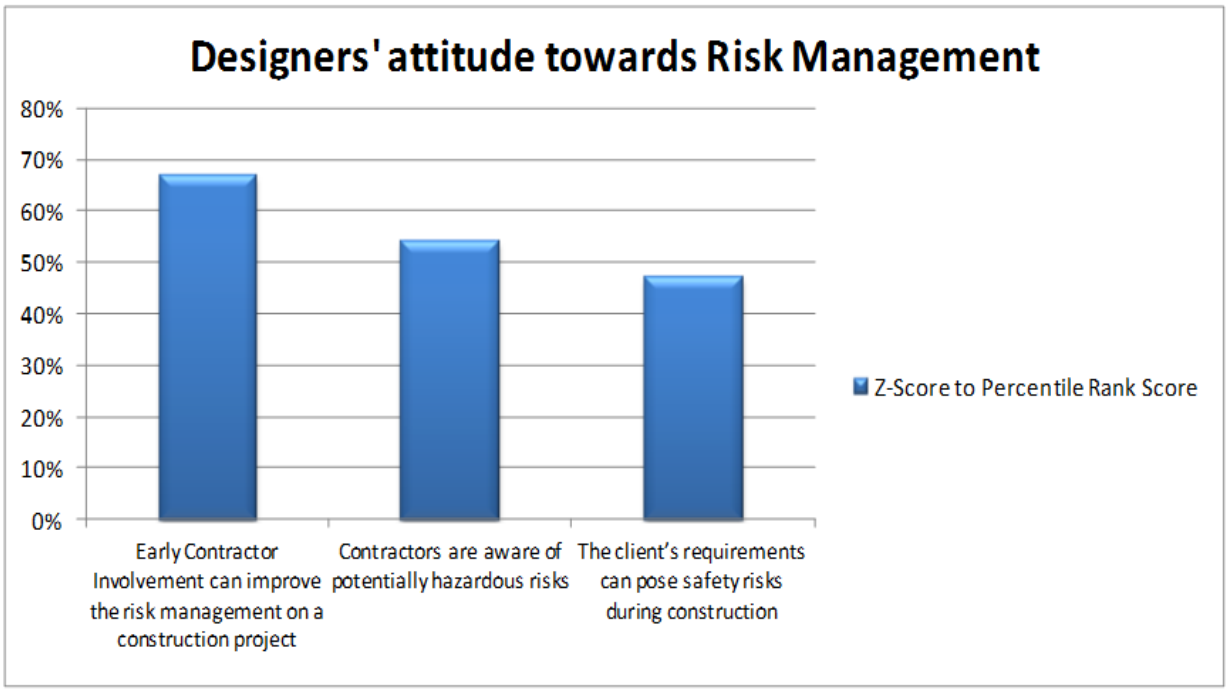


Figure 4.3: Z-Score to Percentile Rank Analysis of the various attitudes the designers in the construction industry have towards the use of ECI in Risk Management.

From the Z-Score analysis above, it is clear that the designers' in the South African construction industry believe that ECI can improve the Risk Management on a construction project as well as contractors can help in risk management if included earlier In the design process as they can identify potential hazards. The three questions that asked the respondents

about risk management ranked on the top 2 box analysis ranged between 47% and 67%. It should be noted that none of the respondents disagreed with the statement that *'Early Contractor Involvement can improve the risk management on a construction project'.* Majority of the respondents agreed with this statement. This outcome is synonymous with the outcome from previous studies conducted in developed countries.

4.7 DESIGNERS' PERSPECTIVE

The main aim of this study was to find out in general, the different perceptions the designers' in the South African construction industry may have. The questions below targeted the designers' perceptions towards ECI and safety performance among other questions. Some of these questions include:

- Designers are committed to safety performance on construction sites;
- Designers will be held liable for accidents and fatalities that occur during the construction stage as a result of Early Contractor Involvement;
- Designers have the required knowledge in design for safety;
- Designers in construction believe they have more knowledge in identifying safety issues than contractors and
- Contractors can take full liability for accidents and fatalities that occur in construction sites after Early Contractor Involvement.

Table Twenty-Three below shows the various attitudes in which the participants had towards the designers' commitment to the safety performance on construction sites.

Table 23: Summary of responses from the question 'Designers are committed to safety performance on construction sites'

Please rate the degree with which you agree or disagree with the following statement. *'Designers are committed to safety performance on construction sites'*				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		2	5%
2	Disagree		6	15%
3	Neutral		8	21%
4	Agree		18	46%
5	Strongly agree		5	13%
	Total		**39**	**100%**

Fifty-nine percent of the participants agreed that designers are committed to safety performance on construction sites. Previous studies carried out in developed countries stated that most participants disagreed with this statement. Most of the participants in those studies believed that the designers' in the construction industry were more concerned with the outcome of their designs and not the safety implications that their designs may have during construction and after the occupation stage.

This difference in opinions between this survey and other surveys conducted asking the same question may be attributed to the number of architects who participated in this study. Architects may believe they are committed to safety performance on construction sites while the engineers may disagree with that statement. More architects participated in this study than engineers; a comparative analysis between some of their responses is done below.

Another reason to explain the difference in the outcome of this study regarding this question may be due to the newly amended construction regulations in South Africa that tighten the rules on safety on construction sites.

4.7.1 COMPARATIVE ANALYSIS

Figure 4.4 below shows a comparative analysis between the architects and engineers responses on the questionnaire survey.

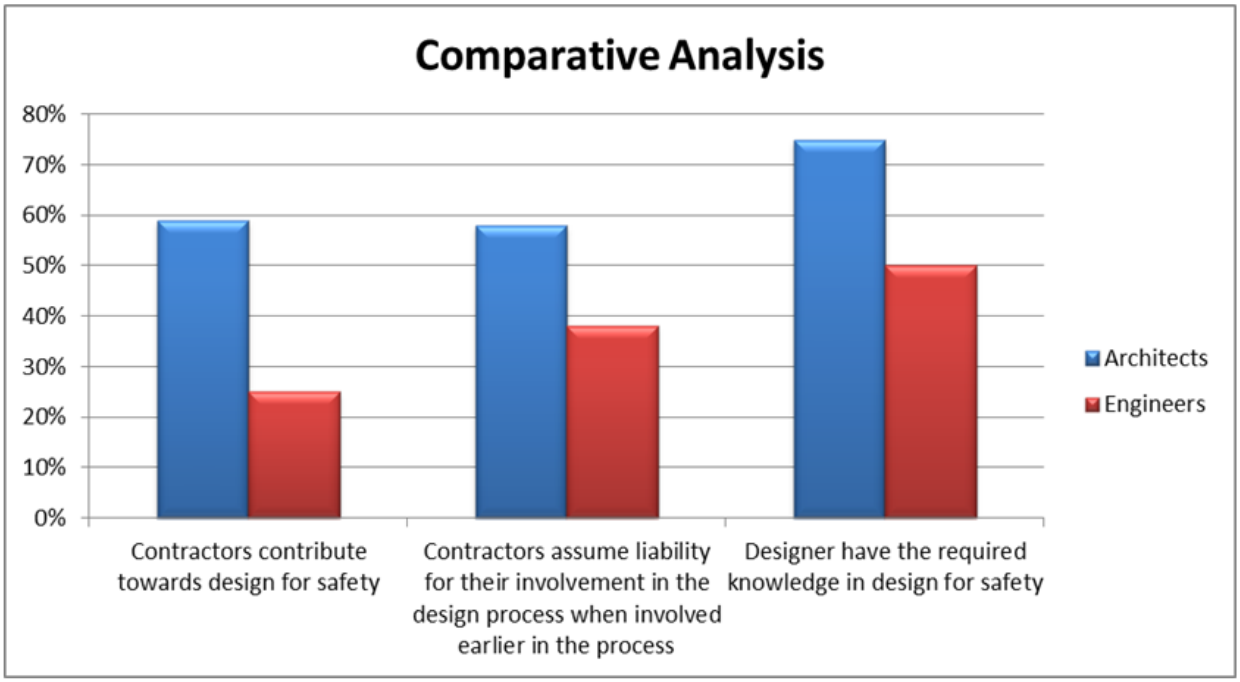


Figure 4.4: Comparative analysis between the architects and engineers responses on the questionnaire survey

A Top 2 Box Analysis was used to analyse the responses that had a difference in opinion between architects and engineers who participated in the questionnaire survey. Out of the 29 questions asked in the questionnaire survey, only three of the questions were answered differently by the architects and engineers. The first question asked the following:

'Contractors can contribute towards design for safety'

Fifty-nine percent of the architects believe that contractors could contribute some knowledge towards designing for safety while only 25% of the engineers deemed this to be true. Architects in the South African construction industry seem to believe that contractors have knowledge to offer in designing for safety and thus could be included in the designing phase of the project while the engineers in the South African construction industry believe otherwise in the matter.

The second question that differed in responses between the architects and engineers asked the following:

'Contractors assume liability for their involvement in the design process when involved earlier in the process'

Fifty-eight percent of the architects that responded to this survey agreed that contractors can assume liability if involved in the project and accidents and fatalities happen during construction while only 38% of the engineers that responded to this survey believed this to be true.

The third question that differed in response between the architects and the engineers that answered this questionnaire survey was the following;

'Designers have the knowledge in designing for safety'

Fifty percent of the engineers believed this to be true while 75% of the architects believed this statement to be true. Fifty percent of the engineers in the South African construction industry believed this statement not to be true.

The above three questions discussed were the only questions that had major differences in response between the architects and the engineers in the South African construction industry. The other twenty six questions asked in the questionnaire survey were answered similarly by both parties.

4.7.2 SIMILARITY BETWEEN ARCHITECTS AND DESIGN ENGINEERS RESPONSES

Figure 4.5 below shows a comparative analysis between the architects and engineers responses on the questionnaire survey.

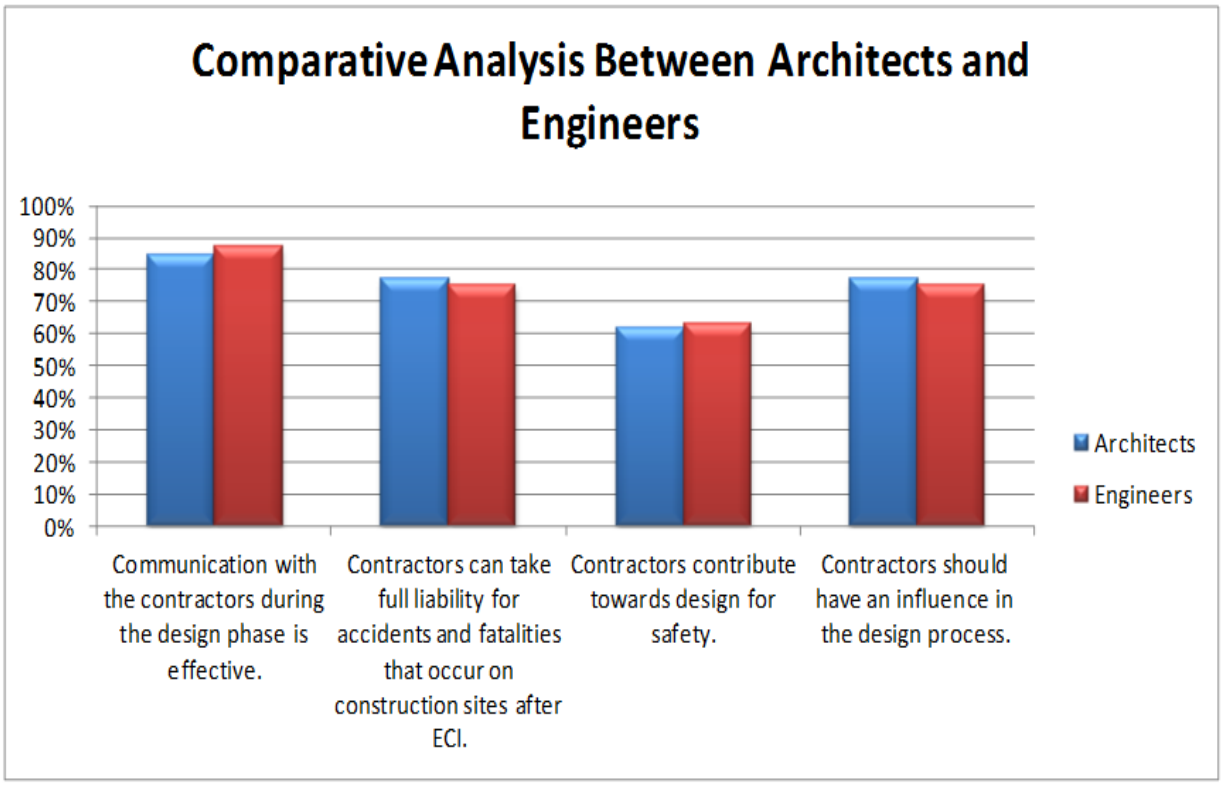


Figure 4.5: Comparative analysis between the architects and engineers responses on the questionnaire survey

Using the Top two box analysis, the architects and the design engineers in the South African construction industry agreed on a number of questions asked by the researcher in the questionnaire survey. Some of these questions include:

- Communication with the contractors during the design phase is effective,
- Contractors can take full liability for accidents and fatalities that occur on construction sites after ECI,
- Contractors contribute towards design for safety and,
- Contractors should have an influence in the design phase.

The above questions had a difference of 1-2% in responses by the South African architects and design engineers who responded to the questionnaire survey. The similarity in responses thus can confirm that the architects and design engineers in the South African construction industry do agree that contractors should be included in the design phase of a construction project as they can contribute to designing for safety.

From the questionnaire survey administered by the researcher, the following questions answered by the architects and design engineers in the South African construction industry had a score of 100% by both the architects and the design engineers. The questions include:

- Contractors have knowledge to offer when involved earlier in the design process.
- ECI can reduce the number of variation claims on a construction site.
- ECI can reduce disputes on a construction project.
- ECI can improve constructability on a construction project.
- The client's requirements can pose safety risks during construction.

From the above questions and the similarity in responses by the South African architects and design engineers, it is clear that both the architects and design engineers in the construction industry agree that ECI has various benefits including improving constructability, a reduction on the number of disputes and variation claims in a construction project among others. It is also clears that the South African architects and design engineers believe that contractors have knowledge to offer if brought in earlier in the design process and thus would be useful in identifying safety risks as well as improving the safety performance of construction sites.

Table Twenty-Four below shows the various attitudes in which the participants had towards the designers' involvement in construction accidents and fatalities after the incorporation of ECI in a project.

Table 24: Summary of responses from the question 'Designers will be held liable for accidents and fatalities that occur during the construction stage as a result of Early Contractor Involvement'

Please rate the degree with which you agree or disagree with the following statement.				
'Designers will be held liable for accidents and fatalities that occur during the construction stage as a result of Early Contractor Involvement'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		2	5%
2	Disagree		3	8%
3	Neutral		7	19%
4	Agree		17	46%
5	Strongly agree		8	22%
	Total		**37**	**100%**

Another main concern that was clear from the literature review was the liability that would befall the designers if accidents and fatalities happened even after including the contractor in the design process of the project. From previous studies conducted, designers believed they would be held liable if accidents and fatalities occurred as a result of their designs even after incorporating ECI into the project. This was considered as one of the reasons why ECI is not a common practice even though it has a positive impact towards safety on construction projects.

Sixty-eight percent of the participants of this survey believe that they would be held liable for any accidents and fatalities that may happen during and after construction after incorporating ECI in the project. Only 13% of the participants disagreed with this statement while 19% of the respondents felt neutral about this statement. This outcome is synonymous with the outcome from previous studies conducted regarding this matter.

Table Twenty-Five below shows the various attitudes in which the participants had towards the designers' knowledge in designing for safety.

Table 25: Summary of responses from the question 'Designers have the required knowledge in design for safety'

Please rate the degree with which you agree or disagree with the following statement.

'Designers have the required knowledge in design for safety'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		2	5%
3	Neutral		10	27%
4	Agree		20	54%
5	Strongly agree		5	14%
	Total		**37**	**100%**

A review of the literature revealed that designers in most of the developed countries believe that they have the required knowledge to design for safety and thus they believe they do not require the contractors' knowledge in designing for safety. This was viewed as one of the reasons why ECI was not popular with majority of the designers in developed countries.

Sixty-eight percent of the participants believed that designers have the required knowledge in designing for safety while 27% of the participants were neutral on the matter. Only 5% of the participants disagreed with this statement. This outcome is also synonymous with the outcome from previous studies conducted in the developed countries.

Table Twenty-Six below shows the various attitudes in which the participants had towards the designers' knowledge in identifying safety issues as compared to contractors.

Table 26: Summary of responses from the question 'Designers in construction believe they have more knowledge in identifying safety issues than contractors'

Please rate the degree with which you agree or disagree with the following statement. ***'Designers in construction believe they have more knowledge in identifying safety issues than contractors'***				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		2	5%
2	Disagree		7	19%
3	Neutral		10	27%
4	Agree		14	38%
5	Strongly agree		4	11%
	Total		**37**	**100%**

Forty-nine percent of the participants believe that designers have more knowledge in identifying safety issues than contactors while 24% of the participants disagree with this statement. Twenty seven percent of the participants were neutral towards this statement. This can be viewed as one of the reasons why ECI is not prevalent in South Africa. Designers in the South African construction industry believe they have more knowledge in identifying safety issues than contractors thus do not require including them in the design phase of a construction project.

Other reasons that prevent the use ECI in the construction industry as discussed in the literature review include:

- Interrelated decisions between architects and engineers can be brought about by ECI in that the different changes brought about by the contractor can bring incompatibility issues and errors during construction;

- In ECI, the client and contractor tend to focus on the construction works more than the design to accelerate the date of completion of the project. This tends to bring about issues of wastage and reworks as not enough attention was paid on the design;
- Clients and contractors are reluctant to disclose too much information on the project before award of contracts;
- Culture change brought about by lack of understanding of the concepts and its benefits;
- Challenges in the contracting practice that is, alternative project delivery methods and;
- Teamwork and partnering issues.

Table Twenty-Seven below shows the various attitudes in which the participants had towards the contractor taking full liability of accidents and fatalities that may happen on construction sites after Early Contractor Involvement.

Table 27: Summary of responses from the question 'Contractors can take full liability for accidents and fatalities that occur in construction sites after Early Contractor Involvement'

Please rate the degree with which you agree or disagree with the following statement. ***'Contractors can take full liability for accidents and fatalities that occur in construction sites after Early Contractor Involvement'***				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		1	3%
2	Disagree		8	21%
3	Neutral		6	16%
4	Agree		11	29%
5	Strongly agree		12	32%
	Total		**37**	**100%**

Sixty-one percent of the participants in this study agree that contractors can take full liability for accidents and fatalities that occur in construction site even after ECI. Only 24% of the participants disagreed with this statement and 16% of the participants were neutral towards

the statement. Though this may be more of a legal or contractual obligation which may vary from project to project as well as location, majority of the designers in South Africa as well as worldwide believe contractors will be more willing to accept full liability for accidents and fatalities if they were included in the design process and did not point out potential safety hazards that may arise from the proposed design prior to construction.

4.7.3 SOUTH AFRICAN DESIGNERS' ATTITUDE TOWARDS SAFETY PERFORMANCE IN CONSTRUCTION

To understand better the outcome of what designers' in the South African construction industry's perception towards safety performance in construction, the researcher analysed the above questions asked concerning their attitude towards safety performance in the construction industry using the Z-Score to Percentile Rank Score analysis.

The researcher ranked the questions according to this so as to compare differences in attitudes from the questions asked. *Figure 4.5* below shows a Z-Score Analysis of the various attitudes the designers in the construction industry have towards Safety Performance on construction sites. From the Z-Score analysis above, it is clear that the designers' in the South African construction industry believe that ECI can improve the Safety Performance on a construction project. Designers believe they would be held liable for accidents and fatalities that may occur by the use of ECI. The five questions that asked the respondents about safety and safety performance ranked on the Z-Score analysis ranged between 26% and 39%. Majority of the designers believed that they would be held liable for accidents and fatalities that may occur during construction phase as a result of ECI. This can be taken as a reason as to why ECI has not been embraced in the South African industry and worldwide as the outcome of this question is synonymous with that done in developed countries.

Only 49% of the participants from the top 2 box analysis believe that designers have more knowledge in identifying safety issues than contractors. From previous studies conducted, designers worldwide believe that contractors may have more knowledge in identifying safety issues and thus would be beneficial to the project in terms of improved safety performance if they were included earlier in the project.

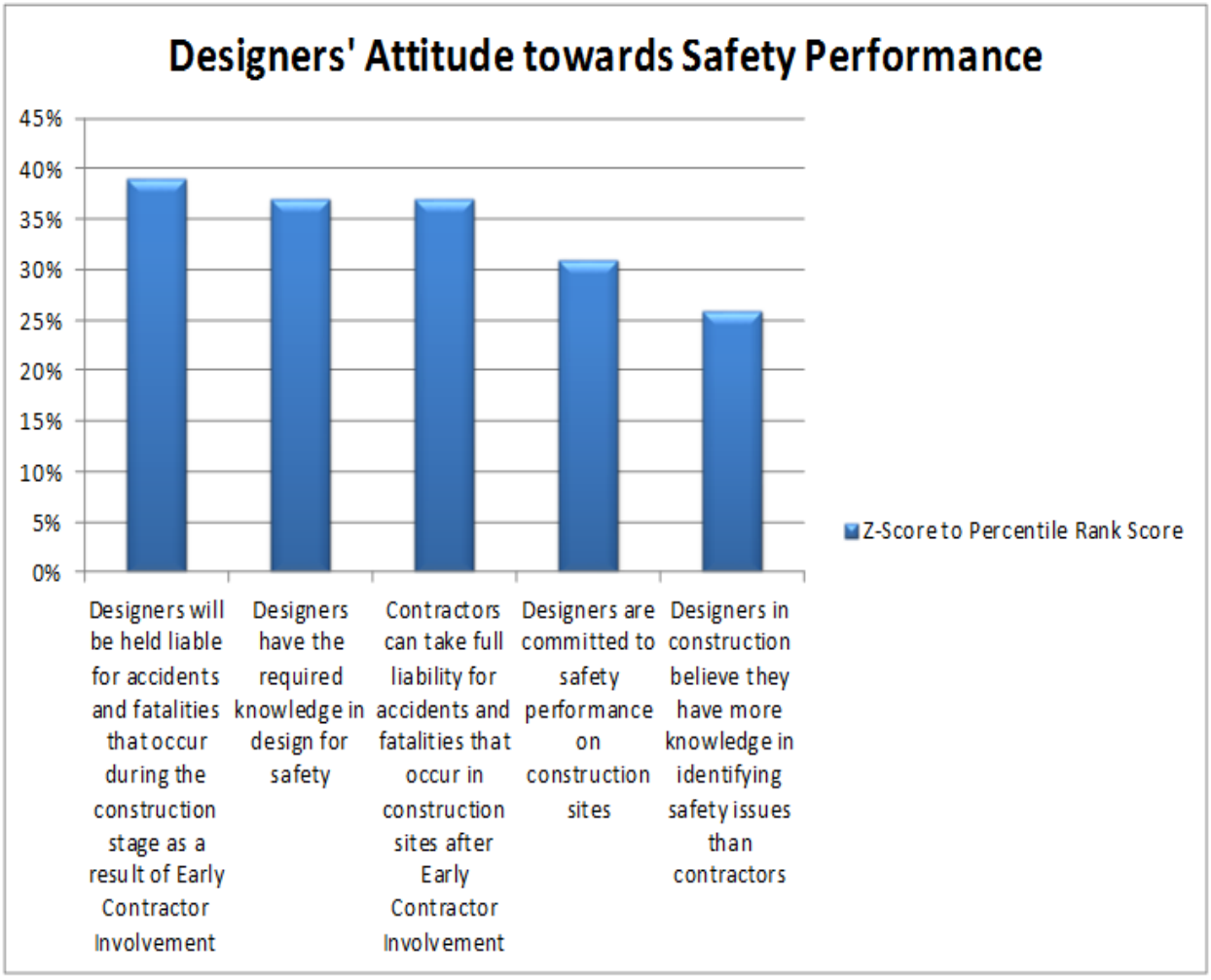


Figure 4.6: Z-Score to Percentile Rank Analysis of the designers' attitude towards Safety Performance on construction sites.

4.8 ANALYSIS OF DESIGNERS VIEWS ON CONTRACTORS

An analysis of the various views the designers in the construction industry may have towards contractors was conducted. This was deemed necessary so as to determine how the designers in the construction industry feel about including the contractors in design phase of a project. The following questions were asked in the questionnaire survey to help determine their various attitudes towards this matter:

- Contractors can contribute towards design for safety;
- Contractors understand the implication of the various designs on safety;
- Contractors have the necessary knowledge to contribute towards designing for safety;
- Contractors are committed to safety promotion/ accident promotion on their construction sites;
- Communication with the contractors during the design phase is effective;
- Contractors assume liability for their involvement in the design process when involved earlier in the process;
- Contractors should have an influence in the design process;
- Contractors experience safety performance constraints when not involved in the design process;
- The involvement of the contractor earlier during the design stage may lengthen the design process and
- Contractors have knowledge to offer when involved earlier in the design process.

Table Twenty-Eight below shows the various attitudes in which the participants had towards the contractors' contribution in designing for safety.

Table 28: Summary of responses from the question 'Contractors can contribute towards design for safety'

Please rate the degree with which you agree or disagree with the following statement.				
'Contractors can contribute towards design for safety'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		10	26%
3	Neutral		6	16%
4	Agree		15	39%
5	Strongly agree		7	18%
	Total		**38**	**100%**

The majority of the survey respondents, 57%, believe that contractors can contribute towards designing for safety. This outcome corresponds with similar studies conducted in developed countries. Designers are open to including contractors in the design phase of the project as they believe contractor have knowledge that can improve safety during and after the construction project is completed.

This question *'Contractors can contribute towards design for safety'* is similar to the question on the table below which asked the respondent if *'Contractors have the necessary knowledge to contribute towards designing for safety'.* The outcome of the first question was 67% as discussed above while the outcome of the second question was that 76% of the participants agreed that contractors have knowledge to contribute towards designing for safety. In both questions, majority of the respondent believe that contactors have information to offer in designing for safety which provides internal validity in this research.

Table Twenty-Nine below shows the various attitudes in which the participants had towards contractors having knowledge to contribute regarding designing for safety.

Table 29: Summary of responses from the question 'Contractors have the necessary knowledge to contribute towards designing for safety'

Please rate the degree with which you agree or disagree with the following statement.				
'Contractors have the necessary knowledge to contribute towards designing for safety'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		1	3%
2	Disagree		5	13%
3	Neutral		3	8%
4	Agree		21	55%
5	Strongly agree		8	21%
	Total		**38**	**100%**

Seventy-six percent of the participants believe that contractors have the necessary knowledge to contribute towards designing for safety while 16% of the participants believe otherwise. Eight percent of the participants felt neutral towards the statement. The designers in the South African construction industry believe contractor have knowledge to contribute towards design for safety thus are willing to incorporate ECI so as to enhance the safety performance of the project during construction and after completion. The outcome of this question is synonymous with that from previous studies conducted in the developed countries.

Table Thirty below shows the various attitudes in which the participants had towards the contractors understanding in the implications of designing for safety.

Table 30: Summary of responses from the question 'Contractors understand the implication of the various designs on safety'

Please rate the degree with which you agree or disagree with the following statement.

'Contractors understand the implication of the various designs on safety'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		4	11%
3	Neutral		9	24%
4	Agree		19	50%
5	Strongly agree		6	16%
	Total		**38**	**100%**

Sixty-six percent of the participants agreed that contractors do indeed understand the implications of designing for safety on construction projects. Only 11% of the participants disagreed with this statement. Twenty four percent of the participants were neutral towards the statement. Previous studies done in more developed countries show that most of the designers in the construction industry do believe contractors understand the implications for not designing for safety and thus, this study's outcome is synonymous with what has been found in those countries.

Contractors are aware of the implication that may arise from not designing for safety as they are the ones who construct the project thus, should be included in designing for safety for better results in the project.

Table Thirty-One below shows the various attitudes in which the participants had towards the contractors' commitment to safety on construction sites.

Table 31: Summary of responses from the question 'Contractors are committed to safety promotion/ accident promotion on their construction sites'

Please rate the degree with which you agree or disagree with the following statement.

'Contractors are committed to safety promotion/ accident promotion on their construction sites'

#	Answer	Bar	Response	%
1	Strongly disagree		3	8%
2	Disagree		5	13%
3	Neutral		6	16%
4	Agree		19	50%
5	Strongly agree		5	13%
	Total		**38**	**100%**

Sixty-three percent of the participants agree that contractors are committed to safety promotion on their construction sites while 21% of the participants disagree with this statement. Only 16% of the participants felt neutral towards this statement. This may be attributed to the strict safety rules and regulations for contractors in South Africa. The outcome of this statement corresponds to that done in previous studies.

Table Thirty-Two below shows the various attitudes in which the participants had towards the effectiveness in communication between the contractor and the design team during the design phase of the project.

Table 32: Summary of responses from the question 'Communication with the contractors during the design phase is effective'

Please rate the degree with which you agree or disagree with the following statement.				
'Communication with the contractors during the design phase is effective'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		6	16%
3	Neutral		8	21%
4	Agree		16	42%
5	Strongly agree		8	21%
	Total		**38**	**100%**

Sixty-three percent of the participants agree that the communication with the contractors during the design phase is effective while 16% of the participants believe otherwise. Twenty one percent of the participants felt neutral towards this statement. Similar studies carried out in developed countries showed that most designers believed that communication with the contractors during the design phase of the project may not be effective and furthermore, may lengthen the design process.

Table Thirty-Three below shows the various attitudes in which the participants had towards the contractors assuming liability for their involvement in the design process.

Table 33: Summary of responses from the question 'Contractors assume liability for their involvement in the design process when involved earlier in the process'

Please rate the degree with which you agree or disagree with the following statement.

'Contractors assume liability for their involvement in the design process when involved earlier in the process'

#	Answer	Bar	Response	%
1	Strongly disagree		2	5%
2	Disagree		10	26%
3	Neutral		5	13%
4	Agree		12	31%
5	Strongly agree		10	26%
	Total		**39**	**100%**

Fifty-seven percent of the respondents believe that contractors can assume liability for their involvement in the design process when involved earlier in the process. Designers in the South African construction industry believe that if the contractor provided the wrong information during the design phase of the project which resulted in accidents and fatalities during the construction period, they would assume liability for their mistakes. Thirty-One percent of the respondents do not believe to be the case and assume otherwise. Thirteen percent of the respondents remained neutral in the matter.

From a review of the literature, previous studies have shown that designers do believe that contractors will take liability in case of accidents and fatalities that may occur from their own misinformation during the design phase of the project.

Table Thirty-Four below shows the various attitudes in which the participants had towards the contractors having an influence in the design process.

Table 34: Summary of responses from the question 'Contractors should have an influence in the design process'

Please rate the degree with which you agree or disagree with the following statement. *'Contractors should have an influence in the design process'*				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		1	3%
2	Disagree		4	11%
3	Neutral		8	22%
4	Agree		18	50%
5	Strongly agree		5	14%
	Total		**36**	**100%**

The majority of the participants, 64%, believe contractors should have an influence in the design process. Fourteen percent of the participants disagreed with this statement while 22% of the participants remained neutral towards the statement. This outcome is similar to that of previous studies conducted. Most designers in the construction industry believe that contractors can help them design for safety and improve the safety performance of a project.

Table Thirty-Five below shows the various attitudes in which the participants had towards the contractors experiencing safety performance constraints when not involved in the design process.

Table 35: Summary of responses from the question 'Contractors experience safety performance constraints when not involved in the design process'

Please rate the degree with which you agree or disagree with the following statement. 'Contractors experience safety performance constraints when not involved in the design process'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		7	19%
3	Neutral		4	11%
4	Agree		22	59%
5	Strongly agree		4	11%
	Total		**37**	**100%**

Seventy percent of the participants believe that contractors experience safety performance constraints when they are not involved in the design process while 19% of the participants do not believe so. Eleven percent of the participants remained neutral towards the matter. From a review of the literature, it is believed that most designers believe that contractors do in fact experience safety performance constraints that may originate from the various design drawings given to them to construct.

Table Thirty-Six below shows the various attitudes in which the participants had towards the ECI lengthening the design process of a project.

Table 36: Summary of responses from the question 'The involvement of the contractor earlier during the design stage may lengthen the design process'

Please rate the degree with which you agree or disagree with the following statement.

'The involvement of the contractor earlier during the design stage may lengthen the design process'

#	Answer	Bar	Response	%
1	Strongly disagree		0	0%
2	Disagree		6	17%
3	Neutral		6	17%
4	Agree		18	50%
5	Strongly agree		6	17%
	Total		**36**	**100%**

Sixty-seven percent of the participants believe that involving the contractor earlier during the design stage may lengthen the design process while 17% of the participants do not believe so. Seventeen percent of the participants felt neutral towards the statement. This outcome is synonymous with that of previous studies conducted. Designers in the construction industry believe that bringing in the contractor earlier in the project may cause friction during the design phase which may lead to the lengthening of the process. It is believed from previous literature that the involvement of the contractor earlier in the design phase may in turn shorten the construction phase as the number of variations and disputes maybe less.

Table Thirty-Seven below shows the various attitudes in which the participants had towards the contractors having knowledge to offer when involved earlier in the design phase of a project.

Table 37: Summary of responses from the question 'Contractors have knowledge to offer when involved earlier in the design process'

Please rate the degree with which you agree or disagree with the following statement.				
'Contractors have knowledge to offer when involved earlier in the design process'				
#	**Answer**	**Bar**	**Response**	**%**
1	Strongly disagree		0	0%
2	Disagree		1	3%
3	Neutral		1	3%
4	Agree		25	68%
5	Strongly agree		10	26%
	Total		**37**	**100%**

Ninety-four percent of the designers in the South African construction industry believe that contractors knowledge to offer when involved in the design phase of the project. Only 3% of the respondents disagreed with this statement. Three percent of the participants felt neutral towards this statement. Designers in the construction industry believe that contractors may have some knowledge to offer during the design phase regarding new technology in the market that may lower the construction cost of the project, reduce the construction time of the project as well as ways of improving on safety during the construction phase. This is in agreement with the outcome from other studies conducted.

4.8.1 SOUTH AFRICAN DESIGNERS' ATTITUDE TOWARDS CONTRACTORS

To understand better the outcome of what designers' in the South African construction industry thought about contractors in the construction industry, the researcher analysed the above questions asked concerning their attitudes towards contractors in the construction industry using the Z-Score to Percentile Rank analysis.

The researcher ranked the questions according to this so as to compare differences in attitudes from the questions asked. *Figure 4.6* shows the various attitudes the designers in the construction industry have towards contractors.

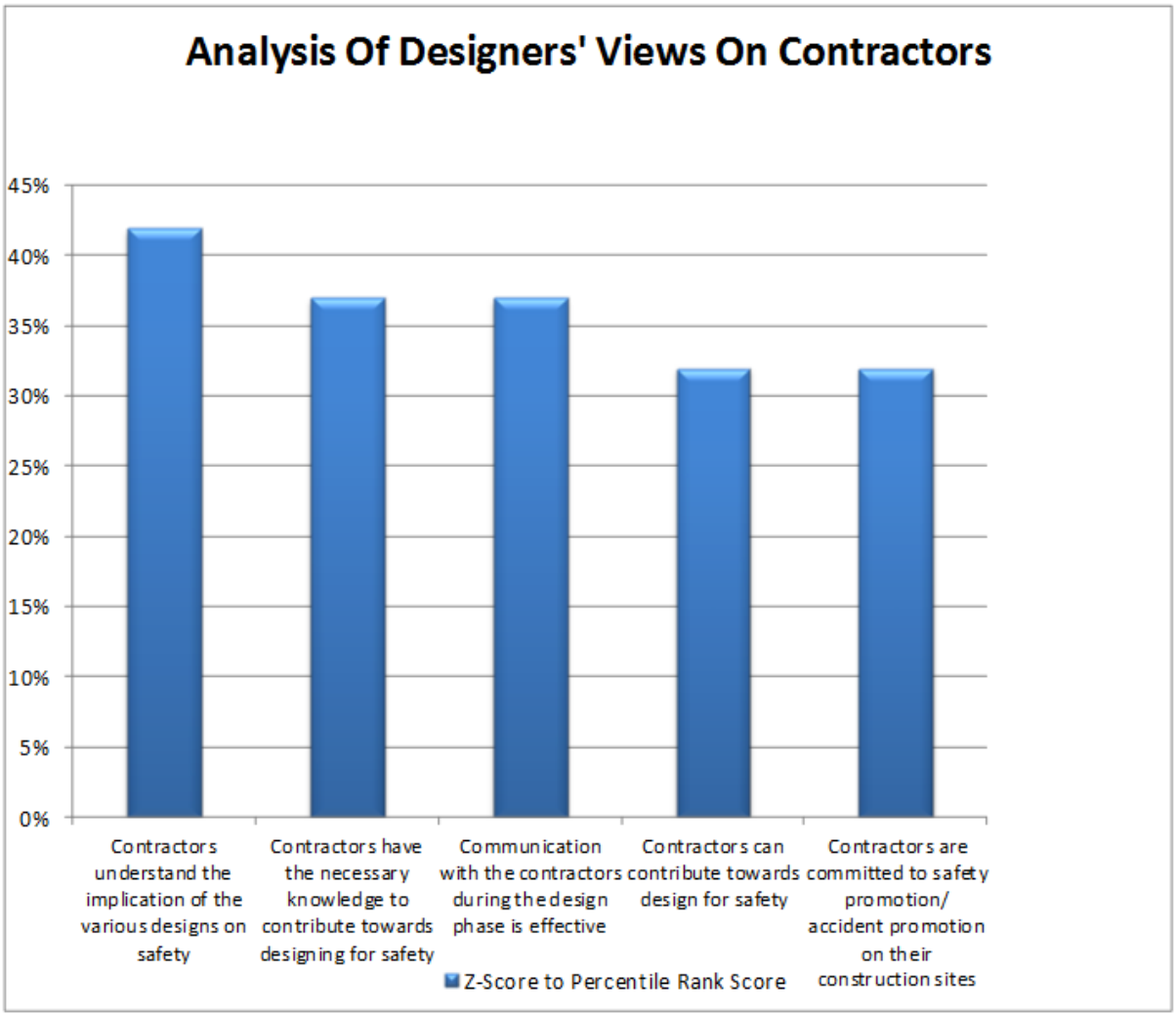


Figure 4.7 (a): Z-Score to Percentile Rank Analysis of an analysis of the designers' views on contractors

The *Figure 4.7* above as well as the continuation below depicts the outcome of what the designers in the South African construction industry think of contractors and their inclusion earlier in the project. The questions asked designers whether contractors had any knowledge to offer if included in the design phase of a construction project as well as their commitment to safety in construction. From the Z-Score to Percentile Rank analysis above as well as below, it is clear that the designers' in the South African construction industry believe that contractors have some knowledge to offer in designing for safety in a construction project.

The ten questions that asked the designers about their attitudes towards contractors and designing for safety ranked on the Z-Score analysis ranged between 62% and 33%. The South African designers in the construction industry strongly believe that contractors do indeed have knowledge to contribute if included earlier in the design phase of the project. This outcome corresponds with that carried out in developed countries.

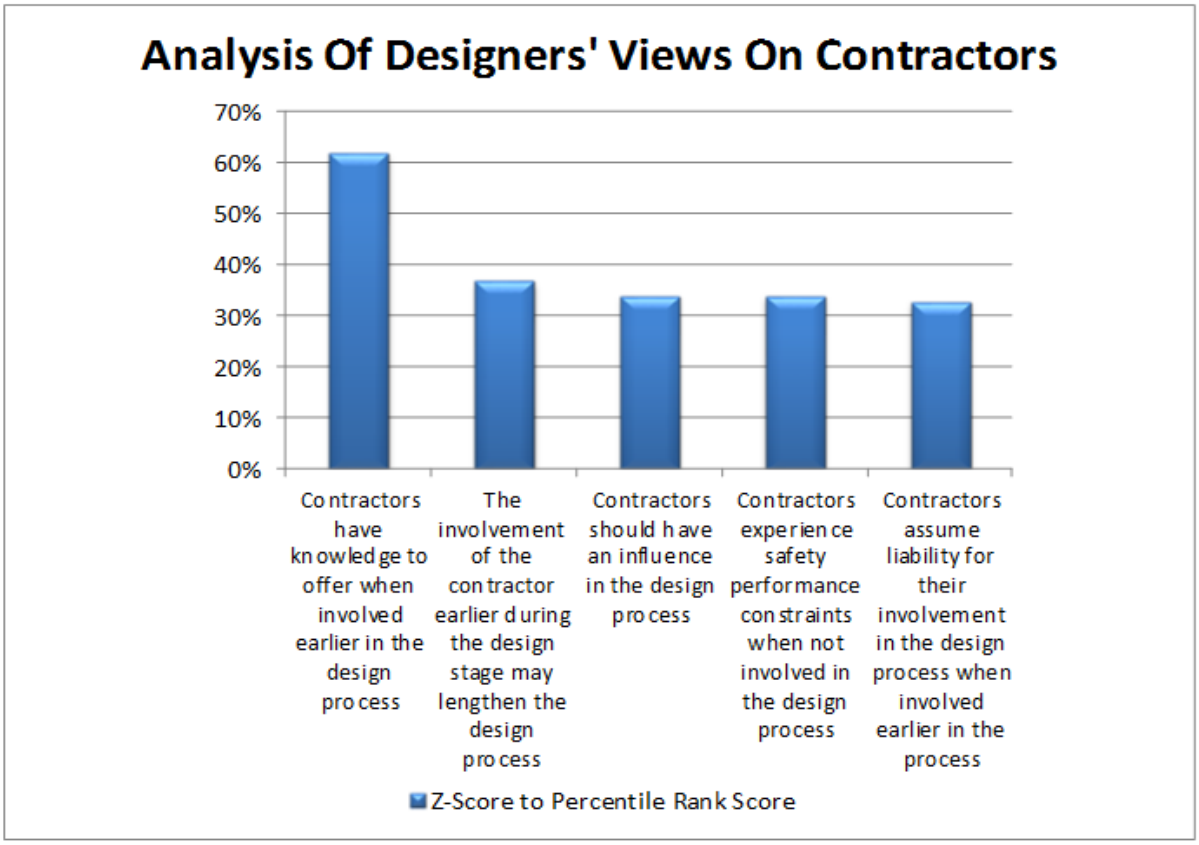


Figure 4.7 (b): Z-Score to Percentile Rank Analysis of an analysis of the designers' views on contractors

4.9 CONCLUSION

A survey of the designers and project managers in Gauteng Province, South Africa indicated an extremely strong feeling that ECI would provide clear benefits in safety of construction sites. The findings of this research reveal that 93% of the questions asked on the questionnaire survey have the same outcome as those studies conducted in the developed countries.

Not including the demographic data, only two questions out of the twenty five questions asked in the questionnaire survey varied in responses compared to studies previously carried out in developed countries. These two questions include:

'Designers are committed to safety performance on construction sites'

The outcome from this study revealed that 59% of the participants agreed with the above statement while 20% of the participants disagreed with it. Twenty one percent of the participants felt neutral on the matter. A review of the literature as well as other studies conducted in developed countries state that most designers were concerned with the outcome of their designs and did not pay much attention to the safety implications of their designs during the construction phase as well as occupation stage.

The difference in this outcome in responses may be attributed to the recently amended Construction Regulations in South Africa that tighten the rules and regulations on safety in construction sites. If this survey was carried out a couple of years back, the outcome may have been the same as that documented in previous studies.

The second question that differed in responses when compared to the literature was;

'Communication with the contractors during the design phase is effective'

The outcome of this question in this research showed that 63% of the participants agreed with the statement while 16% of the participants disagreed with it. Twenty one percent of the participants remained neutral towards the statement. From previous literature and studies carried out in developed countries regarding this question, majority of the designers in the construction industry believed that communication with contractors during the design phase may not be effective and furthermore, may lengthen the design process. The South African designers believe in the contrary, that communication would be more effective if the

contractor is brought during the design stage of the project and in addition, they believe that with every one being involved in the design phase of the project would lessen construction phase duration.

In conclusion, there is very limited Body of Knowledge (BOK) in the various attitudes the designers may have towards ECI and the Safety Performance of construction sites especially in developing countries such as South Africa. From the outcome of this research study, it can be noted that the South African designers believe that ECI can improve health and safety and the safety performance of construction sites among other benefits identified above. In addition, they believe that indeed contractors do have knowledge to offer regarding designing for safety. In overall, designers in the construction industry have a positive attitude towards the use of ECI in construction as a means to improve the safety performance on construction sites.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This study aimed to determine the attitude of designers' in the South African construction company towards the use of ECI as a means to improve the safety performance on construction sites. This chapter will summarize the field findings, discuss the differences in the outcome of some of the results and compare them to previous studies done, draw conclusions from the findings as well as provide recommendations for further studies in this area.

5.2 SUMMARY OF FINDINGS

A review of the literature revealed that the use of ECI has a significant impact to the reduction of accidents and fatalities in the construction industry and overall improvement on the site's safety performance. The use of ECI is not prevalent in South Africa thus, the main research challenge of this study was to identify the various attitudes the designers' in the South African construction have towards the use of ECI in the industry as a means to improve the safety performance on construction sites.

To investigate this problem, a review of the literature was conducted and a questionnaire survey developed to capture the various attitudes the designers' in the South African construction industry may have towards the use of ECI, risk perception as well as the safety culture on construction sites.

This study's *empirical objectives* of this study included the following and their outcome from the questionnaire survey has been discussed below.

- *Identify the trust relationship between designers and contractors*

This research sought to investigate the type of trust relationship there is between the designers and contractors in matters regarding designing for safety. The outcome of this

research showed that designers in the construction industry trust that contractors do have the knowledge to offer regarding safety and can aid in designing for safety.

- *Explore the designers beliefs regarding ECI as a way of increasing the safety performance on construction sites;*

The outcome of this research showed that the designers in the South African construction industry believe that ECI can indeed improve the safety performance of a construction site. This is synonymous with the previous studies conducted regarding the same objective.

- *Explore how the designers feel about ECI and liability issues due to introducing the contractor earlier in the design process;*

This was a main concern with the designers in the construction industry and one of the barriers identified prohibiting the use of ECI in the industry. The data analysis of this research showed that the designers in the construction industry believed that contractors would be willing to take the liability of accidents and fatalities that may happen if they were brought in earlier in the design phase of the project and failed to point out potentially hazardous risks prior to construction.

- *Explore whether the designers' believe contractors feel powerless for not being included in design phase;*

This research revealed that contractors' do in fact feel powerless when not included in the design phase of the project. In most construction projects, the contractor is handed the final drawing to construct and has little to no influence on the design. Consequently, they have no power to aid in designing for safety and improving the safety performance of the project before the construction phase.

- *Explore the designers' beliefs on the communication barrier between designers and contractors;*

The outcome of this research shows that the designers in the South African construction industry believe that communication between the designers and the contractor may not be effective during the design phase of the project. This outcome is synonymous with that of previous studies. Designers believe that during the design phase of the project the communication will be strained but during the construction period of the project after

incorporating ECI, the communication and trust relationship will be improved as compared to projects that did not involve ECI.

- *Explore the designers' beliefs on the commitment of contractors towards safety promotion and improving safety performance of their construction sites.*

This study revealed that designers in the South African construction industry believe that contractors are in fact committed towards the safety promotion of their construction sites and strive to improve their safety performance scores. This outcome is similar to that done in developed countries and this may be attributed to the strict OSHA Regulations adopted by majority of the countries worldwide.

The data collected strived to answer the following research questions. The outcomes of these questions from the questionnaire survey conducted have been discussed below.

Main Research Question

The main research question was:

> *What are the designers' in the construction industry's attitude on the effects of Early Contractor Involvement on the safety performance on construction sites?*

Majority of the designers' in the South African construction industry had a positive perception to the use of ECI in the industry. Designers in the industry were willing to include the contractor in the design phase of the project and help them with designing of safety and risk management analysis before construction works begun in order to minimize accidents and fatalities as a result of design implications as well as improve the overall safety performance of the project.

Research Sub-Question One

> *What is the trust level of designers in construction regarding Early Contractor Involvement?*

The designers in the South African construction industry trust that the use of ECI is beneficial in improving the safety performance on construction sites as well as in the reduction of accidents and fatalities during the construction phase. The designers' in the construction industry also believe that ECI can help improve risk management, constructability as well as reduce the number of variation claims on a construction site among other benefits.

Research Sub-Question Two

How committed are the contractors towards safety promotion on construction sites?

Quite a high number of the designers' in the South African construction industry believe that contractors are committed towards safety promotion in construction. This commitment may be attributed to the stringent safety regulations in the country.

Research Sub-Question Three

Do designers believe that accidents can be reduced/ prevented by Early Contractor Involvement?

All the designers who participated in this study believed that ECI can indeed reduce the number of accidents that may occur during the construction phase of the project. They further believed that some of the accidents could be prevented at the design stage prior through the use of ECI.

Research Sub-Question Four

How do the designers find the communication with the contractors during the design phase to be?

Majority of the designers' in the South African construction industry believe communication with the contractors to be effective if contractor are included earlier in the project as opposed to later in the project. A bond between the designers, contractor and client is formed earlier in the project which extended to during the construction phase.

Research Sub-Question Five

Are the designers concerned about the liability that comes with contractors being involved earlier in the design phase of the construction project?

This was a major concern for the designers in the South African construction industry. Most of the designers' believed that bringing in the contractor earlier in the project may bring about liability issues in case accidents and fatalities occurred during the construction phase of the project.

Research Sub-Question Six

Do designers believe the contractor feel powerless/ constrained when not included in the design phase of the project when it comes to the safety performance during construction?

Most of the respondents believed that not including the contractor in the design phase of the project constrained the contractor in terms of providing modifications and alternatives in the design that would have enhanced the safety performance of the site.

Research Sub-Question Seven

Do the designers believe the contractor have knowledge to offer in safety when included earlier in the design phase of the project?

Majority of the respondents believed contractors have knowledge to offer regarding safety in construction and they should be included in the design phase of the project so as to aid the designers identify safety hazards in their designs prior to construction.

Research Sub-Question Eight

Do the designers believe the contractors are aware of potentially hazardous risk in construction?

Majority of the participants believe that contractors can identify hazardous risk in construction that may arise from the design. Furthermore, the respondents believe that contractors can aid the designers in designing for safety in the project.

Research Sub-Question Nine

What are the possible benefits and barriers of ECI in respect to safety performance?

The respondents identified various benefits of ECI. Some of these benefits included;

- ECI can improve the safety performance on construction sites;
- ECI can reduce the number of variation claims on a construction project;
- ECI can reduce the number of disputes in a construction project;
- ECI can improve the overall site safety of a construction site;
- ECI can improve the constructability of a construction project and
- ECI can improve risk management on a construction project.

Research Aim

The main aim of this research was to investigate the designers' perspective on Early Contractor Involvement as a means to improve the safety performance on construction sites. An analysis of the data collected revealed that the South African construction designers are keen to improve a project's safety performance as well as construction worker safety. The study further revealed that the designers in the South African construction industry have a positive attitude towards the use of ECI in the industry as a way to improve the safety performance on construction sites.

Research Hypothesis

This study tested the following null hypothesis;

Designers' in the South African construction industry do not have a positive attitude towards the effects of Early Contractor Involvement on the safety performance on construction sites.

The research revealed that this was not true and that the designers' in South African construction industry do have a positive attitude towards the effects of Early Contractor Involvement on the safety performance on construction sites.

5.3 CONTRIBUTION

5.3.1 TO KNOWLEDGE

There is limited literature and research done on the attitude the designers may have towards ECI and the Safety Performance of construction sites especially in developing countries such as South Africa. This research strived to note the gaps existing in the literature and previous studies and contribute in adding knowledge in the area to the already existing Body of Knowledge. This research revealed that designers in the South African construction industry believe that if the contractor is included earlier in the design phase of the project, it could improve health and safety and the safety performance of the construction project. Similar

studies have been conducted in developed countries and the outcome of these studies is synonymous with this study.

This research strived to narrow down the already existing gap in the use of ECI to improve health and safety and the safety performance of construction sites and provide a basis for future researchers in this area.

5.3.2 TO PRACTICE

A review of the literature revealed that the construction industry has one of the highest rates of accidents and fatalities worldwide. The benefits of ECI have been studies worldwide and its impact on safety performance and health and safety is evident. This research showed that most designers in the Gauteng Province of South Africa believe that ECI can improve the safety performance and construction worker safety in construction sites. This research strives to improve the safety performance and construction worker safety in construction sites both locally and internationally through the use of ECI.

5.4 LIMITATIONS OF THIS STUDY

The main limitation of this study was the poor response rate from the participants identified to carry out the research. About 10% of the target population responded to the questionnaire survey but irrespective of this, it was deemed that demographic data was sufficient to carry out the research as it was representative of the population although the findings are indicative only and cannot be statistically generalized. In future studies, the number of surveys to be distributed should be increased to throughout South Africa and not just one province such as in this case so as to attempt to reach more designers in the construction industry. The method of distribution of these surveys may be reconsidered so as to get a more appropriate response rate.

5.5 REFLECTION ON THE RESEARCH PROCESS

Various aspects of this research could have been done differently to ensure a more valid and reliable data outcome. For example, a sample number could have been increased in order to get a higher response rate than the current 9%. In addition, the study only covered architects and engineers in the Gauteng Province of South Africa; a full scale research could have been done to include all architects and engineers in South Africa so as to provide a clearer outcome on the topic.

5.6 AREAS OF FURTHER STUDY

There are limited studies on ECI in developing countries. This research picked up on some gaps existing in the literature which include but not limited to the following:

- A full scale study in this research topic should be carried out with architects and engineers from the whole of South Africa included in the survey for a clearer outcome of the topic.
- Contractors' perception towards ECI. A study should be conducted on contractors' perception towards ECI and find out if they are willing to be included earlier in the design phase of a project as opposed to during the construction phase.
- Clients' perception towards ECI should also be considered to find out their attitude towards construction worker safety and safety performance on construction sites as well as the use of ECI on construction projects.
- This research touched on some of the benefits of ECI. A full study on the matter should be conducted to explore other benefits that may arise from the use of ECI in the construction industry.
- A study to explore the barriers of ECI in developing countries should be conducted so as to find out why the use of ECI is not prevalent in the construction industry.

5.7 CONCLUSION AND RECOMMENDATION

Based on the data collected from this study which indicated a string consensus as to the benefit of ECI, a number of conclusions can be formulated regarding the perceptions the designers' may have towards ECI and the safety performance on construction sites. These conclusions are:

- The respondents believe that the use of ECI in construction will be beneficial in improving the safety performance on construction sites. The South African designers in construction embrace the use of ECI in construction sites.
- The majority of the respondents believe that contractors are committed towards safety promotion and thus would be willing to practice ECI so as to reduce the number of accidents and fatalities during construction that may be as a result of the design.
- The participants also believe that bringing in the contractor earlier in the project can enhance communication between the parties involved as well as trust.
- From the data collected, the designers' in the South African construction industry believe if contractors are involved earlier in the project, the contractors would be willing to take liability of any accidents and fatalities that may occur as a result of their misinformation.
- The respondents believe that contractors have knowledge in designing for safety and they can identify areas of risk in a design prior to construction.
- ECI clearly has other benefits in the construction industry other than improvement of safety performance on construction sites.

The following recommendations were identified:

- Policies and guidelines boosting the use of ECI in the South African construction industry and the construction industry in developing countries should be included in the construction regulations such is in other developed countries e.g. Australia. The use of ECI in the construction industry will reduce the number of accidents and fatalities that occur in the industry as well as improve the overall safety performance of construction sites.

- The designers in the construction industry as well as the contractors should be trained by the government or the CIBD on the use of ECI and its benefits as well as on designing for safety so as to improve the safety performance on construction sites.

In conclusion, the construction industry is one of the largest employers in the world with one of the highest accidents and fatalities cases. According to the Global Construction Perspective and Oxford Economics study, the construction industry is estimated to increase to a growth of 70% worldwide by the year 2025. With the growing economy in developing countries, there is a demand for better infrastructure and urbanization. Needless to say, construction projects have just begun in developing countries.

With the rural-urban migration going on currently in most African cities as well as the increased population growth and continued shortage of construction space, there is a need for more multi-storey apartment and office blocks. Multi-storey construction projects have a higher probability for accidents and fatalities to occur especially during the construction phase of the project. The complexity of the construction industry and the hazards associated with it has brought about the laws and regulations both local and international to deal with the high number health and safety related issues in the industry. Previous studies conducted show that the introduction of these laws and regulations in the industry reduced the number of accidents and fatalities. The industry is looking for further ways to improve the health and safety and safety performance on construction projects. From this research study, it is clear that many designers' in the South African construction industry believe that the inclusion of the contractor earlier in the project can drastically improve the health and safety and safety performance of a construction project. The Construction Regulations in South Africa and all countries worldwide should seek to include the use of ECI as a best practice in construction so as to improve health and safety and the overall safety performance in construction.

6.0 REFERENCES

Agumba J., and Haupt T. (2009). "Construction Health and Safety Culture in South African Small and Medium Enterprise." Department of Construction Management and Quantity Surveying, University of Johannesburg. pp 461-472.

AIA California Council (2007). "Integrated project delivery: a working definition". AIA California Council. Sacramento.

Amarjit S. (2001). "Contributions of Designers to Improving Buildability and Constructability" 1st International Structural Engineering & Construction Conference. A.A. Balkema, Honolulu, USA. 128 (2), pp 457-479.

Arditi D., Elhassan A. and Y.C. Toklu Y. (2002). "Constructability Analysis in the Design Firm." Journal of Construction Engineering and Management. 128 (2), pp 144-154.

Atkinson A. and Westall R. (2010). "The Relationship between Integrated Design and Construction and safety on Construction Projects." The Journal of Construction Management and Economics. 28(9), pp 1007-1017.

Babbie E. and Mouton J. (2011). "The Practice of Social Research." Oxford University Press Southern Africa.

Ballard, G. (2008). "The lean project delivery system: An update." Lean Construction Journal. Pp 1-19.

Behm M., (2005). "Linking Construction Fatalities to the Design for Construction Safety Concept." Department of Technology Systems, East Carolina University. 43(8), pp 589-611.

Behm, M., and Culvenor, J. (2011). "Design in Construction: Perceptions of Engineers in Western Australia." Journal of Health and Safety Research and Practice. 3 (1), pp 9-23.

Betts M, Robinson G, Burton C, et al. (2013). "Global Construction 2025 Executive Summary." London: Oxford Economics & Global Construction Perspectives. 30 (3), pp 292-304.

Cheetham D. and Lewis J. (2001). "Productivity, Buidability and Constructability: Is Work Study The Missing Link?" Association of Researchers in Construction Management. 1 (1), 271-280.

Cheng E., Ryan N. and Kelly S. (2011). "Exploring the Perceived Influence of Safety Management Practices on Project Performance in the Construction Industry." Safety Science. 50 (2), pp 363-369.

Christianson C, (2005), "Design for Construction Safety: A case study with an Architect's perceptions." Unpublished Honours Baccalaureate of Science in Construction Engineering Management Project Report. Oregon State University, USA.

CIDB, (2009). "Construction Health & Safety in South Africa: Status & Recommendations." CIDB, Pretoria, South Africa.

CIDB. (2004). "South Africa Construction Industry Status Report – 2004: Synthesis Review on the South African Construction Industry and its Development." CIDB, Pretoria, South Africa.

CIDB. (2008). "The CIDB Construction Industry Indicators Summary Results: 2008." CIDB, Pretoria, South Africa.

CIDB. (2009). "Construction Health & Safety in South Africa: Status & Recommendations." CIDB, Pretoria, South Africa.

CIDB. (2010). "The CIDB Construction Industry Indicators Summary Results: 2009." CIDB, Pretoria, South Africa.

CIDB/CSIR (Construction Industry Development Board with the CSIR (2007). "The State of Municipal Infrastructure in South Africa and its Operations and Maintenance; An Overview." CIDB, Pretoria, South Africa.

Dingsdag, D., Biggs, H., Sheahan, V, and Cipolla, D. (2006). "A Construction Safety Competency Framework: Improving OH&S Performance by Creating and Maintaining a Safety Culture." CRC for Construction Innovation, Brisbane.

Dulaimi, M. and Yazici, E. (2014*). "*Understanding Designing for Construction Safety: The Interaction Between Confidence and Attitude Of Designers and Safety Culture." Architectural Engineering and Design Management. 11(5), pp 325-337.

Dulaimi, M. and Yazici, E. (n.d*).* "Designers' Attitude Towards Designing for Construction Safety: Case of United Arab Emirates." www.academia.edu.

Eadie R., Mckeown C. and Ferguson M. (2012). "The Feasibility and Rationale for using Early Contracctor Involvement in Northern Ireland." 7th International Conference on Innovation in Architecture, Engineering and Construction, Sao Paulo, Brazil.

Eriksson E., Westerberg M., (2010). "Effects of Cooperative Procurement Procedures on Construction Project Performance; A Conceptual Framework." International Journal of Project Management. 29 (2), pp 197-208.

FEMA, (2007/2014). "Claims Registered and Finalised by F.E.M." Federated Mutual Employers' Assurance Company, Johannesburg, South Africa.

Fischer M. and Tatum C. (1997). "Characteristics of Design-Relevant Constructability Knowledge." Journal Construction Engineering and Management. 123 (3), pp 253-260.

Foster V. (2008). "Overhauling the Engine of Growth: Infrastructure in Africa." World Bank, Washington, DC, USA.

Fox S., Marsh L., and Cockerham G. (2002). "Constructability Rules: Guidelines for Successful Application to Bespoke Buildings." Construction Management and Economics. 20 (8), pp 689-696.

Frank H., Ronald M. and Francis E. (2013), "Modern Construction Management." John Wiley & Sons, The Atrium, Southern Gate, Chichester, West Sussex.

Gambatese J., Behm M. and Hinze J. (2005). "Viability of Designing for Construction Worker Safety." Journal of Construction Engineering and Management. 131 (9), pp 1029-1036.

Gambatese, J., Behm, M., and Rajendran, S. (2008). "Design's Role in Construction Accident Causality and Prevention: Perspectives from an Expert Panel." Safety Science. 46(4), pp 675-691.

Gibb, A. and Bust, P. (2006). "Construction Health and Safety in Developing Countries." Great Britain: European Construction Institute. Pp 273-282.

Government of Western Australia (2010). "Project Procurement Method". Department of Treasury and Finance. Government of Western Australia, Perth.

Haupt T. (2003). "A Study of Management Attitudes to a Performance Approach to Construction Worker Safety." Journal of Construction Research. 4 (1), pp 87-100.

Haupt, T. and Smallwood, J. (2007),"Impact of the South African Construction Regulations on Construction Health and Safety". Journal of Engineering, Design and Technology, 5 (1), pp. 23 – 34.

Health and Safety Executive (HSE), (1997). "The Costs of Accidents at Work." Norwich: Health and Safety Executive. www.hse.gov.uk

Health and Safety Executive (HSE), (2002). "Revitalising Health and Safety in Construction." London: Health and Safety Executive. www.hse.gov.uk

Health and Safety Executive (HSE), (2004). "Improving Health and Safety in the Construction Industry." London: The Stationery Office. www.hse.gov.uk

Hecker S. and Gambetese J. (2010). "Safety in Design: A Proactive Approach to construction Worker Safety and Health." Applied Occupational and Environmental Hygiene. 18 (5), pp 339-342.

Hinze J. and Huang X. (2006). "Owner's Role In Construction Safety." Journal of Construction Engineering and Management. 132 (2), pp 164-173.

Hinze J., and Wiegand F. (1992). "Role of Designers in Construction Worker Safety." Journal of Construction, Engineering and Management. 118 (4), pp 677-684.

Hinze J., Raboud P., (1988). "Safety on Large Building Construction Projects." Journal of Construction Engineering and Management. 114 (2), pp 286-293.

Holmes N., Lingard H., Yesilyurt Z. and Munk F. (1999). "An Exploratory Study of Meanings of Risk Control for Long Term and Acute Effect Occupational Health and Safety Risks in Small Business." National Safety Council and Elsevier Science Ltd. 30 (4), pp 251-261.

Holt A. (2005). "Principles of Construction Safety." Blackwell Publishing Ltd.

International Labour Office (ILO), (1992). "Safety and Health in Construction." Geneva: ILO.

Jergeas G. and Van der Put J. (2001). "Benefits of Constructability on Construction Projects." Journal of Construction Engineering and Management. 127(4), pp 281-290.

Jillson, I. (2002). "The National Drug Abuse Policy Delphi: Progress Report and Findings to Date in Linstone; The Delphi Method: Techniques and Applications". Addison-Wesley Publishing Company.

Jones D. (2001). "Keeping the options open: Alliance and Other Forms of Relationship Contracting with Government." Building and Construction Law. 17 (3), pp 153-163.

Karlam N., (1997). "Integrating Safety and Health Performance into CPM." Journal of Construction Engineering and Management. 123 (2), pp 121-126.

Kent D., and Becerik-Gerber B. (2010). "Understanding Construction Industry Experience and Attitudes towards Integrated Project Delivery." Journal of Construction Engineering and Management. 136 (8), pp 815-825.

Kometa, S.T., Olomolaiye, P.O. and Harris, F.C. (1996). "An evaluation of clients' needs and responsibilities in the construction process". Engineering, Construction and Architectural Management, 2 (1), 57–76.

Ku K. and Mills T. (2010). "Research Needs for Building Information Modeling for Construction Safety." Proceedings of the 45th Associated Schools of Construction, Annual International Conference, Boston, MA.

Lam P. and Wong F. (2009). "Improving Building Project Performance: How Buildability Benchmarking Can Help." Journal of Construction Management and Economics. 27 (1), 41-52.

Lehtinen S. (ed). (2013). "African Newsletter; Occupational Health and Safety." Finnish Institute of Occupational Health. Volume 23, Number 3.

Lingard H., Cooke T., and Blismas N. (2012). "Do Perceptions of Supervisors' Safety Responses Mediate the Relationship between Perceptions of the Organizational Safety Climate and Incident Rates in the Construction Supply Chain?" Journal of Construction Engineering and Management. 138 (2), pp 234-241.

Lingard, H. (2013). "Occupational Health and Safety in the Construction Industry." Journal of Construction Management and Economics.

Lingguang S., Yasser M., Simaan A., (2009). "Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance." Journal of Management in Engineering. 25 (1), pp 12-20.

Lonneke H, (2013). "Client-Contractor Participation Can Improve Safety Performance." Safety Science. *Terra et Aqua*, (131).

Love, E. D., O'Donoghue, P. And Damien R. (2014),"Procurement of Public Sector Facilities". 32 (10), pp. 460 – 471.

Love, E.D., O'Donoghue, P. And Damien R., (2014). "Procurement of Public Sector Facilities: Views of Early Contractor Involvement". Emerald Insight. 32 (1), Pp. 460 – 471.

Love, P. and Davis, P. (2009). "Built Environment Procurement Practice: Impediments to Innovation and Opportunities for Change, Innovation and Science". Department of Industry. Canberra, ACT Australia, p. 35.

Ma T., Lam T. and Chan A. (2010). "A Study into the Barriers to the Implementation of Constructability in Relation to Project Procurement Process." Journal of Construction Management and Economics. Pp 95-100.

MacKenzie, J., Gibb, G., and Bouchlaghem, M. (2000). "Communication: The Key to Designing Safely." International Conference of CIB Working Commission W99 and the European Construction Institute (ECI), Designing for Safety and Health Conference, London. Pp 77-84.

Male S. (2002). "Supply Chain Management In Engineering Project Management." 2nd edition. Blackwell Science, Oxford, UK.

Manuele, F. A. (1997). "On the Practice of Safety." Wiley, New York. 42 (7) pp 27.

Mitropoulos, P. and Cupido, G. (2009). "The Role of Production and Teamwork Practices in Construction Safety: A Cognitive Model and an Empirical Case Study." Journal of Safety Research. 40 (4), pp 265-275.

Mokhtar A., Bedard C. and Fazio P. (2000). "Collaborative Planning and Scheduling of Interrelated Design Changes." Journal of Architectural Engineering. 6 (2), pp 66-75.

Mosey, D. (2009). "Early Contractor Involvement in Building Procurement: Contracts, Partnering and Project Management." Wiley-Blackwell.

Musonda, I. & Smallwood, J. 2009. Client commitment and attitude to construction health and safety in Botswana. In: Haupt, T.C. & Smallwood, J.J. (Eds). Proceedings of People in Construction TG59 Conference, 12-14 July, Port Elizabeth, pp. 231-347.

Musonda, I., Pretorius, J. & Haupt, T.C. 2012. Assuring health and safety performance on construction projects: Clients' role and influence. Acta Structilia, 19(1), pp. 71-105.

O'Connor, J., and Miller, J. (1994). "Barriers to Constructability Implementation." Journal Performance Construction Facility. 8 (2), 110-128.

O'Connor J., Rusch S., Schulz M. (1987). "Constructability Concepts for Engineering and Procurement." Journal of Construction Engineering and Management. 113 (2), 235-248.

Peckitt, S., Glendon, A. and Booth, R. (2004). "Social Influences on Safety Culture in the Construction Industry." Construction Safety Management Systems. London: Spon Press.

Puddicombe, M.S. (1997),"Designers and contractors: Impediments to Integration", ASCE Journal of Construction Engineering and Management. 123 (3), pp. 245-252.

Queensland State Government (2008). "Procurement Guidance Series: Alliance Contracts, Chief Procurement Office". Queensland State Government ,Brisbane.

Republic of South Africa (1993). "Occupational safety and health ACT, No. 85 of 1993." Government Gazette, No. 14918.

Republic of South Africa (2003). "Construction Regulations 2003". Government Gazette No. 25207. Pretoria: Government Printer.

Republic of South Africa (2003). "Construction Regulations." Government Gazette , No. 25207.

Republic of South Africa (2014). "Construction Regulations." Government Gazette , No. 37305.

Ross, J. (2003). "Introduction to Project Alliancing." Alliance Contracting Conference, Sydney, Australia, Project Control International Pty Ltd.

Saunders M., Lewis P., Thornhill A., (2012). "Research Methods for Business Students." Pearson Education Limited.

Sawacha E., Naoum S., and Fong D. (1999). "Factors Affecting Safety Performance on Construction Site." International Journal of Project Management. 17 (5), pp 309-315.

Sidwell, A., and Mehertns, V. (1996). "Case Studies in Constructability Implementation, Adelaide." Construction Industry Institute Australia.

Smallwood J. (1996). "The Role of Project Managers in Occupational Health and Safety." Proceedings First International Conference of CIB Working Commission W99 Implementation of Safety and Health on Construction Sites, Lisbon, Portugal. Pp 186-195.

Smallwood J. (1998). "Client Influence on Contractor Health and Safety in South Africa." Building Research and Information. 26 (3), pp 181-189.

Smallwood J. (1999). "The Role of Occupational Health and Safety in Achieving Customer Satisfaction." Customer Satisfaction: A Focus for Research and Practice. CIB W55 and W65 Joint Triennial Symposium. Cape Town.

Smallwood J. (2004). "The Influence of Engineering Designers on Health and Safety During Construction." Journal of the South African Institution of Civil Engineers. 46 (1), pp 2-8.

Smallwood J. (2008). "The Role and Influence of Clients and Designers in Construction Health and Safety." First European Conference on Construction Health and Safety Coordination in the Construction Industry, Barcelona, Spain.

Smallwood J. and Haupt T. (2006). "Impact of the Construction Regulations: An Overview of Industry Perceptions." 3rd South African Construction Health and Safety Conference: A Team approach to Construction Health and Safety. Cape Town, South Africa. 5 (1), pp 23-34.

Smallwood J. and Venter D. (2002). "The Influence of Project Managers on Construction Health and Safety in South Africa." The Australian Journal of Construction Economics and Building. 2(1), pp 57-69.

Smallwood J., (1996). "The Influence of Designers on Occupational Safety and Health." First International Conference of CIB Working Commission W99, Implementation of Safety and Health on Construction Sites. 99 (1), pp 4-7.

Smallwood J., (2010). "Client Influence on Contractor Health and Safety in South Africa." Building Research and Information. Routledge. 26 (3), pp 181- 189.

Smallwood J., Haupt T. and Musonda I. (2009). "Client Attitude to Health and Safety – A Report on Contractor's Perceptions." Acta Structilia, 16(2), pp. 69-85.

Smallwood J., Haupt T., Shakantu W., (2009). "Construction Health and Safety in South Africa." CIDB Report.

Song, L., Mohamed, Y. and AbouRizk, S.M. (2009). "Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance." Journal of Management in Engineering. 25 (1), pp 12-20.

Spillane J. and Oyedele L. (2013). "Strategies for Effective Management of Health and Safety in Confined Site Construction." Australian Journal of Construction Economics and Building. 50 (1).

Tan R. and Lu Y. (1995). "On the Quality of Construction Engineering Design Projects: Criteria and Impacting Factors." International Journal of Quality & Reliability Management. 12(5), pp 18-37.

Teo E., Haupt T. and Feng Y. (2008). "Construction Health and Safety Performance in Developing and Developed Countries: A Parallel Study in South Africa and Singapore." Proceedings of the CIB W99 14th International Conference on Evolution of and Directions in Construction Safety and Health. Gainesville, Florida. Pp 9-11.

Thomas S., Cheng K., Skitmore R., (2004). "A Framework for Evaluating the Safety Performance of Construction Contractors." Department of Civil Engineering, The University of Hong Kong. 40 (10), pp 1347-1355.

Toole, T. M. (2004). “Rethinking Designers’ Roles in Construction Safety.” Designing for Safety and Health in Construction: Procurement, Research and Practice Symposium.

Ugwu O., and Haupt T. (2005). “Key Performance Indicators and assessment methods for infrastructure sustainability - A South African construction industry perspective.” Department of Civil Engineering, The University of Hong Kong. 42 (2), pp 665-680.

Venkatachalam S. (2014). “Problem Areas in Construction Safety and Elements of an Effective Safety Program.” University of the Witwatersrand.

Walker D., and Walker L., (2012). “Understanding Early Contractor Involvement procurement Form.” Association of Researchers in Construction Management. Pp 5-7.

Wong, C.H., Holt, G.D. and Cooper, P.A. (2000), “Lowest price or value? Investigation of UK Construction Clients’ Tender Selection Process”. Construction Management and Economics. 18 (7), pp. 767-774.

Yepes T., Pierce J., and Foster V. (2008). “Making Sense of Sub-Saharan Africa’s Infrastructure Endowment: a Benchmarking Approach.” World Bank. Washington, DC, USA.

Zhang, P., Lingard, H., Blismas, N., Wakefield, R., and Kleiner, B. (2014). “Work-Health and Safety-Risk Perceptions of Construction-Industry Stakeholders Using Photograph-Based Q Methodology.” Journal of Construction Engineering and Management.

APPENDICES

APPENDIX A: PARTICIPANT INFORMATION DOCUMENT

Study title: Designers' perspective on Early Contractor Involvement as a means to improve the safety performance on construction sites.

Dear Potential Participant,

My name is Njeri Karuga Mathenge, a student at the University of the Witwatersrand, Johannesburg, South Africa. The aim of my research study is to learn the different attitudes the designers in the South African construction industry may have on the various effects of Early Contractor Involvement on the safety performance on construction sites. This study is a one-time research project for the purpose of my Masters in (Building) Project Management in Construction.

You are invited take part in this research study and contribute knowledge to the limited literature on this topic available. We are asking you to complete a questionnaire survey, emailed to you. The email contains a link to the Qualtrics Survey Software survey and your responses will be anonymous and not linked to your email address. Your information will only be used for analysis and all reporting will be done in an aggregated format. The questionnaire takes approximately 10 minutes to complete and your answers will be submitted online once it is completed and received by the researcher immediately. The will be used to carry out the questionnaire survey.

You have been randomly selected as a potential participant from architects and engineers in the Gauteng Province of South Africa. This further minimizes the chances of identifying the participants from their answers.

Your cooperation to take part in this research will contribute to a better understanding in the matter and in addition, highly contribute to the gap in the existing literature concerning the designers' role in improving the Safety Performance on the South African construction sites as well as worldwide though involving the contractors earlier in the design phase of the project. Participation in this research is voluntary but you are highly encouraged to participate. The refusal to participate will not be penalized and there will be no loss of benefit for non-participation.

All the information obtained from the questionnaire answered will be kept confidential but absolute confidentiality cannot be guaranteed. All the participants and their personal information will be kept confidential throughout the research unless required by law. All responses will be kept securely by the

researcher and supervisor for a period of five (5) years as required by the university and thereafter destroyed. The main organization that will be permitted to verify and/ or copy the research records for quality assurance purposes and data analysis is the Research Ethics Committee (REC) at the University of the Witwatersrand in Johannesburg, South Africa.

The results and findings of this research will be available to you upon request.

Thank you for taking time to complete this questionnaire. For further information and or reporting study related adverse events, kindly contact the researcher on:

Email: njerikmathenge@gmail.com
Tel: +27 84 087 4507

For further information, reporting of complaints and problems, kindly contact the School of Construction Economics and Management at the University of the Witwatersrand on:

Email: Mantiseng.Sithole@wits.ac.za
Tel: +27 11 717 7663

CONSENT:

I understand all the requirements of this research as described above. My concerns have been addressed to my satisfaction and I agree to take part in this research.

Kindly note that a signed declaration to participate in this research is not required as this may identify you. The confirmation of participation will be deemed obtained if the participant will continue to compute the electronic questionnaire sent.

Thank you for your help.

Yours Faithfully,

Njeri Karuga Mathenge

APPENDIX B: EMAIL INTRODUCTION

Study title: Designers' perspective on Early Contractor Involvement as a means to improve the safety performance on construction sites.

Dear Potential Participant,

My name is Njeri Karuga Mathenge, a student at the University of the Witwatersrand, Johannesburg, South Africa. The aim of my research study is to learn the different attitudes the designers in the South African construction industry may have on the various effects of Early Contractor Involvement on the safety performance on construction sites.

You are invited take part in this research study and contribute knowledge to the limited literature on this topic available. The email contains a link to the Qualtrics Survey Software and your responses will be anonymous and not linked to your email address. Your information will only be used for analysis and all reporting will be done in an aggregated format. The questionnaire takes approximately 10 minutes to complete and your answers will be submitted online once it is completed and received by the researcher immediately.

You have been randomly selected as a potential participant from architects and engineers in the Gauteng Province of South Africa. This further minimizes the chances of identifying the participants from their answers. The results and findings of this research will be available to you upon request.

Thank you for taking time to complete this questionnaire. For further information and or reporting study related adverse events, kindly contact the researcher on:

Email: njerikmathenge@gmail.com
Tel: +27 84 087 4507

If you are willing to participate in this survey, please follow the link below:

Thank you for your help

Yours Faithfully,

Njeri Karuga Mathenge

APPENDIX C: ETHICAL CLEARANCE

School of Construction Economics & Management

University of the Witwatersrand, Johannesburg -PO Box 20, Wits 2050, South Africa • Tel: +27 (0)11 717 7652/77669 · Fax: +27 (0)11 717 9729 Email:CEM@wits.ac.za

SCHOOL OF CONSTRUCTION ECONOMICS AND MANAGEMENT RESEARCH ETHIC COMMITTEE

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER CEM/15/01/MSC**
PROJECT TITLE	Designers' perspective on Early Contractor Involvement as a means to improve the safety performance on construction sites
INVESTIGATOR(S)	Njeri Karuga Mathenge **(ST NO. 766469)**
SCHOOL/DEPARTMENT	**SCHOOL OF CONSTRUCTION ECONOMICS AND MANAGEMENT**
DATE CONSIDERED	29 May 2015
DECISION OF THE COMMITTEE	Approved conditionally with respect to the declaration
EXPIRY DATE	29 May 2017
DATE 29 May 2015	**CHAIRPERSON** (Dr. E Heron)

cc: Supervisor : Dr R Vosloo

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary Mrs. M. Sithole at the CEM reception desk.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature **Date** 01/06/2015

APPENDIX D: SAMPLE QUESTIONNAIRE SURVEY

Designers' attitudes towards ECI as a way to improve Safety Performance on construction sites

Q 1.1 How would you describe your role in the design of construction projects?

- ❍ I am an architect
- ❍ I am a design engineer
- ❍ I am a project manager
- ❍ I am a specialist that does not really do design work
- ❍ Other

Q 1.2 If you have selected other in the previous question - please describe your role.

Q 1.3 How long have you been working in the construction industry?

- ❍ 1 < 5
- ❍ 6 < 10
- ❍ More Than 10 Years

Q 1.4 What is your qualification?

- ❍ BTech
- ❍ BSc 3 Years
- ❍ Honours or 4 year B degree
- ❍ Masters
- ❍ Other

Q2 Please rate the degree with which you agree or disagree with the following statements.

Q 2.1 Designers are committed to safety performance on construction sites.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.2 Contractors contribute towards design for safety.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.3 Contractors understand the implication of the various designs on safety.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.4 Contractors have the necessary knowledge to contribute towards designing for safety.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.5 Contractors are committed to safety promotion/ accident promotion on their construction sites.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.6 Accidents can be prevented by Early Contractor Involvement.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.7 Communication with the contractors during the design phase is effective.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.8 Contractors assume liability for their involvement in the design process when involved earlier in the process.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.9 Contractors can take full liability for accidents and fatalities that occur on construction sites after Early Contractor Involvement.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.10 Designers will be held liable for accidents and fatalities that occur during the construction stage as a result of Early Contractor Involvement.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.11 Accidents and fatalities that happen on the construction site after Early Contractor Involvement will have an impact on your career and success/ credibility and reputation.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.12 Contractors should have an influence in the design process.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.13 Contractors experience safety performance constraints when not involved in the design process.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.14 The client's requirements can pose safety risks during construction.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.15 The involvement of the contractor earlier during the design stage may lengthen the design process.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.16 Contractors have knowledge to offer when involved earlier in the design process.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.17 Designers have the required knowledge in design for safety.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.18 Contractors are aware of potentially hazardous risks.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.19 Designers in construction believe they have more knowledge in identifying safety issues than the contractors.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.20 Early Contractor Involvement can improve the safety performance on a construction site.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.21 Early Contractor Involvement can reduce the number of variation claims on a construction site.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.22 Early Contractor Involvement can reduce disputes on a construction project.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.23 Early Contractor Involvement can improve the site safety on a construction site.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.24 Early Contractor Involvement can improve the constructability on a construction project.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Q 2.25 Early Contractor Involvement can improve the risk management on a construction project.

- ❍ Strongly disagree
- ❍ Disagree
- ❍ Neutral
- ❍ Agree
- ❍ Strongly agree

Thank you for participating in this study. I appreciate your time. If you wish to be informed of the results of this study, please contact me at: njerikmathenge@gmail.com

Njeri Mathenge