AN ANALYSIS OF THE STATE OF INNOVATION IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

by

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Declaration by student

I, the undersigned, hereby confirm that the attached treatise is my own work and that any sources are adequately acknowledged in the text and listed in the bibliography.

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Signature of acceptance and

confirmation by student

Abstract

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This research was prompted by the apparent lack of innovation in the South African construction industry. The aim was to obtain a better understanding of the state of innovation. The strategy involved engaging construction contractors in the mining industry to obtain information regarding their view of innovation in the construction industry. Data was collected following a mixed-method strategy. A literature review, interviews, a focus group and questionnaires formed part of the data-gathering strategy.

A number of findings emerged from the study, notably that innovation is important for a contractor to facilitate differentiation, and to be more competitive. The industry has high levels of competition and low entry barriers. Relationships are complex, with clients demanding complex structures to operate at low cost and within tight schedules. Levels of investment in research and development (R&D) are generally low. There are not enough experienced and trained role-players, and the level of trust between role-players needs to be strengthened. Cooperation between industry and academics, and investment in R&D is insufficient. Government focuses too much on the empowerment of previously disadvantaged individuals, ignoring the innovation history and experience of potential contractors, which means that contractors are not motivated to be innovative. As a legislator, government is viewed as hampering innovation by not ensuring that the training of artisans is up to standard, by enforcing labour laws which do not allow for the easy transfer of skilled employees, and by neglecting to assist underperforming apprentices in improving their skills.

On a positive note, the industry acknowledges that the standard of training at universities is satisfactory, and that contractors are well disposed towards investing in training. Companies have systems in place to capture lessons learned and reward individuals who participate.

To ensure a more innovative construction industry, the nature of relationships among role-players should be reconsidered in order to broaden risk distribution, and to enhance levels of trust. Partnerships should be established to facilitate sustainable investment in R&D. Companies need to ensure that adequate systems are in place to promote innovation.

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CHAPTER 1 – INTRODUCTION

1.1 INTRODUCTION

This research was prompted by the apparent lack of innovation in the South African construction industry. The aim of the study was to obtain a better understanding of the state of innovation amongst contractors, as well as to discover which factors hamper, and which factors contribute towards innovation. The strategy involved engaging construction contractors, at various levels, in order to get firsthand information regarding the aspects mentioned above. The study is focused particularly on innovation amongst contractors working in the mining industry.

1.2 BACKGROUND

Innovation is seen as very important in order for a company to be competitive, more productive and to work more efficiently. (Ruddock & Ruddock, 2009:872; Blayse & Manley, 2004:143). At the same time Dulaimi et al (2002:239) mention that a lack of innovation is associated with loss of credibility among potential clients, as well as an inability to keep up with the dynamic nature of projects.

The construction industry is a large contributor to the Gross National Product (GDP) both in South Africa and internationally. Blayse & Manley (2004:143) note that the construction industry, along with related industries, contributes around 15% to GDPs globally. Tobin and Magenuka (2006:3) note that the construction sector creates 7% of employment globally and that in South Africa the total income from construction was R100.4 billion in 2004 and 403 000 people were employed in the sector.

Yet, historically, the construction industry has been viewed as not very innovative (Blayse & Manley, 2004:143; Nuesse et al, 2011:35). Some of the reasons put forward for this apparent low level of innovation include the nature of construction projects, the relationship between the various role-players, the procurement processes followed in construction projects, low levels of research and development (R&D) spending, and restrictive regulations (Blayse & Manley, 2004:143; Nuesse et al, 2011:35; Nicolini et al, 2000:305; Dulaimi et al, 2005:566; and Gan et al, 1998:281).

While a great deal has been written on the subject of innovation, both in South Africa and internationally, very little research has been done on the state of innovation in the South

African construction industry. The aim of this study is to rectify this shortcoming, in part by focusing on a subsector of the construction industry, namely contractors working in the mining industry.

1.3 PROBLEM

As can be seen from the above, innovation is important for a construction contractor to survive and prosper. However, the construction industry is not viewed as very innovative. Because of the major role that the construction industry plays in providing employment and contributing to the economy, it is essential that the characteristics of the construction industry relating to innovation be understood. If it is to contribute optimally to the development of national goals it needs to arrive at a better understanding of the manner in which reform in the construction industry can take place. The problem is how to stimulate innovation in the South African construction industry. To resolve this problem it is necessary to understand what the level of innovation is among the various role-players in the industry, what the contributing factors are which hamper innovation, and which contributing factors could potentially aid innovation in the industry.

1.4 RESEARCH QUESTIONS

The following questions, therefore, need to be answered:

- What is the state of innovation among contractors in the South African construction industry?
- What are the shortcomings in the South African construction industry with regards to innovation?
- What are the areas where the South African construction industry is doing well with regards to innovation?

1.5 DELIMITATIONS

This study is limited to contractors working in the South African mining sector.

1.6 CONCLUSION

The objective of this chapter is to give a brief overview of the study. This is done by introducing the reader to the study, before briefly explaining the aim. The rationale for the study is clarified, and the problem statements as well as research questions are described. Lastly the delimitations are noted.

The problem is how to stimulate innovation in the South African construction industry. The main research questions focus on the characteristics of innovation in the South African construction industry, as well as the state of innovation among contractors. Other research questions are aimed at the shortcomings, as well as areas where the industry is doing well.

The aim of the next chapter is to discuss the strategy, methods and research design in order to enlighten the reader regarding the process which was followed during the study.

CHAPTER 2 – RESEARCH METHODOLOGY

2.1 INTRODUCTION AND AIM

The aim of this chapter is to discuss the research strategy which was followed in the study. The research methodology will be explained, as well as the design of the research.

2.2 STRATEGY

As the aim of this study is to obtain a better understanding of the state of innovation among contractors, as well as to discover which factors hamper and which factors contribute towards innovation, the strategy involves engaging construction contractors at various levels. However, in order to ensure that the researcher is in a position to thoroughly understand the issues, and to participate meaningfully, a literature review forms part of the research strategy.

Because of the complexity of the issue, it was decided to use a mixed-method approach to data gathering. This will be explained in the next section.

2.3 METHOD

Banister et al (1994:1) put forward the opinion that while qualitative and quantitative research do not necessarily stand directly in opposition to each other, a qualitative researcher will not base conclusions solely on quantitative data, but rather focus on the context and integrity of the material. Banister et al (1994:2) also states that the researcher is central to the sense that is made of the problem at hand.

Data was collected following a mixed-method data collection strategy. According to Axinn and Pearce (2006:19) this manner of collecting data combines elements of more than one method of data collection. In this way the data gathered using one way of sampling is integrated into the application of another method. Axinn and Pearce (2006:19) hold that following a mixed-method strategy affords the researcher the opportunity to utilise various approaches to collect information from a range of sources, thereby gaining new insight into a problem. In this manner bias can be reduced, if not eliminated, and the likelihood of collecting information which might have been missed in a single-method strategy, is greatly reduced. The methods include interviews, focus group and Likert surveys. Banister et al (1994:49) state that interviews are complex and time-consuming. The rationale for using this method includes the fact that it allows for a more articulated response, compared to a fixed

"yes-or-no" response of a quantitative study, thereby giving the researcher better insight. Another rationale for using interviews as a method of data collection is that complex issues can be better examined than the often simplistic approach of trying to force an issue into a rating questionnaire. A semi-structured interview process is suggested by Banister et al (1994:51) as the best way to ensure that new issues and insights can be put forward by the interviewee and incorporated into the study by the researcher. Another observation regarding interviews is that by incorporating interviews in the study, the researcher is forced to take cognisance of his or her own role in the study, and to challenge bias. This leads to a responsibility on the part of the researcher to consider the power relationships in interviews, taking into account gender, age and ethnic differences, in order to ensure that the researcher does not control the outcome of the study. As interviews form part of the primary data-collection method of this study, it was important for the interviewer to keep the above-mentioned points in mind while conducting the interviews.

The research started with a comprehensive literature review. Sources included academic books, magazines, newspapers and journals, both in hard copy and available online. The initial part of the process consisted of scouring academic publications for information on the background of innovation and the construction sector. The next step was to draw some initial conclusions about the occurrence of innovation in the construction industry. This effectively described the current state of innovation in the construction industry. Further investigation of available reading material was done to identify some of the current best practices and possible solutions to problems identified in the previous section.

The intention was to continuously move between the data collected via literature reviews, interviews and focus groups. To achieve this, the preliminary findings from the initial literature review were tested against a number of contractors currently working in the mining industry, on a specific mega project, namely Exxaro's Grootegeluk Medupi Expansion Project. Eleven interviews with eleven interviewees and one focus group was conducted, in which 14 people participated. The intention was to interview the managers of a number of contractors across a spectrum of disciplines, including civil, mechanical and electrical & instrumentation contractors. Subsequent to this, a focus group was conducted with the next lower tier of management of contractors. The motivation for conducting the focus group after the interviews was to test some of the issues raised by management in the interview, against the next lower tier of management on site, as well as to get a different perspective on the issues raised.

The following contractors were included:

- Civil Contractors
    - Stefanutti Stocks Civils
    - Civcon
    - Concor Roads & Earthworks
    - Basil Read
    - Grinaker LTA
    - Makeshift Contractors
- Mechanical Contractors
    - SMEI
    - FLSmidth
    - Group Five Projects
- Electrical & Instrumentation
    - Wade Walker
    - Conco

Following the interviews and focus group, the data collected was analysed and initial conclusions formed. These were then compiled into a survey, which was sent to all the participants of the interviews, with a request that the questionnaires be distributed to the next lower tier of supervision on site as well, to verify the findings. The survey consisted of a summary of the findings, against which the participants could indicate whether they agree or disagree with the findings based on a Likert-type scale. The questionnaire was sent to 43 potential participants, of which 36 responded, resulting in an 83% response rate.

In order to graphically represent the responses to each question, it was decided to utilise radar plots. Radar plots (also known as spider plots, polar charts or star charts) comprise a method of plotting data (the responses to questions in the surveys) on a chart of three or more variables represented on axes starting in the same point. This method was selected, as it easily indicated outliers and commonality in responses. Although there are more complex tools to analyse the data, the benefit of using a radar plot is that the relative responses to the various questions can be easily summarized in a manner which is easy to understand.

Based on the results of the survey, the final conclusions and recommendations were drafted.

2.4 RESEARCH DESIGN

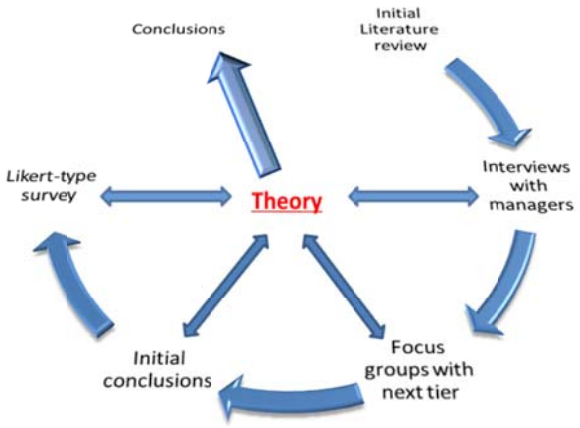


Figure 1: Process flow of research design

The process illustrated in Figure 1 started with the initial literature review, during which some observations were made regarding innovation in the construction industry. This was then expanded upon during interviews with the managers of numerous contractors, followed by a focus group session with the next tier of management on site. The same set of questions which formed part of the interviews, were used during the focus group. A semi-formal approach was followed during the focus group, where a set of questions were asked, and respondents were free to expound as required. Initial conclusions were drawn from the data, which were compiled into a survey, which was sent to all the participants. The results of the survey, along with all the data from the literature review, interviews and focus group were then used to draw final conclusions and recommendations.

2.5 CONCLUSION

In this chapter, the strategy and method used during the research are explained, and the research design described. This is done to enlighten the reader on the process followed during the study.

In essence, a mixed-method strategy to data gathering is set out. This means that data will be gathered via literature reviews, interviews, focus groups and questionnaires.

In the next chapter the secondary data, namely the literature review, will be expanded upon. After that the following two chapters will deal with the primary data gathered during interviews and focus groups, as well as by means of a questionnaire.

CHAPTER 3 – LITERATURE REVIEW

3.1 INTRODUCTION AND AIM

In this chapter, a discussion of the literature available on the subject of construction innovation follows. The literature review is broken down into various subsections, each dealing with a specific issue relating to innovation. This chapter is divided into thirteen subsections, the first and the last being the introduction and the conclusion respectively. The eleven subsections in between deal with specific areas of innovation which were identified during the literature interview. The themes were identified by examining the raw qualitative data and assigning labels to the text, in the form of highlighted sections. This form of coding is often called “open coding”. After completing this exercise for all of the literature review as well as transcriptions of the interviews and focus group, a large number of codes were condensed into a number of themes by examining the commonalities within the codes. The eleven subsections are discussed briefly below.

Why Innovate? - In this section the impetus for innovation in the construction industry is explained.

Types of innovation - The various ways in which types of innovation are classified are explained in this section.

Problems regarding innovation - In this section the obstacles to innovation which occur in the construction industry are listed.

Contribution of role-players to innovation - The role which the various role-players in the construction industry play with regards to innovation is explored in this section. Typically these role-players are government, clients, design engineers, suppliers and contractors.

Contributing factors to successful innovation – Some of the factors which are mentioned in literature, as contributing to successful innovation, are discussed in this section.

Culture – The role which organisational culture plays in improving innovation is discussed in this section.

Research & Development – In this section the role and importance of research and development activities for successful innovation, are explored. The different approaches

which various countries take towards involvement in research and development are also explored.

Formal systems to promote innovation – In this section the different practices and systems which are used to capture and disseminate knowledge and innovative practices are considered.

Skills and their role in innovation – The role of skilled individuals in innovation, as well as the means to ensure that adequate skills remain available in the industry, are explored in this section.

Procurement practices and its role in stimulating innovation – The various approaches to procurement of construction projects are investigated in this section, along with the effect on innovation which could potentially be associated with these approaches.

Promoting innovation – In this section various best practices and recommendations on improving innovation in the construction industry, as mentioned in literature, are discussed.

3.2 WHY INNOVATE?

According to Blayse & Manley (2004:143), the construction industry, along with related industries such as manufacturers of products and systems, designers and property managers, accounts for about 15% of the gross national product of most nations, which makes it one of the most important industries in modern economies. Dulaimi et al (2005:566) postulate that firms gain a competitive advantage through innovation by differentiating themselves from competitors. Ruddock & Ruddock (2009:872) note that innovation is one of the drivers which lead to growth in productivity and efficiency. At the same time Blayse & Manley (2004:143) point out that innovation is crucial if a contractor is to be competitive, both in order to win contracts and to be profitable. Some of the other advantages of being an innovative company include acquiring the reputation as a progressive company, better operations and acquiring distinctive technical capabilities. Dulaimi et al (2002:239) note that more demanding clients, the increased complexity of projects and an ever-changing environment have necessitated innovation in construction.

Steward and Fenn (2006:177) mention that the construction industry, because of the intense competition and low margins as well as its fragmented and project-based nature, is risk adverse and has become "… a large group of homogeneous competitors with a lack of long term initiatives." It is, therefore, crucial for contractors to distinguish themselves in order to

gain contracts. Innovation is thought to be one way of achieving this. However, it should be noted that Winch (2003:652) found that a direct comparison of the level of innovation between different industries is difficult, due to the inherent differences in these industries, and that it may be better to compare the level of innovation between the construction industries of different countries.

3.3 TYPES OF INNOVATION

Various classifications of innovation exist, based on the degree of novelty of a particular product or process. It is important to understand the different theories regarding the types of innovation, as this helps in understanding the different approaches in managing innovation. Slaughter (1998:226) distinguishes between various forms of innovation, namely "incremental" (small, based on existing knowledge), "radical" (normally associated with a breakthrough), "modular" (a change of a component of the process), "architectural" (a change in the way which other systems or components are interacted with) or "system" (numerous integrated innovations). Another method of distinguishing between types of innovation is "technical" (product or process innovation) or "organisational" (changes to organisational structure, management techniques or strategic direction). In the mining construction industry incremental innovation would, for instance, include the use of a new type of drill or pavement breaker which is a small improvement on a previous model, while a radical innovation would be using fiber concrete instead of traditional steel-reinforced concrete in workshop floors. An example of organisational innovation could be if a construction company decides to adopt a "just in time" approach to supply chain practices or if it redesigned its organisational structure.

Some other ways of classifying innovations include that of Pinkse & Dommisse (2009:515), who add that architectural innovation encompasses the process of using one or more of the components which work in tandem to form a product in a new way, while the product as a whole remains the same. Ruddock and Ruddock (2009:871) describe the concepts of hidden innovation as "technical progress" due to investment in intangible assets, rather than just in R&D. Examples includes computerised information (Knowledge Management systems and hardware) and economic competencies (human capital and structure of the organisation). Should a contractor invest in a new Knowledge Management system which assists in capturing and disseminating information regarding innovations, this could be considered hidden innovation. Another example would be if a contractor were to invest in a training scheme for employees, aimed at improving their ability to innovate.

3.4 PROBLEMS REGARDING INNOVATION

Various hindrances to innovation are identified in literature. These include:

Problem 1 - Low research and development (R&D) investment

One of the problems mentioned by Blayse & Manley (2004:143) regarding innovation in construction is low research and development (R&D) investment. Dulaimi et al (2002:239) observe that the low levels of investment in R&D and innovation hamper the development of the construction industry. They also mention competitiveness and specialisation as factors which contribute to fragmentation and which impede innovation. It would seem that the competitive nature of the industry, along with extreme specialisation, leads to low levels of investment in R&D, as well as low levels of sharing knowledge across organisational boundaries.

Problem 2 - Loosely-coupled supply chains

Blayse & Manley (2004:143) note that the temporary and ad hoc nature of relations between the various role-players, as well as the often adversarial approach to contracting, does not lend itself to proper innovation. Because innovations are often conceived either up- or downstream of a certain role-player, it is important to be able to share this information among role-players, and for this reason a tighter coupling is seen as being beneficial. Nicolini et al (2000:306) add that the traditional competitive tendering process in which cost savings are achieved by pressuring the parties lower down the supply chain ladder (normally the contractor), achieve fewer results than those where design or process innovation is achieved through collaboration.

Problem 3 - Weak collaboration between industry and academics

The opinion that there is not enough collaboration between the construction industry and academics is mentioned by Blayse & Manley (2004:143). Academics are seen as “innovation brokers” by Blayse & Manley (2004:148) who act as originators and keepers of knowledge, as well as partaking in the process of disseminating knowledge. These academics can also assist in evaluating the applicability of innovative products and practices.

Problem 4 - Nature of construction

Powell (1999:434) holds that construction companies often do not realise when they are innovative and that traditional R&D is not viewed as producing innovation, whereas continuous improvement (where research is driven by needs identified by industry and

implemented into the construction process) is seen as more beneficial. In essence Powel (1999:435) suggests that incremental innovation has a better success rate than radical innovations, and advocates a culture change in order to promote the search for continuous improvement. Nuesse et al (2011:35) note the low number of registered patents and the relatively low level of investment in research in the construction industry, as opposed to other sectors. The nature of construction is blamed for the fact that innovations are often forgotten about and not transferred to subsequent projects. Nicolini et al (2000:305) note that the nature of the relationship between clients, suppliers, contractors and designers often inhibits innovation, and that the perceptions, as well as the setting of this relationship, needs to be changed. Dulaimi et al (2005:566) list conservatism among a large number of role-players along with the extreme levels of specialisation as some of the factors which contribute to low levels of innovation in the construction industry.

A common thread when discussing problems regarding innovation in the construction industry seems to be the relative isolation in which the various role-players function, as well as the extreme levels of specialisation in the industry.

3.5 CONTRIBUTIONS OF ROLE-PLAYERS WITH REGARDS TO INNOVATION

The view that not all role-players are equally involved in the innovation process has been investigated by a number of writers. Pries & Dorée (2005:562) note that more than 64% of innovations in the industry come from suppliers, around 11% from contractors and less than 9% from architects or consultants. Construction companies contribute mostly through process innovation while suppliers contribute through product innovation. Gan et al (1998:281) mention that regulators are viewed by many contractors and designers as limiting and as a burden, rather than an aid to innovation.

With regards to the reason why innovation takes place in the construction industry, a number of theories have been put forward. Ivory (2005:862) notes that the traditional view that innovation in construction happens via technology push, where technologies which are developed through R&D are tested in the market, and market pull, where typically clients will demand innovation through new requirements, failed to take into account the complex project environment. He suggests that consulting engineers act as gatekeepers or brokers of technology to clients. Consultants often have to convince clients to try new designs or technology in order to enhance the standing of the consultant in the engineering community and to develop their skills. On site, the contractor has to be innovative in the processes which they follow, especially with regards to quality assurance. It is noted by Ivory (2005:864) that a construction project is a complex undertaking, with many role-players who

often have diverging interests. The importance of consensus building between the various role-players is seen as vital. It is noted that clients, when they attempt to prevent innovation in projects, do so because they are risk averse, lack the skills to execute, or simply do not see the benefits of innovating. Manley (2008:230) found that manufacturers invest much more in R&D than consultants or contractors and are thus more likely to be innovative. Suppliers are, however, guilty of not fostering close ties with other role-players, especially contractors. Traditionally it is engineers who specify the use of innovative products for use on projects. It is, however, noted that suppliers need to play a more active role in promoting patented technology by engaging with contractors and end-users. Using relationship networks effectively could help manufacturers to achieve this goal.

Clients sometimes see innovation as a deterrent for a number of reasons. Manley (2006:1295) notes that some of the deterrents to innovation from clients include:

- The client is not innovation-orientated.
- Innovation may be seen as potentially increasing costs and time during construction, even though it may reduce overall cost over the lifespan of a structure.
- Clients may have to do more work while evaluating the applicability of innovative products and alternative methods, which places pressure on the client's resources.

It is also noted that clients can drive innovation in construction in several ways. These include:

- Expecting exceptional results.
- Making financial benefits for innovation part of contracts.
- Ensuring that relationships in projects are optimum.
- Moving to value-based tender evaluation instead of price-driven tenders.
- Including the innovation history of prospective contractors in the assessment of tenders.
- Ensuring that standards and specifications are performance- or outcome-based, and not too prescriptive.
- Allowing for a sharing of authority, or a partnering approach, to ensure that ideas and alternatives from contractors are incorporated in the end product.

As the client is an important determinant of innovation in a construction project, it is important to note that Manley (2006:1295) found that the internal innovativeness of a client results in innovation throughout the entire industry. This ability to innovate is mentioned by

Manley as being affected by the level of experience of employees. Inadequate technical competence of clients is believed to be one of the stumbling blocks to ensuring innovation on a project.

3.6 CONTRIBUTING FACTORS TO SUCCESSFUL INNOVATION

As a large part of this study is aimed at determining which factors may assist in ensuring that the construction industry is more innovative, it is important to note that Blayse & Manley (2004:143) identify six contributing factors to innovation in construction, namely procurement systems (partnering/collaborative approach seen as more conducive to innovation than competitive tendering and traditional fixed-price contracts), standards and regulations (performance-based regulations seen as more beneficial than prescriptive regulations), clients and manufacturers (clients can initiate innovation by being "demanding" while manufacturers often come up with new designs and have better R&D opportunities due to being more "stable"), the structure of production (the nature of projects is not conducive to innovation and the high durability demands on the end product inhibits innovation), relationships in the industry (relationships are generally short-lived and knowledge is often not transferred to future projects), and the nature of organisational resources (the culture, skills, processes and strategy within the organisation). Pinkse & Dommisse (2009:521) found that the involvement of more demanding consumers (clients) has introduced a higher level of innovation in the construction industry, and that suppliers are often the greatest innovators in the industry. Dulaimi et al (2005:566) add that fostering an innovative culture, as well as having "champions" to drive the innovation process, is imperative if a company is to become innovative. The Project Manager is noted by Dulaimi as an essential champion for the cause. Rowlinson & Cheung (2008:3) also suggest the addition of an innovation manager to drive innovation. Pries & Dorée (2005:563) note that the need to improve productivity is the main motivator for construction innovation, while a regulatory framework which supports innovation is also recognised as a significant contributor.

Ensuring that proper inter-organisational relationships are maintained can greatly contribute to successful innovation. McKenzie (2005:17) proposes that there are four types of inter-organisational relationships which role-players can enter into. These are: a) Supplier/buyer partnerships (normally long-term relationships where one partner provides a service or knowledge that the others do not possess); b) Alliances (where closely-related companies in a fast-moving field such as electronics where it is seen as too expensive to own all the knowledge in-house); c) Consortia (similar to alliances, but normally in complex environments such as the aircraft industry where a large number of companies have to work

together to deliver the end product), and d) Inter-organisational communities (these are set up specifically to look at innovation and knowledge transfer and might even consist of competing companies). It would seem that the construction industry would lend itself to an alliance or partnership, but that inter-organisational communities would be greatly beneficial to the construction industry. Faniran et al (2001:421) note that it is crucial to ensure smooth communication and movement of project information between the various role-players on a construction project, and that the different role-players normally have conflicting priorities and objectives. They add that the construction industry is generally highly fragmented, non-collaborative and distinctly unique. In order to change this, the industry should adopt collaborative working practices which should include sharing information electronically across company borders. By implementing an integrated information management system (IMS), all the role-players can be given instant access to project information, depending on the role of the participant in the project. In the process errors can be minimised, resulting in increased productivity and quality assurance will be enhanced. It is noted by Faniran et al, however, that in order to achieve this, the financial layout of such a system will have to be kept in mind, and the culture will have to change in order for people to adopt the new system. By capturing site instructions, technical queries and the change-control process on this system, along with lessons learned and other knowledge areas, all parties should be in a better position to share knowledge.

3.7 CULTURE

If an innovation drive is to succeed, either in a construction firm or in the industry as a whole, the buy-in of employees is vital. As the culture within an organisation is key to determining the response and approach of individuals to various initiatives, it is important to note that Hartman (2006:159) mentions that individuals will only participate in innovation if they feel part of the organisation. He suggests that the culture of an organisation is critically important in motivating individuals to partake in innovation. Employees need to believe in innovation as an organisational value and agree with the norms relating to innovation in the organisation.

Management practices, such as providing quick feedback, allowing autonomous work, implementation of a comprehensive reward, and an incentive scheme, are seen as vital by Hartman (2006:163) in establishing a culture conducive to collaboration in an organisation. Hartman notes that a “no blame” culture should be instilled, in order to allow employees the freedom to experiment. Employees should be encouraged to challenge the norms and status quo and to take risks. Information should be shared freely, in both directions, between the various levels of the organisation. These practices from management should be consistent

and transparent. According to O'Reilly and Chatman (1996:157), management can ensure employees are motivated to innovate by providing open work places and public spaces where collaboration and communication can take place, hosting workshops and implementing hotlines, and by organising excursions to various sites and suppliers.

Valencia et al (2010:466) found that the culture of an organisation can both enhance and inhibit innovation. While a culture which is based on flexibility and change and which is externally orientated while valuing risk taking and creativity (labeled an Adhocracy) is seen as promoting innovation, a culture which is control-orientated and focused on the internal organisation and which places emphasis on close adherence to rules and regulations and efficiency, is seen as stifling innovation. Leonard & Sensiper (1998:126) add that organisations with an excessive focus on hierarchy, as well as those where analysis is valued more than intuition, along with those where failure is penalised, all struggle to innovate, as the motivation to do so is low. It is suggested that managers should create an environment where different thinking styles are encouraged and failure is not necessarily seen as bad.

In growing companies, due to rapid expansion, a number of new employees join the company which means that people do not know each other and that they do not necessarily trust each other. Some form of alignment session is suggested by Leonard & Sensiper (1998:128) as a way to create a culture of trust and familiarity.

Companies which behave in an ethical way are found by Riivari et al (2012:310) to be more innovative, especially with regards to behavioral, strategic and process innovations. This could be because ethical organisations focus on transparency, which is also a requirement for innovation. In addition, in ethical organisations it is often management who live the values, which again is a requirement for innovation. More important, employees may associate more freely with organisations which focus on ethical behaviour, and because they care for the organisation and feel part of it, may contribute more easily to innovation.

3.8 RESEARCH AND DEVELOPMENT

The requirements of richer, more developed first world countries with regards to innovation may differ from those of developing countries where resources may not be as freely available. Seaden and Manseau (2012:192) note that in developing countries, such as South Africa, the focus on providing large numbers of new houses and other infrastructure at low cost necessitates government's involvement in construction. However, not many programs support R&D and innovation and those that do exist are based in high-technology

economies, and are thus perhaps not suited to the unique circumstance of another country. It is, therefore, important to ensure that R&D efforts in South Africa be concentrated on finding solutions to the unique problems experienced locally, and to be aware that solutions which may work well in high tech, and less in cash-constrained countries, may not necessarily be ideal for local requirements.

One of the aims of R&D should be to distinguish a company from its competitors by gaining strategic advantage. Manley et al (2009:764) found that the single-business strategy that most strongly distinguishes innovative companies from their counterparts is their investment in R&D. Highly innovative firms focus on technological innovations, while those firms which are less innovative focus mainly on organisational innovation such as management practices. It is stated that, although organisational innovation is important, technological innovation plays a bigger role in driving growth. Gann (1997:263) mentions numerous reasons why the construction industry should invest in R&D. Due to changing demands, investment patterns seem to be moving away from traditional construction. Because people are demanding options, the type of structures and the locations where they are built are changing. They demand functional buildings, housing and sophisticated equipment. Due to globalisation and privatisation, government has divested itself from a number of sectors in which it previously held a big stake, such as power station design. This means that governments do not plough as much money into R&D as they had done previously. Because the private sector is more fragmented, it is not always clear who should take over this role, and who the experts are. The shorter turnaround times demanded by clients in tenders are also regarded as a reason to invest in R&D. Gann suggests that government should at least partially fund R&D in construction, firstly because the fragmented industry is not likely to invest enough in R&D and secondly, because government would benefit from having more knowledgeable employees, who can better enforce current regulations, and who will be more innovative when writing new legislation. If government funds R&D, it may also help develop skilled people who could enter the private sector where they in turn can help innovation.

Depending on the socio-economic situation in a country, governments have different approaches to involvement in R&D in the construction industry. Seaden and Manseau (2012: 189) mention that countries with a centralised structure, such as Japan, France and the UK, have construction ministries which look after the industry and actively promote value over price as a determinant of public sector procurement. In countries with a federal type of constitution, such as the USA, Germany and Australia, the responsibility is normally placed with individual states, and construction does not receive separate attention, but is rather grouped alongside other industries. The latter seems to be more closely aligned to South

Africa's approach than the former, although South Africa does have a Construction Industry Development Board which falls under the Department of Public Works (DPW). However, the DPW also looks at other aspects, and not only at the construction industry.

According to Seaden and Manseau (2012:194) if the social approach of government is to be considered, four distinct approaches regarding innovation are identified.

- In market-driven systems such as the USA and Australia, it is left to the market to allocate resources to construction research. Regulations and involvement by government are kept to a minimum. Because of the focus on commercial issues, negotiations are normally adversarial.
- In government-led systems, such as France, Germany and the Netherlands, where government has a big social responsibility and plays a large role in the market place, government often sponsors innovative projects. This type of approach is signified by a significant number of regulations and governments often get involved in commercial negotiations.
- In social-democratic systems, such as in the Scandinavian countries, the focus is on the relationship between governments, labour and industries. Governments are deeply involved in stimulating innovation.
- In meso-corporatist systems, such as in Japan where very large corporations dominate the private sector, investing in innovation by private firms is considered a national value. The public sector and private firms negotiate on government's involvement in training, regulations and innovation-related issues. It would seem that South Africa subscribes to the market-driven system, with limited involvement in innovation from government.

Some of the trends which Seaden and Manseau (2012:191) have identified in relation to governments' involvement in innovation include:

- Governments favour approaches where they are involved in setting long-term strategic goals for the construction sector.
- Governments are involved in innovation through funding of universities and through other government institutions.
- Governments focus more on site-related problems and on the supply chain, than trying to assist in coming up with innovative products.

- Governments favour the funding of R&D in collaboration with private firms, along with providing tax breaks for R&D-orientated firms, instead of the outright funding of R&D.
- There is an ever-increasing focus on environmental and community interests throughout the project lifecycle.

Due to the complex nature and large number of areas of specialisation in the construction industry, it is perhaps not feasible that one organisation should possess all the internal capabilities required to be innovative across the broad spectrum of knowledge areas. Van Gils et al (2009:493) observe that, due to the high rate and complexity of technological change, most companies cannot rely on internal experts for innovation. Whenever an engineering or scientific problem is encountered which cannot be solved in-house, external experts and new approaches are required. They note that often universities and other public research bodies are called upon to assist. Most governments, especially in Europe, realise that collaboration between these public research bodies and the private sector could unlock growth and, therefore, actively rally for this. This meant that academics, apart from teaching and conducting research, now have another role, namely contributing to the economy. It is believed that external sources of innovation and R&D are susceptible to problems, mainly due to a lack of trust, misalignment of goals and distance between partners. In universities a number of factors have been identified which limit the contribution of academia, namely a lack of entrepreneurial culture and motivations, as well as a lack of proper reward schemes. In addition, private sector companies may not have the absorptive capabilities to receive and use knowledge. In order to overcome this problem, a number of tactics can be followed. These include temporary employment of academics by industry, firms investing in an academic spin-off company, academics consulting on specific issues in a firm, forming a joint venture with a university to do specific research or a firm purchasing a license/patent from a university. Each of these strategies has a specific place, depending on the goal of the firm. If the firm wishes to build technical competence internally, it would form a research consortium or create a joint venture with universities to ensure that skills are transferred, whereas if the goal is purely to innovate a firm may fund research or employ a university to do R&D under contract. Whatever the goals, it seems as if outsourcing R&D to public research facilities may have a positive spin-off for firms which may not possess the technical or scientific know-how internally. Seaden and Manseau (2012:193) found that in South Africa there is a shift from public sector R&D funding and public R&D organisations, to competitive bidding. There is, however, an increased emphasis on encouraging partnerships among private sector firms, universities and other research bodies.

It is also recommended by Manley et al (2009:766) that a coordinated effort be undertaken with regards to R&D that funding be made available for R&D, and that R&D efforts be concentrated on activities which will raise productivity. In order to achieve this, higher levels of integration between the various role-players are suggested. A number of other suggestions are put forward, such as:

- Greater integration (earlier involvement of contractors in projects, a win-win attitude in the industry, implementing design-and-build contracts and the adoption of ERP-type software systems across supply chain processes); and
- Greater R&D efforts (tax incentives, government leadership, reward systems for innovation, links with universities, cross-organisational cooperation, allocating sufficient tender periods to allow innovation, and establishing central R&D organisations funded from contract levies or by professional bodies).

3.9 FORMAL SYSTEMS TO PROMOTE INNOVATION

Formal systems to promote innovation are mentioned by numerous writers as vitally important in the construction industry, due to the short-lived and fragmented nature of projects. Tan et al (2006:149) mention that some of the reasons why knowledge is lost between projects are the time-lapse in capturing the knowledge, the high turnover of staff and the redeployment of staff, and people's reluctance to share knowledge. They state that it is important to capture knowledge on an on-going basis, and to make it available in a form which can be re-used both on the same and subsequent projects. In addition, it is noted that because they are done at the conclusion of a project, post-project reviews of knowledge gained, do not help in improving the current project, and that much of the knowledge would have been lost by then due to the time gap. Drejer and Vinding (2006:927) found that companies which have formal systems to transfer learning between projects, are 1.7 times more likely to be innovative as firms which do not have these systems.

In a study where the listed construction companies on the JSE were assessed on a number of issues which contribute to knowledge management, Tobin and Magenuka (2006:9) found that the lowest score achieved on average by these companies, was for having knowledge hubs and centres. The second lowest score received was for having the right people and skills in the organisation. Thus, it would seem that there is ample room for improvement in the South African construction industry with regards to ensuring that adequate knowledge-sharing resources are in place, and in appointing, developing and retaining the most suitable people with the required skills, in appropriate positions.

The importance of focusing on the learning element of lessons learned is highlighted by Thompson (2005:20). He notes that it is important for a firm not to become so caught up in the process of logging data to the extent that lessons are not conveyed to new personnel. He suggests that the data should be captured on site, and not in some remote office. In this way friendly competition between various sites and business units can be encouraged. Both negative (what not to do) and positive (what worked) lessons should be captured, and the data should be put in context. Things like the validity (whether it is applicable to specific circumstances), current situation (has the solution been superseded by newer technology?) and availability (is there perhaps proprietary technology involved which might not be available?) should be considered when attempting to use the lessons-learned database. Davidson (2006:6) states that simply capturing lessons learned in a database adds no value, and that only by using the database, is value unlocked. He suggests that lessons should be peer reviewed and reviewed regularly to establish relevancy and accuracy. Only if the lessons cannot be better communicated via training, by embedding it in processes or through the use of checklists, should the lessons be captured in the database. Not only the lessons learned, but the value added by the knowledge, should be recorded. Giving feedback to contributors is highlighted as a valuable tool to ensure that they continue contributing.

Another way of ensuring that employees collaborate in innovation drives is the use of suggestion systems. Buech et al (2010:507) assert that a suggestion system aids innovation because it facilitates cost savings and channels innovative behaviour in a useful direction. It is seen as a direct way for employees to contribute, because they can get feedback on their suggestion, and it is easy to give recognition to the appropriate person. They note that the driving factor in ensuring employee participation in a suggestion system is that feedback should be efficient and fair. Another factor is employee well-being. It is suggested that companies should look after their employees' well-being, as this will result in active participation in suggestion systems.

Suggestion systems are, however, not the only channel available. Dawson (2005:17) points out that by utilising the various communication channels available, professionals from different companies, such as clients, engineers and contractors, can add value to discussions, and thereby assist innovation. By automating routine tasks, professionals are afforded more time to apply themselves to innovative processes. Von Stamm (2005:29) holds that informal networks are very important for innovation projects because it enables those who require specific skill sets to have access to people with the required skills. Unfortunately skilled and knowledgeable employees are often the ones who are most easily

lured away by competitors and, therefore, their specific skills and knowledge are often lost to the organisation if it is not captured timeously. It is, therefore, a good idea to create expert databases which assist in bringing together experts with those who require their specific skills. The benefit of bringing experts and knowledge seekers together, instead of trying to capture the knowledge of experts on paper, is that existing knowledge can often inhibit innovation, and that it is, therefore, sometimes better not to capture the exact words, but rather the idea, or better yet, bring the relevant parties together to enable informal sharing of ideas. This may also overcome the reluctance of experts to participate in formal knowledge sharing and lessons learned sessions.

Not all experts agree that a formal system aimed at capturing the actual lessons learned is the correct way to go. Horibe (2007:8) postulates that often the efforts to capture lessons learned in formal systems are a waste of time, because the context and experiences cannot be captured effectively. People also do not want to give up their hard-earned knowledge, as they feel that in the process they will become redundant. She suggests that it might be better to create a list of experts on various matters, and involve these experts whenever the need arises.

Social media such as blogs, podcasts, wikis and RSS feeds are mentioned by Horibe (2007:13) as a way to ensure that the quality and quantity of inputs improve. One reason for this is the fact that these mediums are more transparent, ensuring that employees receive recognition for their contributions. By seeing other employees' status reports, collaboration and discussions are stimulated. Personal profile pages can be a valuable source of information regarding specific knowledge areas of employees, as well as a forum to ask questions.

The importance of marrying the correct system or approach to various applications and organisational needs is noted by numerous writers. Tan et al (2006:157) suggest the use of a "live" system to capture and disseminate information. Their suggestion is to have a web-based knowledge base where the knowledge is stored. Individuals are motivated to use the system, and group sessions are held where the inputs from groups are captured. This is an on-going effort, and not only aimed at the conclusion of the project. According to Craig and Sommerville (2006:131), by using the appropriate information management system (IMS), contractors can increase collaboration and integration among project members.

3.10 SKILLS AND THEIR ROLE IN INNOVATION

It seems to be a recognised fact that skills are required in order to innovate. However, attracting, retaining and nurturing these skills are the challenge. Leonard & Sensiper (1998:112) state that a company's ability to innovate rests in the individual and collective expertise of its employees. Manley et al (2009:771) found that innovative companies invest much more in training employees than those which are less innovative. Innovative companies are also more interested in recruiting new graduates. Dulaimi et al (2002:238) suggest the creation of a knowledgeable workforce as a cornerstone of stimulating innovation in the construction industry along with a culture where innovativeness, originality and creativity is rewarded, at company, industry and professional level.

A number of writers, including Manley (2009:772) and Foster (2005: 9), recognise the lack of skills as a potential stumbling block to innovation. Foster (2005:28) mentions that a worldwide shortage of skills is looming, as the "Baby Boomer" generation is heading for retirement. She proposes an integrated talent-management approach to overcome this problem. This includes identifying critical skills, and attracting and retaining individuals who can fill these positions. Ensuring that succession planning is in place is seen as crucial by Foster. She mentions that some companies even bring back retired employees to train young workers.

Foster (2005:31) proposes that in order to ensure continuity when the older generation finally does retire a couple of measures can be put in place. These include:

- Training and developing young talented people and ensuring that effective mentoring programs are in place.
- Building a network with retired employees. In this way this valuable skill set will remain available.
- Making sure that succession planning is not based on assumption, but on facts. This includes finding out when individuals plan on retiring in order to ensure that knowledgeable workers are not sidelined while they may be planning to stay in the organisation for a number of years.

3.11 PROCUREMENT PRACTICES AND THEIR ROLE IN STIMULATING INNOVATION

Firms involved in construction may choose to adopt various approaches to the procurement of projects. While some clients may choose to from strategic, long-term alliances with engineers and contractors, others see bigger benefits in relatively short-lived relationships.

Manley et al (2009:772) found that two of the biggest differences between innovative companies and those which are considered less innovative, are the degree to which they pursue alliance contracts, and the degree to which they pursue partnering contracts. This seems to indicate that innovative firms realise that the room to innovate is greater in an alliance or partnering agreement than in the traditional short-term competitive bidding process.

As innovative construction methods and products are usually unproven, implementing these may not always be successful. Because of the tendency to focus mainly on price when evaluating tenders, Steward & Fenn (2006:177) note that the tendering demands in conventional procurement practices, where the focus is on lower risk and lower prices, creates a situation where this pressure is passed on to the supply chain, resulting in low-risk, tried-and-tested methods and products being used.

The manner in which projects are managed on the commercial front, as well as the forming of partnerships is advocated by a number of writers. Nicolini et al (2000:304) suggest the introduction of non-confrontational approaches to the management of construction projects and better management of critical interfaces, along with an improvement in the allocation of risk, in order to allow for more cost-saving innovations to surface. Rowlinson & Cheung (2008:3) also advocate relational contracting, with long-term relationships based on trust, as opposed to confrontation, as a way of promoting innovation in the construction industry. These relationships will typically be partnering, alliancing or joint-venturing, and aim to enhance communication, trust, risk-sharing and the achievement of mutual objectives. Naim & Barlow (2003:601) propose a management innovation in the form of a lean and agile approach to supply chain management.

3.12 PROMOTING INNOVATION

As innovation is seen as key to ensure success in the construction industry, a number of approaches are suggested by authors to promote innovation. These are discussed below. Taylor (2006:8) suggests having regular breakaway sessions, where employees are encouraged to be creative and share knowledge. During these sessions employees should be shown that all ideas are valuable. Taylor also suggests that management should interact with frontline staff in order to familiarise themselves with problems, and at the same time to make staff feel more valued. The creation of an appropriate reward and recognition scheme which creates proper channels to submit ideas, and which demonstrates the financial impact of successful ideas, is seen as vital in encouraging employees to participate in innovation. Ensuring that such employees receive company-wide recognition is proposed as a great

motivator as well. The company intranet is suggested as a good platform to facilitate this process. The creation of a virtual magazine, which can be read online or emailed to employees, is seen as a fun and interesting way to ensure that employees use the system. O'Reilly and Chatman (1996) add that management could use various recognition schemes to ensure that employees actively participate. These include setting clear goals, giving regular and concise feedback on proposals, including pay raises and fringe benefits as a reward for ideas which are utilised, and creating flexible and pleasant working conditions. By providing time and finances for experimentation, top management can cultivate a culture of innovation. Bossink (2004:211) found that the leadership style of managers affects the organisation's ability to innovate. Although different leadership styles influence the ability to innovate differently, it is found that consistency in leadership style is actually more important than the specific style. Leaders should champion the cause of innovation and provide a strategic vision. It is also found that managers should inject information, knowledge and competence into the project to enhance innovation.

Other authors have also investigated ways of ensuring that employees participate in innovation drives. Antikainen et al (2010:105) found that monetary rewards are not the best way to get people involved in innovation. They list numerous factors which motivate people to participate. These include altruism, attachment to the group, firm recognition, relationships and social support, ideology, intellectual stimulation, personal learning, peer recognition, reciprocity and enhancing reputation. It seems that recognition, more than monetary rewards, is a big driver for people to participate.

Although a lot of emphasis is put on having formal systems in place, innovation can also happen in an organic way. To ensure that this happens, management must ensure that proposals are implemented and that those responsible are given recognition. By training people, they will not only be better skilled to contribute to innovation, but because they are motivated, they will be more willing to contribute. Hartman (2006:169) adds that apart from motivating people and deepening their skills level, attending courses also exposes employees to new ideas and puts them in touch with relevant experts.

Taking a conscious decision to innovate, and making this part of the strategic approach of a company, is seen as cardinal in ensuring innovation success. Steward & Fenn (2006:174) note that the strategy of a firm is one of the main drivers of innovation. They suggest integrating the supply chain (the client, contractor and supplier must work closer together) and adopting "best value" practices, where the contractor plays an important role in assisting the client to define what value means, not only in the construction phase, but also for the

company that will own and operate the structure over its lifetime. In this way the contractor can help the client realise the potential pitfalls of appointing a contractor solely on price, instead of considering, for example, the innovation history of a contractor. For this to work, the contractor has to gain access to the client in order to have strategic discussions. The main driver of innovation, according to Steward and Fenn, is strategy aimed at encouraging participation and producing innovations.

Some of the innovative practices listed by Manley (2006:1301), which are presently being used in the construction industry, include alliance contracting and design-and-construct contracts, IT-based project management systems, private-public partnerships (PPP), long-term agreements between role-players, quality certifications such as ISO 9000, use of websites and intranets, use of risk-sharing contracts, and allocating larger budgets for training and developing staff.

A number of strategies are put forward by Blayse & Manly (2004:152) to enhance innovations, such as ensuring that clients are more demanding and knowledgeable, building better relationships within the industry, facilitating more long-term relationships and better management of knowledge transfer between projects. Nuesse et al (2011:35) suggest the establishment of research clusters which aim at fostering innovation in particular sectors of the industry, as well as closer collaboration between academic institutions and industry, in order to facilitate research into specific problem areas. Pinkse & Dommisse (2009:521) suggest that the ability of a firm to gather information regarding innovations, as well as its absorptive capacity (its internal technical abilities), should be developed in order to become more innovative.

Legislation is also seen as a potential hindrance to innovation. Pries & Dorée (2005:563) suggest the implementation of a different way of drafting legislation through the use of performance-based rules, rather than prescriptive rules. Gan et al (1998:281) concurs, adding that more freedom is allowed by performance-based rules, because only the final performance standard is set (such as overall strength or level of isolation), while the prescriptive approach specifies a large number of attributes such as material, dimension and various other specification.

3.13 CONCLUSION

In this chapter, secondary data as found in the literature is discussed in order to gain a better perspective of the problems and solutions regarding innovation in the construction industry.

The aim was to better equip the researcher to liaise with role-players during interviews and focus groups, and to assist in compiling a comprehensive questionnaire.

Some of the findings from the literature review include:

Why innovate? – Being innovative is important for a construction firm, as it helps contractors in winning contracts, enhances its reputation, assists profitability, and helps distinguishing contractors in an industry which is characterised by a large number of homogenous competitors.

Types of innovation – Innovation can be classified by the degree of novelty, such as incremental, radical, modular, architectural or system innovation. Another way of distinguishing between innovations is to determine if the innovation revolves around new products or capabilities (technical innovation) or new organisational designs (organisational innovation).

Problems regarding innovation – A number of hindrances to innovation exist. These include the fact that there are traditionally low levels of investment in R&D in the industry, that the manner in which construction projects are procured does not lend itself to innovation, that there is less than ideal collaboration between industry and academics, and the nature of the construction industry which operates in a project-based environment. All of these factors are seen as hampering innovation in the industry.

Contribution of role-players with regards to innovation – Not all the role-players involved in the construction industry are equally innovative, and each of the role-players influences innovation differently. Clients can assist greatly by being more demanding and ensuring that they are knowledgeable regarding innovations, and by evaluating the innovation history of a potential contractor prior to awarding tenders. Manufacturers generally invest most in R&D, and are, therefore, at the forefront of innovation in the industry.

Factors contributing to innovation – Various factors are identified which contribute to successful innovation in the construction industry. These include the procurement system implemented, clients being more focused on performance and outcomes than on dictating methods and products to be used, and clients being more demanding and implementing relationships which last over longer periods and over several projects. Having “champions” who specifically drive innovation efforts or even an innovation manger is also seen as beneficial. The implementation of integrated information management systems across company borders and various role-players is seen as beneficial to smooth collaboration.

Culture – For innovation to be successful, employees need to feel part of a company and should want to contribute. This can be achieved by instilling a culture where employees feel appreciated and are given the chance to contribute. To achieve this, feedback has to be given quickly, employees must be allowed to work autonomously, and a comprehensive reward system for innovative ideas has to be in place. In addition, employees should be given the freedom to challenge norms, and be allowed to fail without fear of reprisal. Public spaces where information and ideas can be shared should be created and formal and informal sessions scheduled to promote sharing.

Research and Development – Investment in R&D is found to be one of the biggest differentiators between innovative companies and their less successful counterparts. Various reasons are put forward why construction firms need to invest in R&D, including changing demands from clients and customers, such as a bigger choice regarding the types of materials, location of buildings and the types of equipment to be installed. Customers also demand shorter turnaround times on projects. South Africa appears to favour a model where government views the construction industry as a part of the broader industry, and does not have an entire government department specifically tasked with looking solely at the construction industry. South Africa also seems to favour an approach where private sector companies are mostly responsible for investment in R&D. In general, governments favour being involved in R&D by funding universities and other government institutions. Governments also tend to focus more on site-related problems and procurement practices than in assisting with innovative products. Governments offer tax breaks for innovative companies rather than direct funding of R&D and focus more on environmental and community concerns throughout the project's life-cycle. Collaboration across disciplines and company borders and between academics and industry is noted as beneficial practices. In addition, greater integration is advocated as a beneficial practice as well as greater R&D efforts, such as allowing longer tendering periods, to enable more R&D.

Formal systems to promote innovation – Due to the fragmented nature and relative short duration of construction projects, there should be a greater focus on capturing knowledge gained during projects as well as lessons learned in order to ensure that innovative practices are carried over to subsequent projects and that knowledge seekers are put in touch with those who are experts in specific areas. Capturing not only the lessons learned, but also its context, is important. Only if a lesson cannot be better communicated via training, embedding it in processes, or through the use of checklists, should the lesson be recorded. In order to ensure that contributors continue collaborating regular feedback should be given. Suggestion systems, as well as other more informal systems, should be considered to allow

for sharing of ideas and information. Creating an expert database across project borders enables better collaboration, and may assist to better transfer knowledge which is hard to capture in a system. Social media such as blogs and wikis are seen as a good way to ensure that the quality and quantity of inputs improve, as these are transparent and give recognition to contributors. Personal profiles also enable identification of experts.

The role of skills in innovation – Skills are seen as important in order to be able to innovate. Innovative companies recruit more graduates and invest more in training. Following an integrated talent-management approach is suggested as a good way of retaining and nurturing talent. This is done by identifying critical skills, and attracting and retaining as well as developing these skill sets. Succession planning is also crucial. Mentoring, as well as bringing back retired employees to train young employees, is also proposed as a good way of ensuring that appropriate skills are nurtured.

Procurement practices – Companies which follow a strategy of forming long-term alliances between clients and contractors are seen as more innovative than those which focus on short-lived relationships. By adopting non-confrontational approaches to managing projects, and allocating risk more evenly across role-players, innovation can be stimulated.

Promoting innovation – Various other suggestions to enhance innovation are put forward. These include having regular breakaway sessions where employees are shown that their ideas matter, management interacting with frontline staff more often, having appropriate reward and recognition schemes, and ensuring company-wide recognition for good ideas. Other suggestions include creating a company-wide virtual magazine where ideas are communicated. Leadership should be consistent in its approach to innovation and research clusters should be implemented across the industry.

The process followed during the interviews and focus group, along with the outcome of the focus group and interviews, will be discussed in the next chapter.

CHAPTER 4 – DATA COLLECTION: INTERVIEWS & FOCUS GROUP

4.1 INTRODUCTION AND AIM

In the previous chapter, a number of aspects regarding innovation in the construction industry were identified. A number of key issues which were identified were converted into a set of questions, which were used as the backbone of the interviews and focus groups.

As mentioned in Chapter 2, a semi-structured interview style was followed, which meant that, although there was a set list of questions, these were used as a guideline, and the interview was allowed to take its own course. This was done in order to allow the interviewees freedom to express their views and to allow the interviewer to ask additional questions to gain better insight.

The interviews were conducted with top level management on a construction site. These contractors represent various disciplines, including civil, electrical, structural and mechanical, and earthworks contractors. In total eight individual interviews were conducted, as well as one focus group. Twelve people were involved in the focus group.

The focus group was conducted with the next lower level of personnel on a construction site. These included foremen, safety officers, personnel practitioners, engineers and technicians. The same set of questions which were used in the interviews, were used during the focus group. Again, a semi-structured interview approach was followed to allow participants freedom to explore various issues.

A list of the questions used as a baseline is available in Annexure A at the back of this report.

This chapter is a summary of the findings of the interviews and focus group. The data will be discussed under the following themes:

- Why innovate?
- The roles of various role-players in innovation.
- Culture.
- Research and development.
- Formal systems to promote innovation.
- Skills and their role in innovation.

- Government as regulator and client.
- Procurement strategies and their role in stimulating innovation.
- Promoting innovation.

These themes emerged in the literature review and were carried through to the interviews and focus group. Under each of the themes, a number of points were discussed which relate to each of the research questions.

4.2 WHY INNOVATE?

All the contractors who were interviewed felt that it is important for a construction contractor to be innovative and various reasons were given. The opinion that a contractor needs to be innovative to complete a project successfully was held. The market is viewed as being very competitive, with very tight margins. The only way to outshine the competition appears to be by doing something different, by looking at new technology, methods or materials. It is also noted that often more personnel are responsible for tendering for a project than those responsible for the execution thereof. Should site personnel realise that the project is priced incorrectly innovative methods are often the only way to ensure that the project will still be profitable. It is noted that contractors are adapting to the changing nature of projects..

International competition is noted as another factor which plays a role. If South African contractors want to be competitive, both locally and abroad, they would have to be able to innovate/compete with the best.

4.3 THE ROLES OF VARIOUS ROLE-PLAYERS IN INNOVATION

On the issue of the roles which various role-players play in innovation, there are many opinions. It is felt by some of the interviewees that the standards and regulations which a client imposes on a project generally stifle innovation. This is because it inhibits the degree to which a contractor could innovate. It also makes it more difficult for the contractor or design engineer to implement new and innovative products or methods, because these parties would have to convince the client to change certain norms. It is contended that some clients are more willing than others to do so. However, often the time spent to convince the client or engineer to adopt a proposal from the contractor, means that any saving in time or cost from the proposal is negated. This is noted as stifling innovation.

The relative level of experience of a client is said to a factor which might influence its ability to innovate. The opinion is held that older and more experienced clients are easier to

convince to accept innovative practices, because they generally have more experience. This is somewhat against expectation, as one would have assumed that a young organisation or at least one which is relatively new to projects, would have fewer old habits, and would, therefore, be more open to innovation. It is noted that often the internal systems of a client do not allow for anything which is outside the norm. Having an inexperienced person in a position where he has to make a decision on the client's workforce is seen as a big problem. Such an individual would most likely not be prepared to deviate from the norm. Instead he would most likely only stick to tried-and-trusted-practices, which could inhibit innovation. On the other hand, experienced clients could be too set in their ways, which would stifle innovation. Having a client with inexperienced employees is seen as a big stumbling block as such people would not consider alternatives. It is noted that if the client, engineer or contractor has experienced staff who understand their role and who understand the constraints of the other parties, the relationship between the various parties may be better, which should allow for innovation.

Having extensive interaction between engineers, clients and contractors throughout the conceptualisation, design and implementation phases, is seen as being beneficial to innovation. As clients often have experience in operating plants, they are regarded as being able to add valuable insight into what worked and what does not. If the client is proactive and open to sharing knowledge, a number of changes could be implemented early in the design phase, which could be very beneficial to innovation.

Often engineers also have a lot of experience in a specific field which, if brought to the table in open dialogue, would benefit the project. Being able to communicate directly with designers is noted by some of the contractors as being of great benefit, as this negates the cumbersome processes which are common in some construction projects. Having design engineers who want their designs to work, is also noted as a benefit. It is thought that often the individuals involved in the relationship make all the difference. If the exact project is managed with two sets of different people, the outcome would be completely different. If there are personality clashes, the outcome would be negative, irrespective of the type of contract used. The general view seems to be that on average relationships in the industry are reasonable, as long as the rules of engagement are laid out at the start of a project, and all the parties are compliant. Communication is also recognised as being vitally important.

It is believed that the client, by being prescriptive and having a fixed set of standards and procedures, forces the contractor to be innovative in order to be able to achieve the desired outcome. The flip side of the coin is also important, where clients have inadequate standards

and procedures in place, which cause the contractor to lose time and money trying to find out what the correct procedures and standards are. It would seem that an optimum balance between openness and strictness needs to be achieved to allow innovation to flow. It is noted that in the past specifications were outcome-based, meaning that the focus was on ensuring that the specified results were achieved. However, there seems to be a trend in moving towards specifications which try to dictate the methods which should be used to achieve results. This is seen as preventing the contractor from using innovative methods to achieve the desired outcomes.

Mention is made of clients' focus on quality and safety procedures, and that the requirements from clients regarding these two facets hamper innovation, both because a number of innovative ideas are rejected by the client due to perceived requirements of either quality or safety, and also because the amount of administration required by these procedures occupy the time of individuals who could otherwise have been free to innovate. It is also acknowledged that a contractor has to be innovative to ensure a very good safety record, as most clients would not consider appointing a contractor with a bad safety record. Safety training is considered as pivotal in achieving this.

The practice of clients, especially on large projects, to procure most of the large equipment themselves, and issue these to the contractor for installation, is known to stifle innovation, as clients would often prefer to depend on known technology. In this manner clients are missing the opportunity to be innovative by not incorporating new technology. It is, however, noted that there is a need to establish commonality of spares, and that clients need to optimise inventory levels of critical spares, as this could inhibit the implementation of new technology, especially in existing plants and facilities. However, contractors could invest in new measuring and acceptance technology to ensure that quality control during manufacturing and construction is enhanced.

Designers are accepted as one of the role-players who force other role-players to be innovative. Contractors and suppliers often have to come up with innovative solutions in order to be able to construct according to the design engineer's specifications. Unfortunately the designs, although innovative, are not always easy to construct, thereby necessitating other role-players to be innovative. The relevant codes of practice and standards are noted as restrictive and detract from engineers' ability to innovate. Design engineers are noted as being good readers and equally good at networking. In this manner they are able to gain valuable knowledge regarding innovations, and often implemented these in their designs. The relatively low level of skills in South Africa is, however, believed to be a stumbling block

in implementing some of the innovative designs which engineers attempt to bring into the local industry. The way in which designers are appointed is noted as a concern. Often, the amount of money paid to a design engineering company is a fixed percentage of the overall cost of the project. There may be a conflict of interest, as engineers may deliberately inflate the cost of works in order to receive a bigger remuneration. This may make them less willing to accept proposals which could potentially save time and money.

Another problem which is apparent, is that when engineers bring in innovative ideas from overseas, they often try to apply the rules which apply abroad. For instance, rules regarding the transport of concrete which may be applicable in certain situations abroad where it may be very cold or hot, may not apply in South Africa at all. Installing several sets of water stops in water-retaining structures may be a good idea in an area with high levels of seismic activity in order to prevent potential leaks, but again, these may be completely inappropriate in South Africa. If these “innovative” practices were to be applied locally, they may end up adding costs and time to the project, without adding any real value. Often the reasons behind certain overseas innovations are misunderstood. It is known that the overseas practice of placing roller-compacted concrete (RCC) using conveyors led to the innovation of using grout-enriched RCC. This was done to negate the use of two separate types of concrete. However, in South Africa conveyors are not utilised as much, and yet South Africans also tried to use grout-enriched RCC, which led to increases in costs with no apparent saving in time.

Government is seen by a number of interviewees as being the least innovative. Reasons for this include having the worse skill set of all role-players. In general government employees are also seen as being less motivated, inexperienced in construction projects, and the least dynamic people in the country.

As a legislator, government is tasked with drafting the laws and regulations which guide, not only the behaviour of contractors, clients and engineers, but also those of government employees. Government employees are forced to follow very strict procurement strategies, which are seen as not being conducive to innovation. Due to the excessive focus on the tender price, and to a lesser degree Broad Based Black Economic Empowerment (BBBEE) rules, it is perceived as being very difficult to propose alternatives during a public sector tender process. Because the focus is so much on the tender price, often other factors, such as the relative levels of experience of prospective contractors as well as the skills of individuals who would be involved in the project, are not considered. Therefore, tenders are often awarded to companies which do not possess the skills to innovate effectively.

Legislation, such as the Mine Health and Safety Act (Act 29 of 1996) and the Construction Regulations (2003, amended in 2012 – part of the Occupational Health and Safety Act, 1993, Act no. 85 of 1993), are seen to have been written in retrospect, trying to prevent actions which in the past caused fatalities or serious injuries, and are, therefore, not forward-looking. It is noted that these laws have been "written in blood" and that any attempt to discuss or disagree with sections thereof, or with the way in which they are applied, are met with fierce resistance.

Although the legislation mentioned above may impede innovation to a degree, it is also thought to be a trigger for other innovations. Contractors appear to be forced to innovate, not only to cope with legislation and a highly competitive environment, but also due to the changing nature of projects in the country. Although projects have been run on commercial terms for a long time, with a tender and contract forming the basis of the relationship between the client and contractor, there seems to be a shift towards a strict contractual approach, where often the main players are not people with construction experience, but with legal backgrounds. It is noted that contractors have learned valuable lessons lately. Where before, construction disputes were settled by construction professionals on site, there seems to be a trend in involving lawyers. Contractors are adapting their management structures to allow for a more formal commercial division, incorporating commercial managers, quantity surveyors and legal practitioners. These supplement the production division which is responsible for executing the physical project.

Mention is also made of contractors adapting their management structure to be more flexible. A number of functions which are traditionally done at head office level, such as costing, are being managed, at least partially, at site level. The same goes for procurement and planning activities.

One of the reasons why contractors' innovation initiatives fail is due to the approach they follow. Although the necessity to innovate is appreciated, the wrong people are often appointed to manage the drive towards innovation. Appointing an experienced quality manager might seem like a good idea, but it is believed that it is sometimes better to appoint a new person who could appreciate new ideas. Using a person who has a long history in another field may also backfire because such a person may not understand the new role.

4.4 CULTURE

A number of participants have strong feelings regarding the role that culture plays in innovation. On a micro level the culture in organisations is named as an important influence

in innovation. It is accepted that the openness of management and their willingness to test new ideas, play a bigger role in innovation than the relative size or maturity of an organisation. It is also believed that having a role model in management may encourage innovation in the organisation, even more than monetary incentives. The mindset of the client seems to be important, as a mentally active, curious and risk-inclined client may be more willing to allow new ideas to be implemented.

On a macro level, the culture of South Africa as a nation is recognised. There is a strong feeling that the norms and values of the country in general are not conducive to innovation. Mention is made of a “third world mentality” and that South Africans should get away from this and not accept unproductive, inefficient practices as is the norm at present.

The prevalence of corruption in tenders and procurement is raised as a big problem, as it is felt that uncompetitive procurement practices eliminate the incentive for innovation. Innovative companies, which may come up with a very innovative approach to a project, are not given the chance to put this into practice if tenders are awarded to companies which are less innovative, but who are prepared to spend money on bribes, or which happen to have the right political connections.

The modern trend where the so-called Generations X and Y want instant satisfaction, and who are not willing to work hard for a long period of time to achieve success, is also named as a contributor to the problems experienced regarding the lack of skilled people in construction. It is noted that in bygone days, people were willing to work for a meager salary while being trained, because they knew that eventually they would benefit from the sacrifice. People could see the vision then, whereas nowadays the youth seem to be unfocussed. A number of reasons are put forward for this, such as the history of the country, absent parents, the role of the media and even the prevalence of drugs. However, the solution seems to be to give the youth a vision on which to focus. One of the suggestions is to ensure that learners are exposed to an array of possibilities from a young age. Perhaps construction companies should visit schools and expose learners to the various disciplines in construction. Learners could also be encouraged to visit construction sites in order to gain fist-hand knowledge.

It is worth noting that older, experienced artisans and foremen are not always seen as the saviours of the construction industry. It is understood that often an experienced employee would be resistant to adopting a new technology or practice, especially if it would mean that that person might lose one or more of his long-term crew, due the new innovation being

more effective, thereby reducing the required number of employees. It was also noted that more effort is often required to convince older employees to adopt new practices or technology, especially when electronics are involved. It seems as if having a good blend of eager young minds and experienced older workers is the best solution. Having major age gaps is seen as a potential stumbling block, as there may be a communication breakdown between the two generations if this middle group is absent.

Another problem is the culture in listed companies focusing solely on returns and profits on a year-on-year basis. This short-term thinking, instead of a strategic long-term vision, means that companies may not invest in systems and training to ensure innovation over a long period.

4.5 RESEARCH & DEVELOPMENT

In general the feeling seems to be that not enough is spent by construction contractors on research and development (R&D).

Although a number of companies have some system in place to promote continuous improvement and the sharing of knowledge gained between projects, in general there is a feeling that more money could be spent on research and development of new products and techniques. Some of the reasons advocated are the relatively short duration of projects, and the accompanying lack of continuity. Suppliers, who operate in a more sustainable and long-term environment, are regarded as the role-players who apparently invest most in R&D, although it is felt that much of the innovation happens abroad, and that South African suppliers only adopt, or slightly adapt to, international products. It is also accepted that South Africa is so far behind international role-players that some of the technology already abandoned overseas would still locally be considered innovative. However, there are also some contractors who suggest that South African contractors are not very far behind the rest of the world.

It was mentioned in the interviews that contractors would only invest in R&D if there is a possibility to use technology stretching over a number of projects. Contractors would be unwilling to spend money on innovations which could not be used after a single project, as the likelihood of reaping financial rewards becomes less if the initial cost could not be written off over several projects.

4.6 FORMAL SYSTEMS TO PROMOTE INNOVATION

Although almost all the contractors have some type of system in place to capture lessons learned, it varies from a paper-based procedure which is only completed at the end of a project, to dynamic systems which are actively used. At the very least, lessons learned during a project are captured and made available should the contractor tender for a similar project or for the same client. Often, the people involved in a certain project would be invited to brief the parties involved in a subsequent tender. Informal sessions are also used where representatives of various sites come together and share knowledge and experiences, as well as lessons learned.

Some contractors have schemes in place to ensure that innovation is captured and distributed throughout the organisation. These include web-based platforms and paper-based systems. A problem pointed out during the interviews was that large contractors who have more than one division often do not share the knowledge across the various divisions.

There is evidence that contractors use industry guidelines and that best practice reports guide their operations. External consultants, such as McKinsey, are also brought in to assist in compiling plans to improve performance, and by implication, innovation.

Ensuring that skilled employees remain content is thought of as an important motivator to innovate. If a skilled worker is lost due to resignation, a valuable asset is lost, which impacts negatively on the ability to innovate. Therefore, the focus is on keeping the employee happy. Having an open-door approach, giving small but frequent bonuses, and supporting the employee during difficult times, are seen as some of the main motivators.

The fact that technology is often considered as being expensive relative to less advanced methods such as informal sharing of knowledge is considered a possible inhibitor of innovation.

Contractors also invested in computer-aided design (CAD) and other information technology (IT) systems, as well as telecommunication technology, to enable better communication and collaboration.

Although some contractors feel that South Africa is far behind other countries with regards to the technology being used, mention is made of numerous innovative tools being used, such as magnetic base drills and impact tools.

4.7 SKILLS AND THEIR ROLE IN INNOVATION

Perhaps the single topic which caused the most discussion, and on which almost all the contractors agreed, is the issue of skills, or more specifically, the lack of skills in the South African construction industry and the effect it has on the ability of contractors to innovate. The general feeling seems to be that skills are required to innovate, and that the more radical the innovation, the more advanced the required skills would be.

It is noted that it is easier for contractors who are involved in a single specialised discipline to innovate, than contractors who are involved in a large number of generalised disciplines. It is also noted that incremental innovation probably comes from generalists, while radical innovation would be expected from specialists. Smaller companies on smaller projects are seen as being responsible for incremental innovation, while big companies (which have the financial means) on big projects are seen as being responsible for radical innovations.

In general, the quality of training in tertiary institutions such as universities is viewed as world class, and engineers and technicians are described as being, in general, very competent. There also seems to be systems in place to either take these individuals through a formal system after graduating, to expose them to the various facets of engineering, or at least have the young graduate work under a mentor. This mentor (or in some cases mentors) is shadowed by the young graduate, and in the process vital knowledge is imparted. It seems to be more in the artisan/foreman trades that the system which is supposed to educate the next generation, is failing.

The problem seems to be that, due to the general low level of skills, and the inherent inability to transfer skills, the skilled workers who would normally be involved in innovation, end up spending their time doing repetitive tasks due to the inability of the next lower tier of skilled workers to do their work properly. There is talk of a “missing generation” stemming from the fact that the skilled cadre of workers are ageing and are not being replaced at an adequate rate. Foremen and experienced artisans are often the people who are responsible for innovation on a construction site. Because of a general lack of experience and skills amongst this group, the responsibility to innovate now rests on engineers and technicians, who should ideally be involved in managing the project.

It is appreciated that the nature of projects is changing, with more and more administrative responsibilities being imposed on engineers and technicians. The additional burdens of innovation and administration, along with numerous meetings imposed by the client do not bode well for innovation, production, quality or safety. It is suggested that it may be time to

look at the way in which projects are structured by the client with respect to the amount of time required form the site managers of the contractors.

Almost all the participants feel that there is a general lack of skills in the South African construction industry. The apparent lack of competent people is noted as possibly leading to a situation where it may be advisable to utilise highly specialised equipment used in Europe or North America, but that using that same equipment may cause delays in this country, because a local agent may not have the capability or capacity to effect repairs to such equipment.

The reasons for the skills shortage seem to be varied. The inability to transfer unskilled or semi-skilled personnel to subsequent projects due to the requirements of labour laws is cited as one factor. Another is the lack of a coherent artisan training scheme. Yet another problem seems to be the culture which seems to have been fostered in the country through the implementation of the Sectorial Education and Training Authorities (SETAs), which seem to have caused the misconception that a short course could replace formal, structured and long-term training in combination with appropriate experience. The impression seems to exist among workers that a two-week course could replace the old system where a student would go through years of practical and theoretical training, prior to being declared competent. It is noted that currently, in order to complete a trade test, an apprentice has to complete numerous shorter modules which lead to a high drop-out rate. It is apparent that due to an oversupply of people who have done short courses, there is no lack of people who have knowledge, but that very few know how to apply that knowledge. It is said that, although the South African education system is supposed to be outcome-based, learners seem to lack the insight which should enable them to work independently. It is also thought that the type of person who becomes an artisan does not necessarily like to read and go too much into theory. Rather, these individuals want to work hands-on. With the focus on theoretical courses, a number of the more practically-minded workers become frustrated.

Another problem is employers' lack of understanding of the legislation which established the SETAs.

The departure of skilled individuals from South Africa through emigration or long-term stints abroad is seen as a big problem. Possible reasons for this include corruption and concerns over the future of the country.

The image of the construction industry is viewed as a possible hindrance for bright young minds to enter the industry. It is noted that young people do not want to get their hands dirty. The youth are made aware of “flashy” and high-paying jobs by the media, and this is accepted as the norm. The fact that construction workers move around a lot and are often away from home for extended periods contribute to the negative image of the industry among potential workers.

At the same time the fact that there are numerous disciplines and roles available in construction, is seen as a positive point. Construction could be an exciting field for a young person to enter, as long as young people are made aware of the options which are available. Some of the possible solutions to this are that schools could bring learners to construction sites on open days, and that construction organisations such as the South African Federation of Civil Engineering Contractors (SAFCEC) could facilitate these visits. It is also noted that remuneration levels in construction have caught up with other fields, and that this may attract talented individuals to the sector. However, the fact remains that there is a skills gap which needs to be overcome, and that institutions have to step up to help eliminate this gap.

A number of participants feel that a company that invests in training their personnel would be more dynamic than an organisation which does not train its staff, or even one which tries to source skilled people through “poaching”, rather than training their own personnel. Mention is made of the necessity of having a good mix of young, dynamic and skilled workers (such as young engineers) and experienced personnel. The former is considered as being enthusiastic and daring, while the latter could guide this enthusiasm through experience and contribute ideas when the former gets stuck on a problem. The direct sharing of knowledge and skills through mentorship is suggested by a number of contractors as being a crucial tool in skilling a person to be able to innovate. It is acknowledged that companies who promote people within the organisation, taking them through a process, including training, and who nurture them from a relatively junior level until they reach senior positions, are often innovative. This is due to the availability of motivated, experienced and knowledgeable people who understand the internal politics of the organisation, and who know where knowledge in the organisation resides. The solution proposed by most interviewees to solving the lack of skilled artisans, includes the urgent implementation of a formalised project to train artisans. The old system, which was followed before 1996, is suggested as a starting point. Such a system could be carried out either entirely by the private sector, or in conjunction with government, although most participants feel that government should play a significant role in this. The system would see companies (and perhaps even government)

enlisting large numbers of individuals in apprenticeships programs, where the individual would sign some form of contract, and thereafter be put through a formal system which would comprise formal training as well as practical experience. Once the learner achieves a certain skill level, he would write a trade test, which would involve a theoretical and practical component. Upon completion of the trade test, the learner would contractually have to work for the sponsoring company for a predetermined period. Unfortunately this system is not likely to work unless both private sector and government commit to it. It may also require government to look at modifying labour law in order to enable companies to get rid of non-performing individuals more easily. The focus on employing certain sections of the population seems to play a role as well. Mention is made that sometimes, due to an inability to find suitably skilled people from a designated group of the population, less skilled people are appointed, which obviously affects the ability to innovate.

4.8 GOVERNMENT AS REGULATOR AND CLIENT

The prevailing feeling seems to be that government should be much stricter on corruption. Corruption is identified as a very big hindrance to innovation. It seems that government should also be more consistent in the way it applies rules and regulations in order to create more stability. Labour laws and the way they are implemented, are also regarded by a number of respondents as an obstacle. The rigidity of labour laws as well as the relative difficulty in getting rid of unproductive and underperforming staff was pointed out as a problem.

Another area where government could play a big role is in establishing a system which could produce skilled workers. Not only is the lack of a proper training system which produces skilled and experienced artisans named as a shortcoming, but also the requirements of labour law, and most government tenders, to include a large local labour component. Although most participants agree that there should be a certain local labour content in any project, it is thought that the practice of not allowing general laborers to be transferred to subsequent projects, means that the general skill level of workers only reach a certain stage before these individuals lose their jobs and, therefore, cannot continue developing. In the process there is a certain level of skills which never get transferred. This is flagged as a major problem as the skilled section of the labour market is seen as getting older, and that the lack of transfer of skills may, in the foreseeable future, lead to a total lack of skills at or beyond a certain level. Governments globally own (and thus construct) between 10 and 25% of total fixed assets per country. This makes them an important client. As a large client, government is not seen as being very innovative in its drive for labour-intensive projects.

While it is understood that the unemployment rate is relatively high in South Africa, and that labour-intensive projects do bring some short-term relief in a localised area, the problem is that it is actually not very innovative to use manual labour, as new technology, which could lead to a reduction of labourers, is not implemented. The highly unionised environment is evidently another problem in labour-intensive projects. Because profit margins are relatively low in construction and competition high, demands from organised labour or delayed completion due to industrial action could mean the difference between a contractor's survival and going under. It is perceived that although it might lead to local employment being stimulated in the interim, labour-intensive projects actually lead to unproductive and uneconomical practices, which are not conducive to innovation.

One suggestion emanating from the interviews was that government should evaluate their projects in order to see where things go wrong, and to try and improve on subsequent projects. Lessons-learned sessions and better sharing of knowledge are suggested.

The role of industry bodies such as the South African Federation of Civil Engineering Contractors (SAFCEC) in convincing government to consider alternative procurement methods, as well as in convincing government to stamp out corruption and in assisting to secure markets outside South Africa is seen as pivotal. These bodies should also play a role in establishing training schools to train skilled workers for specific demands in the industry. However, it is clear that contractors are reluctant to belong to these bodies, because they do much more than just bargain with government. Should a contractor join these organisations, they would be compelled to comply with, amongst others, the wage agreements which these bodies negotiate with unions. This is seen as too restrictive by especially smaller contractors. It is suggested that an organisation which supplies information regarding innovation, but which is not prescriptive, would be preferred.

4.9 PROCUREMENT STRATEGIES & ITS ROLE IN STIMULATING INNOVATION

There appears to be no agreement regarding the best procurement practice to stimulate innovation. On the one hand the establishment of long-term relationships between clients and contractors would benefit innovation because it would enable contractors to invest more money in research and development. The ensuing trust inherent in such a relationship may also make the client more open to suggestions from the contractor. However, it is noted that competition stimulates innovation, and that the lack of competition may undermine the incentive that a contractor may have to innovate.

One example of innovation is that clients may no longer simply evaluate tenders based on submissions and price, but to interview the prospective management on site in order to evaluate their suitability for the project.

The way in which tenders are compiled and adjudicated is seen as another problem with regards to innovation. It is noted that, for instance, prior to constructing a roller-compacted concrete (RCC) dam, a test section should be built to ensure that the correct plant, mix designs, aggregates etcetera would be used when the actual dam wall is constructed. However, if no allowance is made for such a test section in the tender, the less experienced contractor who does not work the price of doing this into the cost estimate, would be chosen as the successful tenderer. Once the work starts, there would undoubtedly be quality problems. Thus, the experience of the client when compiling and adjudicating the tender again plays a role in ensuring that the contractor with enough experience and skills to ensure that the work is done correctly is appointed.

The propensity of clients to follow traditional procurement methods, where a design engineer designs the work and a contractor constructs is noted as not always the best way to go. Often alternative procurement methods, such as Engineer, Procure, Construct and Manage (EPCM) are better suited to a specific project. In these types of relationships, it may be easier to innovate as the engineer and contractor are part of the same team and would thus be able to come up with a better way of doing things, ensuring cheaper and faster completion.

It is held by some of the interviewees that, when evaluating tenders, the client simply looks at price and time taken to complete the work. This makes it very difficult for contractors to be innovative as no time is allowed for proposing alternatives. The excessive focus of clients on shortening the duration of the construction period is seen as a real stumbling block to innovation, as clients push so much for production that they are unwilling to take the time to consider alternatives, even if those alternatives may end up saving time in the long run.

The form of contract used by the client is also said to be a possible hindrance or aid to innovation. In South Africa there are various forms of contracts in use. Among these are the FIDIC suite of contracts, the New Engineering Contract (NEC) form of contract, the General Conditions of Contract (GCC), and various in-house contracts unique to institutions. The plethora of different contracts offers various options to the client. Some forms of contract are seen to be better suited to certain types of projects. One way the client could enhance innovation is to ensure that the correct form of contract is used on various projects.

4.10 PROMOTING INNOVATION

While monetary rewards to promote innovation among employees would seem obvious this measure is not the only one mentioned by interviewees. In fact, non-financial incentives seem to be more important to a number of respondents. One way of ensuring the use of innovation incentives is to audit employees on their use of knowledge-sharing systems on a regular basis. The presence of role models in the organisation, who could be seen as championing the cause of innovation, is also held to be a positive contributor, along with having an open-minded, young and dynamic management team. If top management displays commitment to the drive, workers would also contribute more readily.

One of the deterrents to innovation mentioned in the interviews is that it is often stated in employment contracts that any innovation which the employee comes up with, belongs to the company. Perhaps this rule should be adapted to ensure that both the employee and employer benefit from innovations.

An interesting point raised in the interviews was the changing face of employment in construction. Where it was almost unheard of a couple of years ago that management of construction sites were in the hands of short-term employees, it is becoming more common for clients, contractors and engineering companies to use contract-based employees to manage projects. It is observed that short-term employees would generally be more reluctant to challenge norms or push boundaries because they may be more concerned with ensuring continued employment, or may not be sure which route to follow to get approval for changes. Such employees may also be hesitant because they do not understand the internal politics of the organisation. There may be less motivation for such employees to push the boundaries as they often do not participate in incentive schemes and would, therefore, not share in any savings derived from innovation.

In general it seemed that by leveling the playing field by negating corruption and ensuring that the most innovative contractor is awarded the work through an open and competitive market, innovation would get the biggest boost.

4.11 SUMMARY OF DIFFERENCES IN FINDINGS OF FOCUS GROUP AND INTERVIEWS

While the interviews were conducted with the managers on site, which were normally experienced Engineers or Project Managers, the focus groups included the next lower tier of management on site. Included in this group were safety officers, artisans, foremen and junior engineers. In general, these individuals form the first line of contact with problems

encountered on construction sites. While the responses to the various questions were more or less in line with those given by the senior managers who were interviewed, a number of different views did emerge during the focus group. In a number of instances, the participants in the focus groups were more vocal and outspoken than the participants in the interviews had been. Where the participants in the interviews appeared to view the situation more from a management perspective, the focus group members appeared to have a more hands-on approach, and concentrated more on the practical problems encountered on a day-to-day basis.

With regards to the questions regarding the factors which hamper innovation, there were particularly strong views, and specifically the lack of skilled artisans and the lack of a coherent training scheme for artisans. It was very clear that the participants in the focus group felt strongly that the current training scheme for artisans did not produce artisans of a high standard, and that something had to be done urgently to rectify this. The participants felt that the previous system, where apprentices were put through a formal and structured training program, which culminated in a trade test, was more successful in producing productive and capable artisans, than the current system which is more unstructured.

While both the participants in the interviews and the focus groups agreed that there were systems in place to capture knowledge between projects, it was clear that not as many employees were aware of this system as management would appear to think.

The participants in the focus groups were also more outspoken regarding the role which government should play in developing the construction industry, and in ensuring that innovation does take place. The participants highlighted the fact that government used to manage, and in a number of cases, subsidize the artisan training scheme which was previously responsible for ensuring that artisans were trained. In the latest training scheme, government appears to be outsourcing the training. At the same time the new system is not understood well by most employers, and therefore the numbers and quality of training has decreased dramatically. The result of this is that fever artisans are produced, and that the quality of artisans in general has decreased. The participants in the focus group was of the opinion that the artisan training scheme should be redesigned, to included more formal training, where an individual enters a structured training course, which culminates in a trade test.

The participants in the focus group did not have very strong opinions on a number of the questions, such as those dealing with from of contract. This could be because, at the level where these individuals operate, they do not deal with these issues.

4.11 CONCLUSION

The main findings from this chapter include:

Why innovate?

It is important for a construction contractor to be innovative, due to competition and the need to differentiate from competitors. Fairclough (2002) found that the construction industry needs to increase the rate of innovation. Thus, innovation can assist in sustaining a contractor and securing contracts and profitability. International competition is an important driver for innovation, if local contractors are to compete with the rest of the world's contractors. Restrictive labour legislation makes it difficult to transfer personnel between sites, thus making it difficult to properly train individuals over the long term. This is another reason why contractors need to innovate. Rising labour costs and unproductive workers contribute to the problem.

The role of various role-players in innovation

Although some clients inhibit innovation by being too prescriptive by not allowing innovative ideas to be implemented, most clients are open to proposals from contractors. The relative maturity of the client organisation plays a role as more experienced clients seem more willing to consider alternatives.

Design engineers challenge contractors by prescribing challenging specifications and by designing challenging structures. Designers need to ensure that innovative methods and designs from abroad are implemented for the right reasons, and made applicable to local circumstances.

Government, as a client, is seen to be the least innovative by not possessing the required skill set to manage construction processes. As a legislator, government's focus on being overly prescriptive with regard to the rules pertaining to procurement is found to be too restrictive to allow for innovation. Other legislation is also viewed as being focused too much on the past, and not open to innovative solutions.

Contractors are viewed as adapting to changing circumstances by changing their management style and structure. Not only are they employing more commercial and legal personnel to assist in dispute resolution, but a number of functions which were previously considered as “head office functions”, have moved to construction sites. In some instances innovation drives among contractors fail because the wrong persons are tasked with overseeing these initiatives.

Culture

Top management plays a major role in innovation by being seen as open to new ideas and by actively promoting innovation. Clients who are open-minded assist innovation. South Africa is seen as having a “third-world mentality” and it is accepted that this must change in order to combat inefficiency and corruption. The youth, who are important for the future success of innovation in construction, are seen as visionless and in need of direction. Companies need to focus on drivers other than short-term profits in order to invest in training and innovation systems which will produce results over the medium to long term.

Research and development

Overall, not enough has been invested in research and development (R&D). Suppliers, who operate in a more stable environment, invest more in R&D than other role-payers. If contractors are willing to distribute the cost of R&D over several projects, they would be more willing to invest in these initiatives.

Formal systems to share innovation

Systems to capture lessons learned range from very basic, paper-driven systems to IT-based dynamic systems. Contractors often do not share information across divisions.

Skills and their role in innovation

While the training of engineers and technicians is generally good, serious concerns are raised regarding artisan training, and the systems in place to ensure that adequate numbers of properly trained artisans are produced. The requirements of labour law, as well as training systems and the emigration of skilled individuals, are recognised as contributing factors. As skilled individuals are seen to contribute the most to innovation, the lack of skilled people could potentially affect the industry’s ability to innovate.

Government as regulator and client

The rigidity of labour laws, the high levels of corruption and the inconsistent application of rules and regulations, are some of the problems relating to government's role in innovation in the construction industry. The training system of artisans, in which government is a leading partner, needs a serious overhaul. By focusing on labour-intensive projects, government prevents some types of innovative approaches to projects. Government should implement reviews on projects, after completion, in order to ensure that lessons learned are carried forward.

Procurement strategies and their role in stimulating innovation

There are different opinions regarding the best approach to the procurement of construction projects. While long-term relationships between role-players could aid in higher levels of trust and cooperation, competitive tendering urges contractors to remain innovative. Clients apply innovative procurement practices by not only considering price, but also experience and the innovation history of contractors. Experienced clients place more emphasis on criteria other than price when adjudicating tender proposals. By considering alternative, non-traditional approaches to contracting, such as Engineer, Procure, Construct and Manage (EPCM) contracts, clients could assist innovation. Clients should ensure that the correct form of contract is used in order to aid innovation.

Promoting innovation

To ensure that employees participate in innovation drives, both financial and other motivators are suggested. Auditing employees on their participation, ensuring adequate role models and having a young dynamic management team are some of the suggestions put forward to ensure that employees participate. Ensuring that employees benefit from innovative proposals and receive recognition is also important.

In this chapter the findings during the interviews and focus group are discussed. These findings, along with the insights from the literature review, were used to compile a questionnaire. This questionnaire was sent to the various contractors who participated in the interviews, with a request that the senior personnel, as well as the next lower tier on site complete the questionnaires. This process, as well the findings from the questionnaires, is discussed in the following chapter.

CHAPTER 5 - SURVEY

5.1 INTRODUCTION AND AIM

In the previous chapter a part of the primary data gathering process, namely interviews and a focus group, was discussed. In this chapter the second part of the primary data-gathering process is discussed.

Questionnaires were sent out to all the contractors who participated in the interviews. These questionnaires contain questions regarding a range of topics which were identified during the interviews, focus group and literature reviews. The aim of the questionnaires was to test some of the findings from an earlier investigation against a larger and broader base. The contractors were requested to hand the questionnaires to the next lower tier of management which ranged across disciplines, including artisans, engineers and technicians, foremen, safety officers and administrative staff. In this way it was hoped that a more varied view regarding factors affecting innovation could be obtained. .

The questionnaire is divided into subsections, each subsection dealing with a specific topic identified earlier in the research. Although the sections mentioned below are not exactly the same as used in the previous chapter, they relate to issues which came out of the literature review, focus group and interviews. Because the questionnaires would be completed by individuals without the benefit of the researcher being nearby to explain certain concepts, it was deemed to be better to group the questions in such a way that there would be a natural progression. In this way it was hoped that participants would better understand the questions.

The sections which are introduced in the questionnaires, are General (questions regarding South African innovation as well as types of innovation), Research & Development, Relationships in the industry, Distribution of risk, Tender processes, Various role-players, Standards and procedures, Skills & experience in the construction industry, Education and training, Knowledge Management & innovation systems, Organisational culture, and Government's role.

Questionnaires were sent to forty-three participants, of which thirty-six were returned. The high response rate of 83% can be attributed to the fact that the questionnaires of each contractor were handed to the individuals who were interviewed earlier on, and thus a personal connection was established between the researcher and interviewee. The main

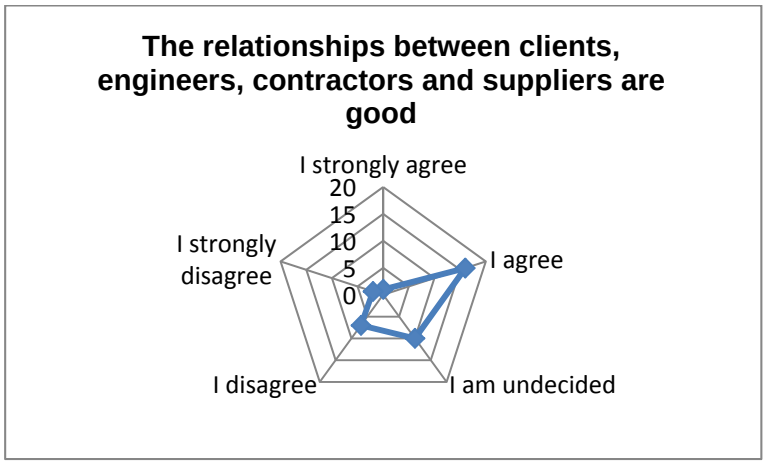
reason for not achieving an even higher response rate is that some contractors did not want to distribute the questionnaires below a certain level in their hierarchy, as they felt that this may result in uninformed responses.

In order to prepare the data for discussion, all the responses were captured and converted into radar plots. Radar plots were selected, as it gives a quick overview of the results of the responses. This enables the reader to clearly see the actual number of responses, as well as trends.

In order to explain the manner in which a radar plot is constructed, one of the questions in the survey can be used as an example. In response to the question: “The relationship between clients, engineers, contractors and suppliers are good”, the response was as follows:

Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
1	16	10	10	1

By assigning the 5 possible responses to the various axes, and then plotting the number of responses corresponding to each axis, a diagrammatic representation of the results is produced, in one view, as indicated below:



In the section which follows, each of the responses will be discussed, referring to the summarised data in the radar plot. Where appropriate, some light may be shed on the findings of the survey by referring to the information which was gathered during the interviews and focus group.

An example of the questionnaire is included in Annexure B at the back of this research report.

5.2 BACKGROUND

5.2.1 Type of contractor

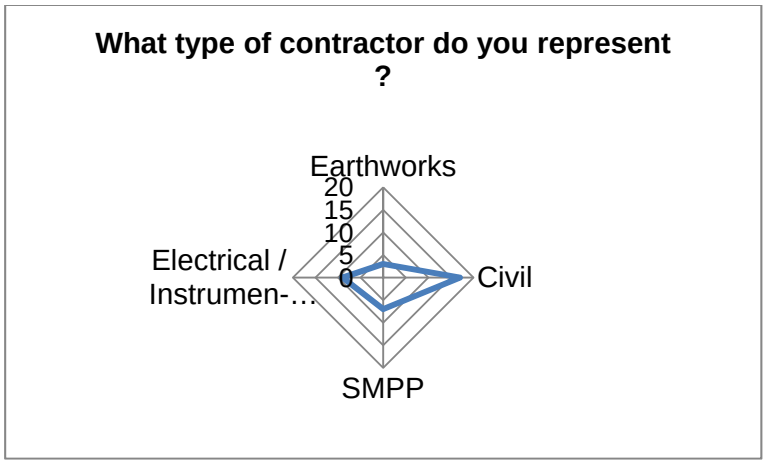


Figure 5.2 A

Of the 36 respondents, three are earthworks contractors, 17 civil contractors, seven structural, mechanical, piping and plate work (SMPP) contractors and nine electrical/instrumentation contractors. This ratio is roughly equivalent to the ratio of the various contractors on the site where the study was conducted. The main motivation for this question is to enable the researcher to look at the differences in responses, if any, on specific questions from the various disciplines.

5.2.2 Role on site

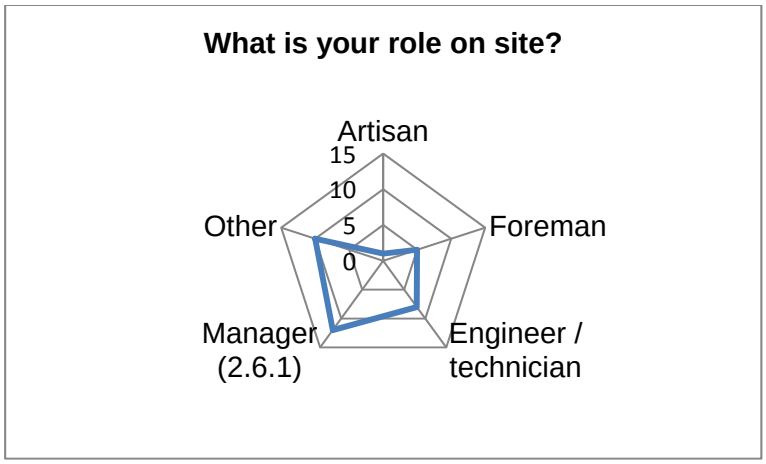


Figure 5.2 B

33% of the respondents are managers, 22% are engineers or technicians, 14% are foremen, and 3% are artisans, while 28% fulfill other roles, such as safety officers on site. As the goal was to get the responses of management and the next lower tier of the organisation, it was

expected that not too many responses would be received from labourers or other semi-skilled trades. It was the manager of each contractor's prerogative to decide who would complete the questionnaire, although the request was that the next lower tier should be included. This seems to have been the case. Managers of construction contractors on a site normally come through the ranks as do foremen. These categories represent the majority of the responses. Therefore the views of these individuals should be based on years of experience.

5.3 GENERAL

5.3.1 The importance of innovation

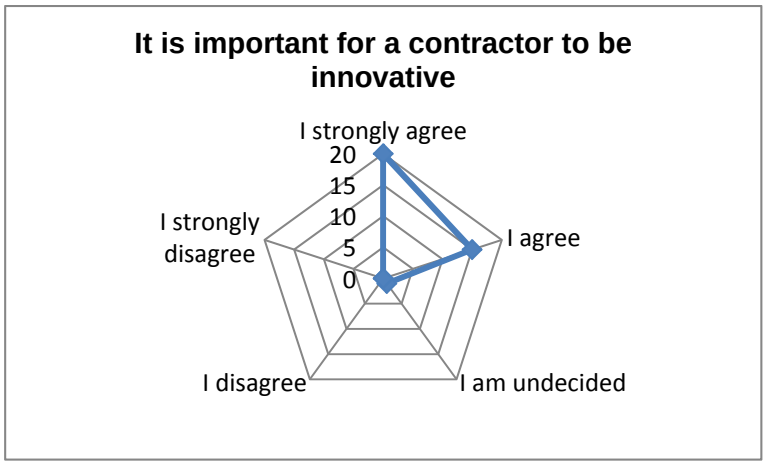


Figure 5.3 A

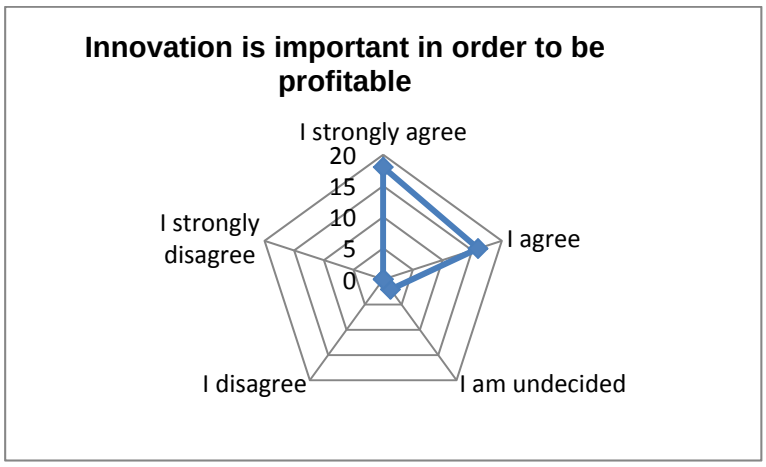


Figure 5.3 B

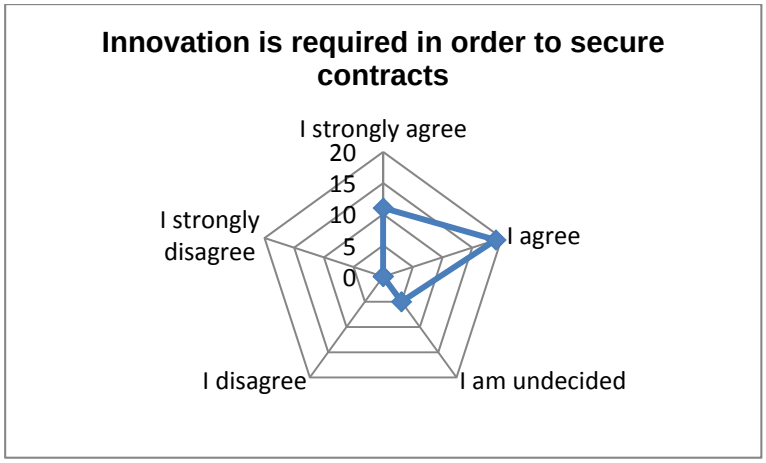


Figure 5.3 C

As can be seen from the radar plots, most of the respondents feel that it is important for a contractor to be innovative. This confirms the preliminary findings, which indicate that a contractor needs to be innovative, not only to survive, but to secure contracts and to be profitable. Being innovative is also seen as beneficial to the reputation of a contractor. The fact that most respondents agree strongly that the contractor must be innovative indicates that there is a perception that there is a strong correlation between levels of innovation in a company and its ability to survive. The tight margins and high levels of competition, which were pointed out during the interviews, seem to necessitate innovativeness among contractors, along with the cost of labour and restrictive labour legislation. This could be seen from the responses to the questions regarding profitability and ability to secure contracts, with which most respondents either agree or strongly agree. Thus, the responses correlate with the findings of Dulaimi et al (2005:566) and of Blayse & Manley (2004:143).

5.3.2. The state of innovation

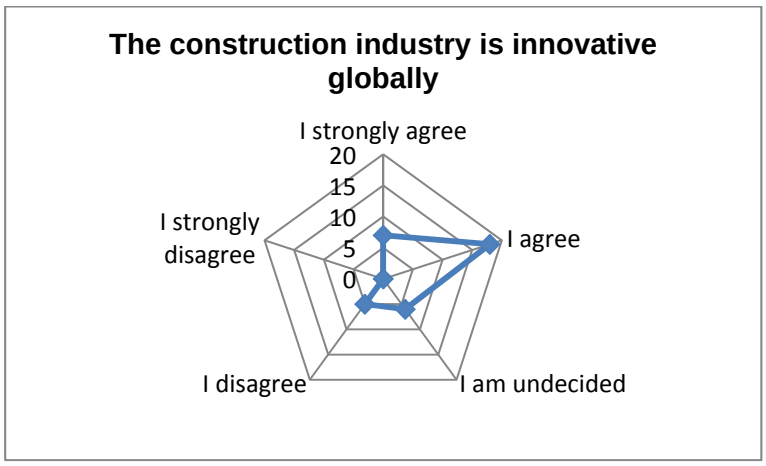


Figure 5.3 D

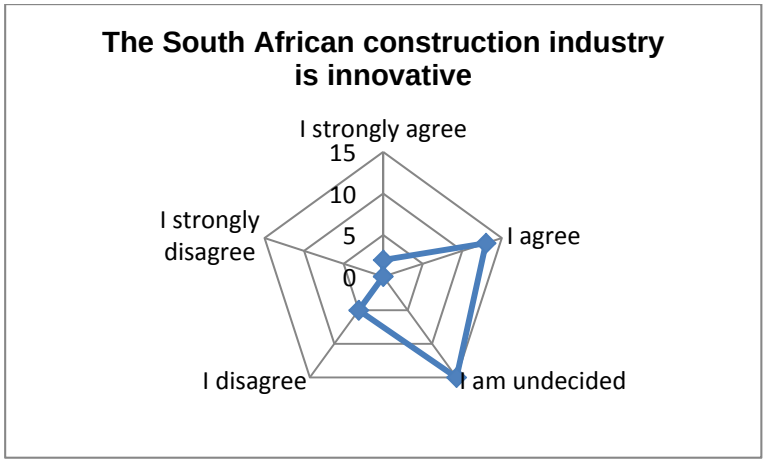


Figure 5.3 E

It is clear that most respondents feel that both the international and South African construction industries are innovative, although the global industry is clearly seen as more innovative than the local industry. Internationally, construction innovation is seen as being hampered by, amongst others, weak collaboration between industry and academics, low levels of investment in R&D and the nature of projects. Some of the reasons noted during the interviews as possible hampering factors to innovation in South Africa include the levels of experience of role-players, insufficient skills and lack of proper training, and procurement strategies. A number of these issues are dealt with later on in the questionnaire.

5.3.3 Types of innovation

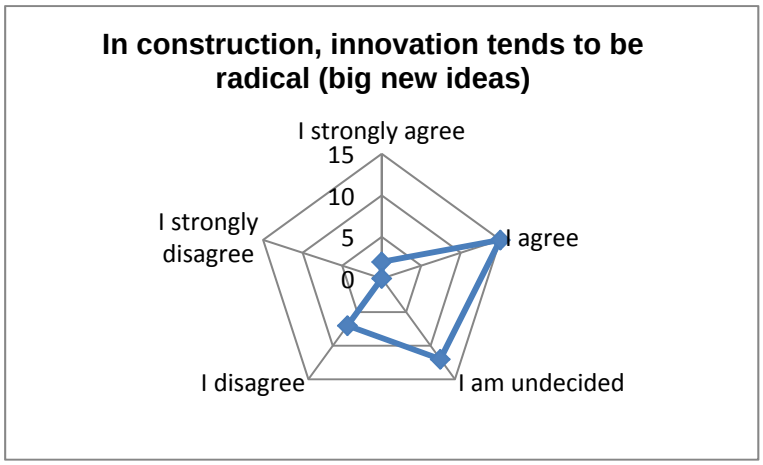


Figure 5.3 F

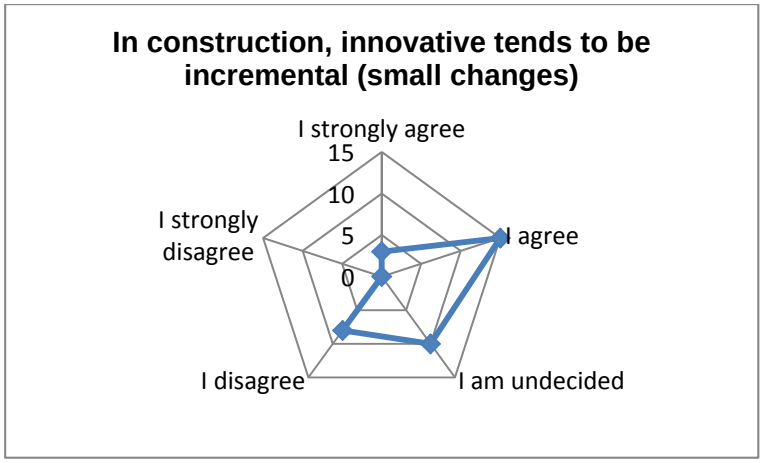


Figure 5.3 G

There is no clear distinction between the types of innovation (radical or incremental) which respondents see most in the industry. This leads one to assume that these occurred more or less in equal measures. If one examines the responses to the questions regarding investment in R&D and collaboration between academics and industry, a possible explanation could be found as to why there are not more innovations. Relatively few respondents feel that there is adequate investment in R&D. Levels of collaboration between academics and industry are also viewed as being low. Thus, these two areas would have to be addressed in order to stimulate innovation in the industry.

5.4 RESEARCH & DEVELOPMENT

5.4.1 R&D in the industry

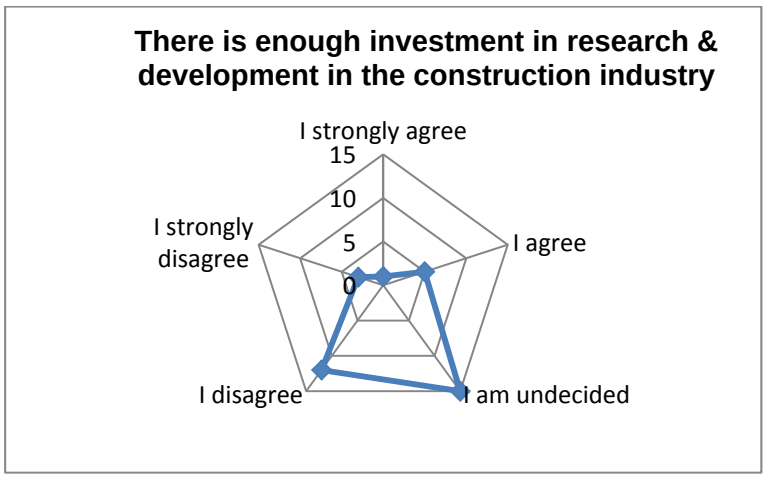


Figure 5.4 A

17% of the respondents feel that there is enough investment in R&D in the construction industry while 42% feel there is not enough investment. Clearly there is room for more investment. The high level of undecided respondents seems to indicate that while most

participants agree that innovation is important, a large number are unsure of the exact level of investment in R&D in the industry.

5.4.2 R&D in companies

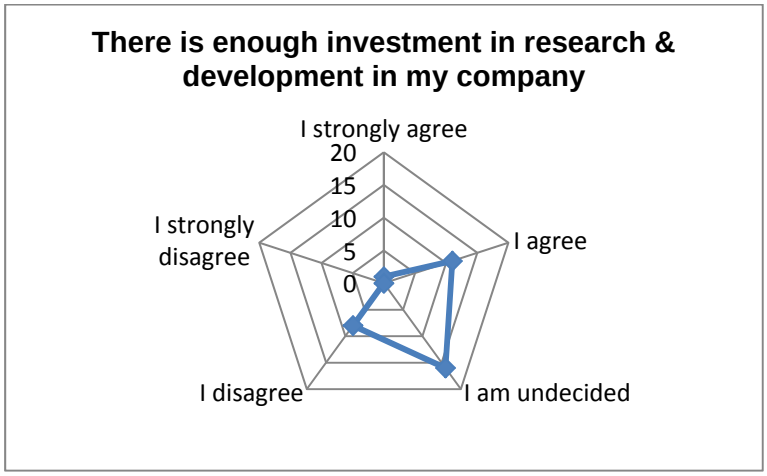


Figure 5.4 B

Respondents are more satisfied with the level of investment in R&D in their own companies, than with that of the industry as a whole, although only 33% are satisfied, while 22% are unsatisfied. This would seem to point to room for improvement.

5.4.3 Collaboration in the industry

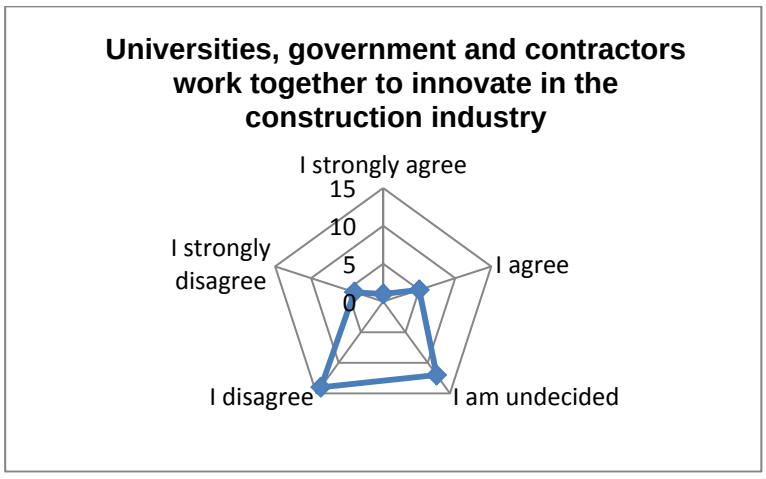


Figure 5.4 C

50% of the respondents feel that there is no cooperation between universities, government and contractors, while only 17% feel that there is cooperation between these bodies. While most companies could not afford to implement large scale R&D initiatives on their own, the ability to find knowledgeable individuals or organisations, such as universities, to partner with, was seen as vital for innovation.

5.5 RELATIONSHIPS IN THE INDUSTRY

5.5.1 The state of relationships in the industry

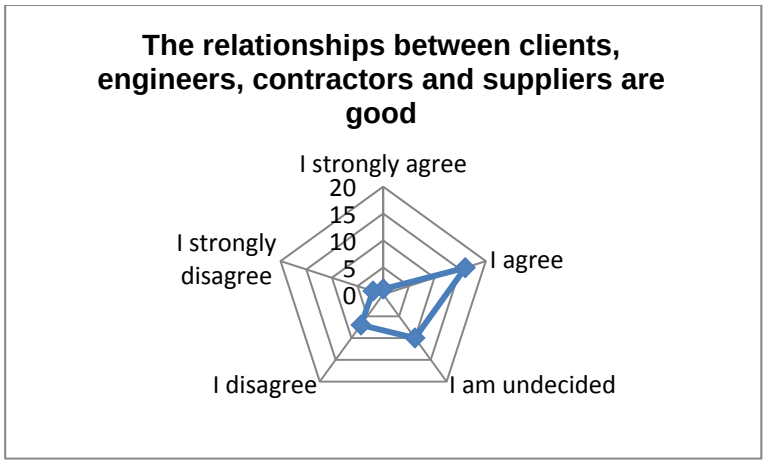


Figure 5.5 A

47% of respondents feel that relationships in the industry are good, while 25% are of the opinion that the relationship is not good. As a certain level of trust needs to exist between role-players and if clients and engineers are to accept proposals for alternatives, this figure, while reasonable, could be higher, which may lead to more innovation.

5.5.2 Trust between role-players

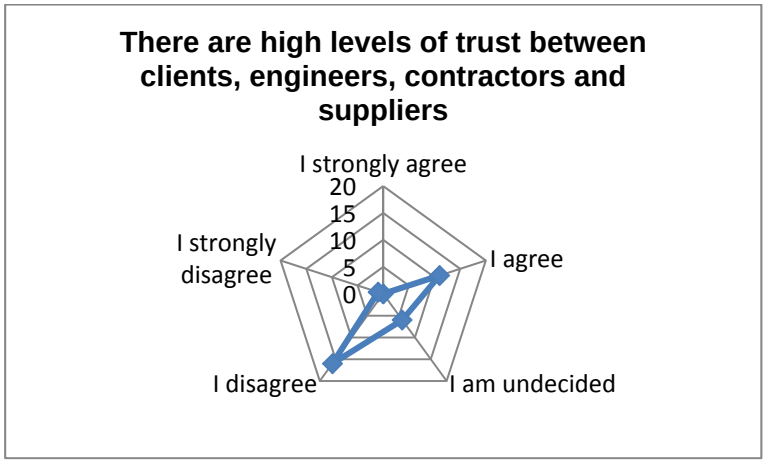


Figure 5.5 B

While 32% feel that there are high levels of trust between the role-players, 50% feel that there are levels of mistrust between the role-players. The link between trust and innovation is deemed important, in the sense that clients and engineers need to trust the contractor, if the contractor is to be considered a partner in the relationship. Only if there are adequate levels of trust between the parties, will contractors feel free to participate fully in the innovation process, and will clients and engineers consider proposed alternatives.

5.5.3 Acceptance of alternative proposals

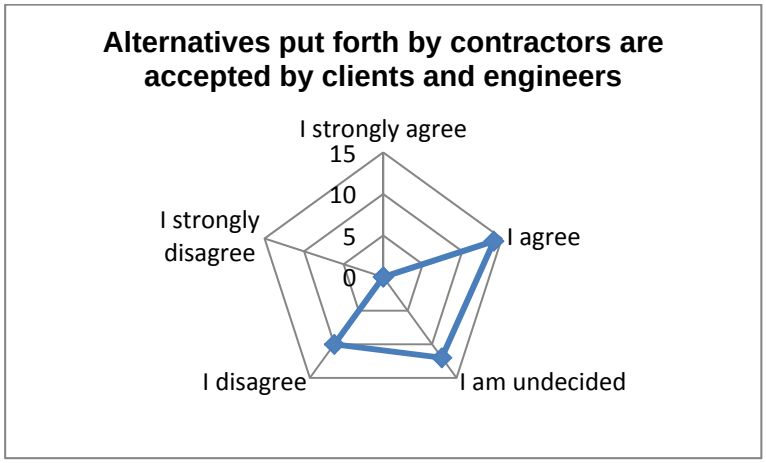


Figure 5.5 C

39% are of the opinion that alternatives which are proposed by contractors are considered, while 28% feel that this is not the case. Again there are some positive signs here, as this seems to indicate that contractors are recognised by engineers and clients as a valuable and knowledgeable partner in the construction process. As contractors are the people working at the coalface, they are often in a good position to contribute positively. If their inputs are recognised and valued, innovation could be boosted. The fact that the alternatives put forward by contractors are considered also seems to indicate a certain level of maturity among engineers and clients, which bodes well for future projects.

5.5.4 The role of attitude of key individuals

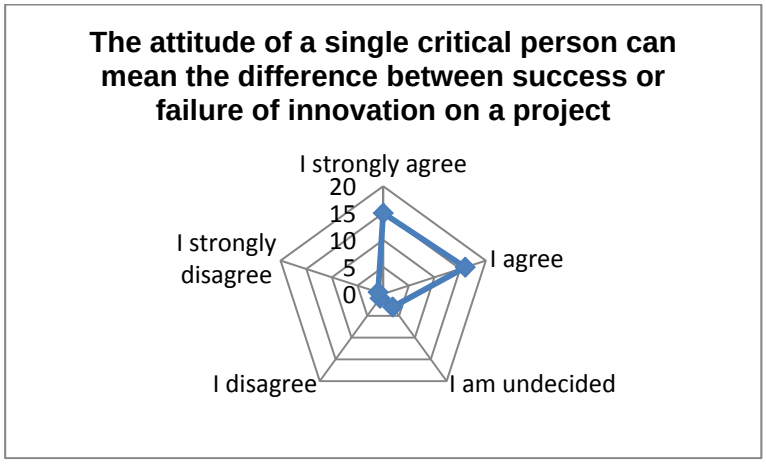


Figure 5.5 D

86% of respondents agree that the attitude of critical role-players is important for innovation to succeed. This is perhaps one of the most difficult problems to solve on construction projects, as it is not always easy to predict what a specific person's reaction and behaviour will be in any given situation. While people are often deployed or appointed for a specific

project based on their technical competencies, it seems that in fact their attitudes and behaviour play at least as important a part in the success of innovation on a project. In recent years a number of companies have started to include psychological evaluation and other initiatives which do not focus solely on the technical abilities of employees, as a prerequisite for choosing participants on projects. The responses to this question seem to indicate that a lot more emphasis should be placed on this aspect in order to ensure success.

5.5.5 The importance of people vs. the form of contract

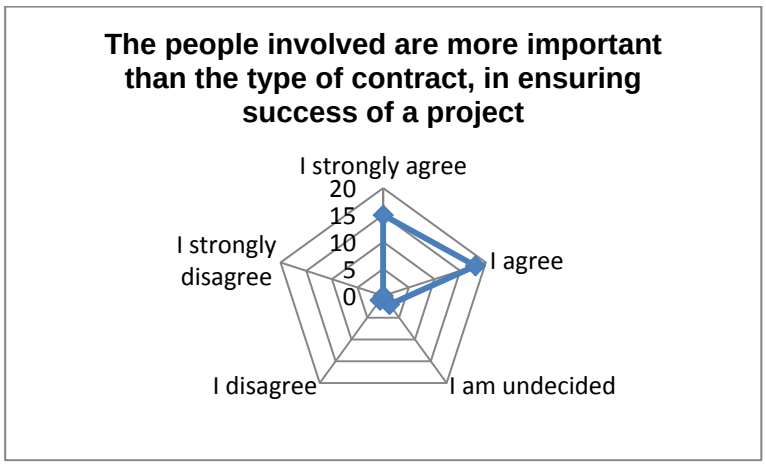


Figure 5.5 E

92% of the respondents feel that the people involved in a construction project are more important than the type of contract in securing the success of a project. This correlates well with the response to the previous question, although it places the focus not only on the role of key individuals, but on entire teams. This question is included in the questionnaire and as mentioned during the interviews, the personal style which participants in a project display is very important in determining the way in which certain key decisions will be affected and which could influence innovation. It is believed that by adhering strictly to the letter of the contract but by neglecting personal relationships, a very clinical culture could be established, which is not always advantageous. The response to the question seems to confirm this.

5.6 DISTRIBUTION OF RISK

5.6.1 The relative distribution of risk in a construction project

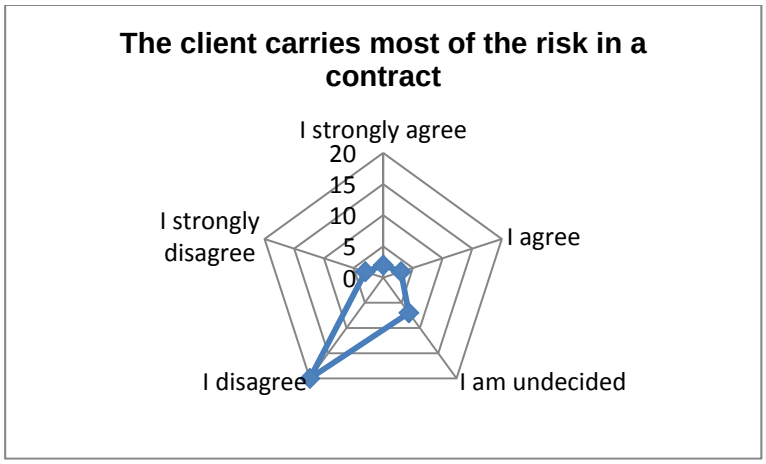


Figure 5.6 A

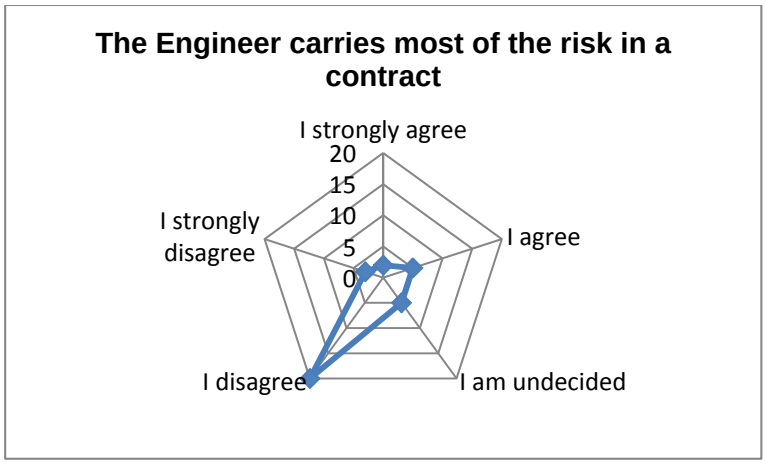


Figure 5.6 B

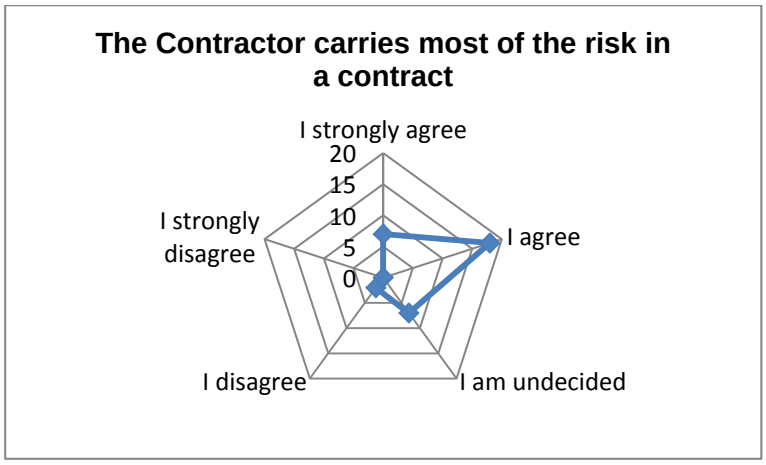


Figure 5.6 C

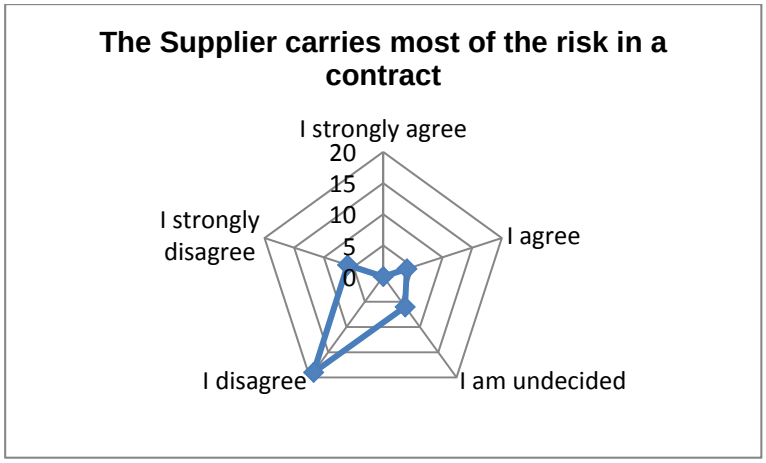


Figure 5.6 D

Although not stated outright in the interview question, the form of contract plays a significant role in the distribution of risk. The question did not distinguish between various contract types, and thus dealt with contracts in general. Fourteen per cent of the respondents feel that the client carries most of the risk, as opposed to 20% who feel that the engineer carries most of the risk, 74% who feel the contractor carries most of the risk, and 11% who feel that the supplier carries most of the risk. Clearly most of the respondents feel that the contractor bears the brunt of the risk. There may be some bias, although there appears to be some truth in this. Because the contractor is relatively low down in the supply chain, and in most forms of tender has very little input in the design, site selection or even wording of the contract document, the contractor is often forced to price a tender with a number of assumptions and uncertainties. Due to the high levels of competition and low margins in the industry, contractors are often hesitant to include too many provisions when tendering. By pricing in all the unknowns, contractors often lose out on tenders and thus they are reluctant to do so. If one considers the responses to the questions regarding the roles of individuals on projects, it seems clear that a contractor deals with a large number of unknowns when tendering for a project, and would probably never secure a contract if he has to make provision for all the unknowns in a tender price. It was noted during the interviews that, once a tender has been awarded to a contractor, and the contractor realises that some of the unexpected risks are playing out there are not many avenues available to the contractor to resolve the problem. Most forms of contract would force the contractor to claim for additional time and costs. While this is the norm, it is also frowned upon by many clients, who may label the contractor as “claim-prone” and thus prevent the contractor from securing follow-on contracts from that specific client. It is noted that some of the other approaches to projects, such as design and build, would ensure a better distribution of the risk among the role players.

The responses to the questions seem to indicate that a contractor has to be very innovative to survive, and indeed thrive, in this risky, uncertain environment. At the same time, if some of the risk and uncertainty could be absorbed by some of the other participants, the contractor could potentially contribute more to innovation. For instance, if the contractor could be brought in earlier in the process to give timeous inputs on certain aspects, this may result in less risk to the contractor, while at the same time culminating in more innovative designs and construction methods.

5.7 TENDER PROCESSES

5.7.1 Current procurement practices of clients

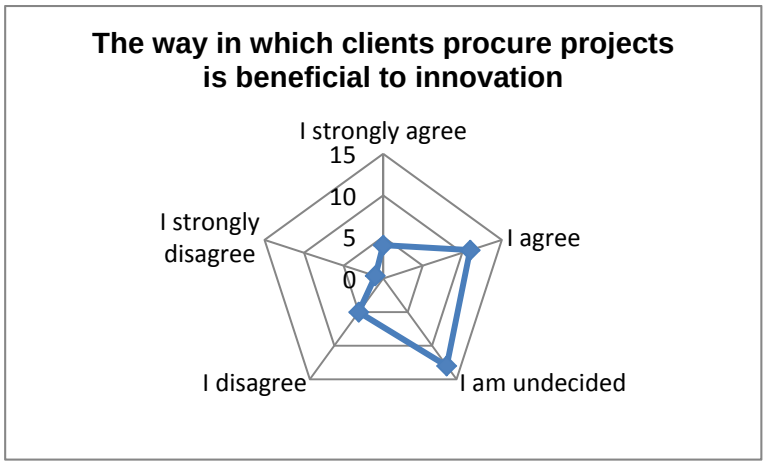


Figure 5.7 A

Fourty four per cent agree that the way in which clients procure projects is beneficial to innovation, while 18% feel that it is not. By considering the responses to the next three questions, it seems that most respondents feel that progress has been made regarding the way contracts are procured, and that innovation does benefit from procurement practices. This is an encouraging sign, although it contradicts some of the earlier findings.

5.7.2 The role of competitive tendering in innovation

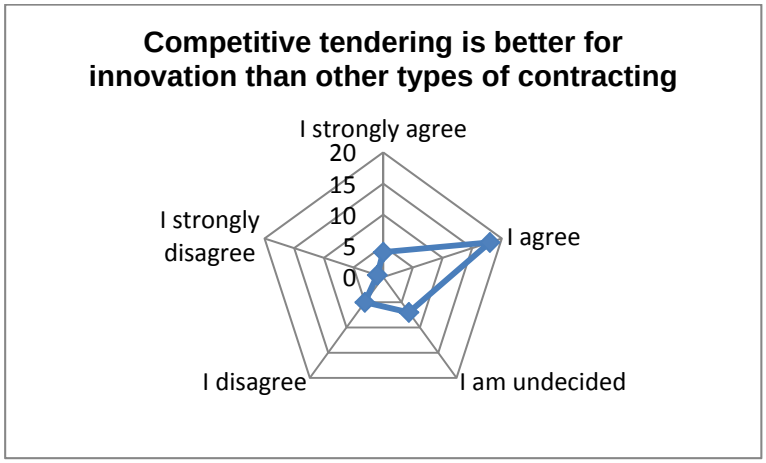


Figure 5.7 B

63% of respondents agree that competitive tendering is beneficial to innovation, as opposed to 17% who disagree. Although the literature seems to indicate that long-term relationships may be more beneficial for innovation than competitive tendering (Blayse & Manley, 2004:143; Steward & Fenn, 2006:177; Manley et al, 2009:772), it would seem that respondents are of the opinion that there is a place for competition as well. It seemed as if the market does reward those companies who manage to convert innovative ideas into more competitive practices.

5.7.3 Contractor involvement in design

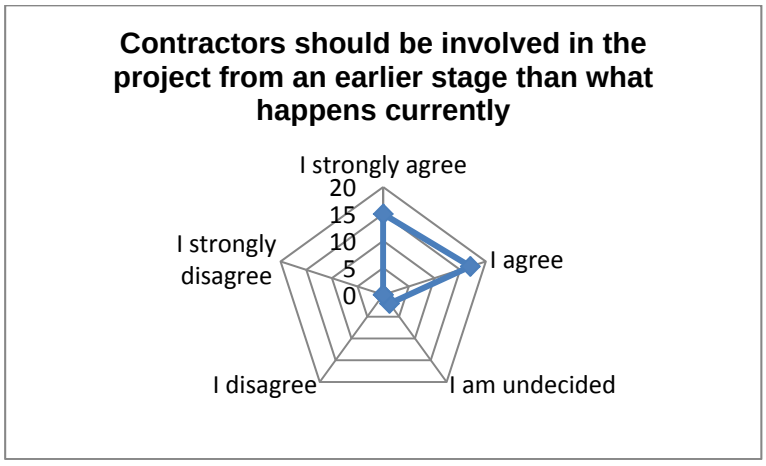


Figure 5.7 C

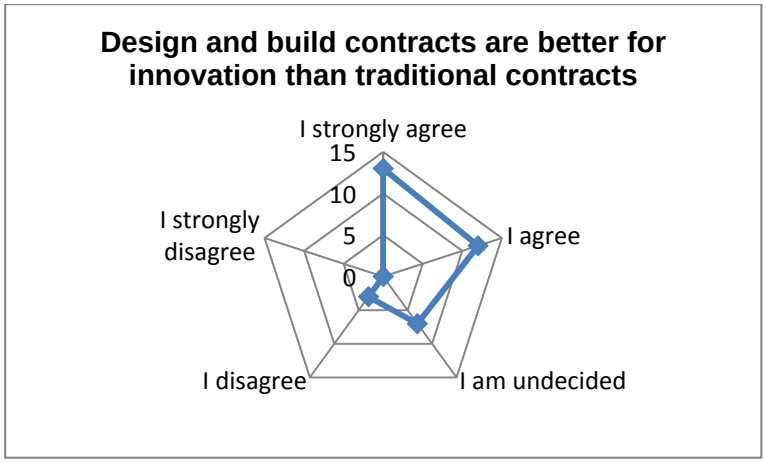


Figure 5.7 D

94% of respondents feel that contractors should be involved from the early stages of a project, while 71% feel that design and built contracts are better for innovation than traditional contracts. Both of these questions focus on involving the contractor in the design and decision-making process. Contractors offer a different perspective, specifically regarding constructability, and thus it makes sense that involving contractors during the design phase would result in easier construct, as well as more economical designs. By making the contractor a partner rather than an adversary through the use of design and build partnerships, greater levels of trust and collaboration could be established. Often this form of contract assists in ensuring knowledge sharing and capturing across the various disciplines, which also makes innovation easier.

5.7.4 The innovation history of contractors as tender criterion

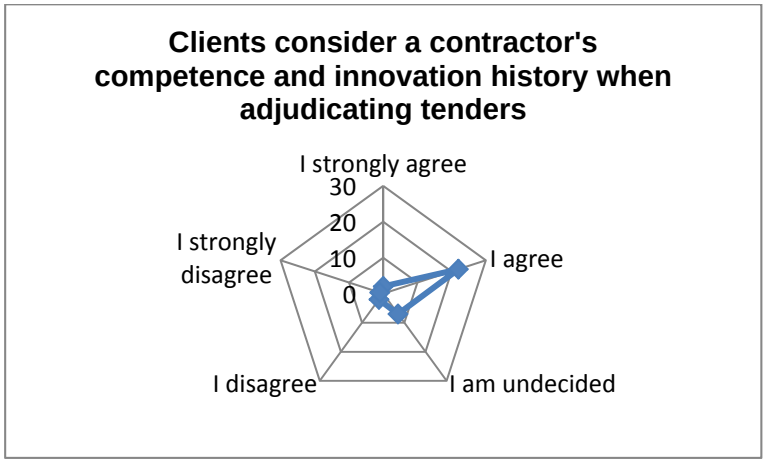


Figure 5.7 E

Seventy one per cent of respondents agree that clients consider a contractor's innovation history when adjudicating tenders. As this practice means that clients do not focus solely on price or potential schedule implications, the responses to this question are encouraging. By looking at the past performance of contractors, and even specific individuals, clients could

assist innovation. As noted before, placing too much emphasis on price at the cost of other constraints allows unscrupulous “cowboys” to outbid competent and ethical contractors, thereby stifling innovation. It is, therefore, vital that clients realise that the innovation history of contractors is an important determinant of future success.

5.8 THE CULTURE OF VARIOUS ROLE PLAYERS IN INNOVATION

5.8.1 The level of conservatism of role-players

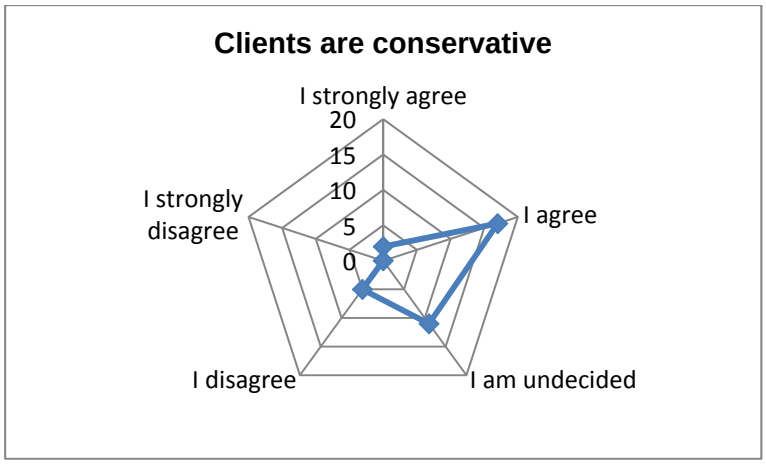


Figure 5.8 A

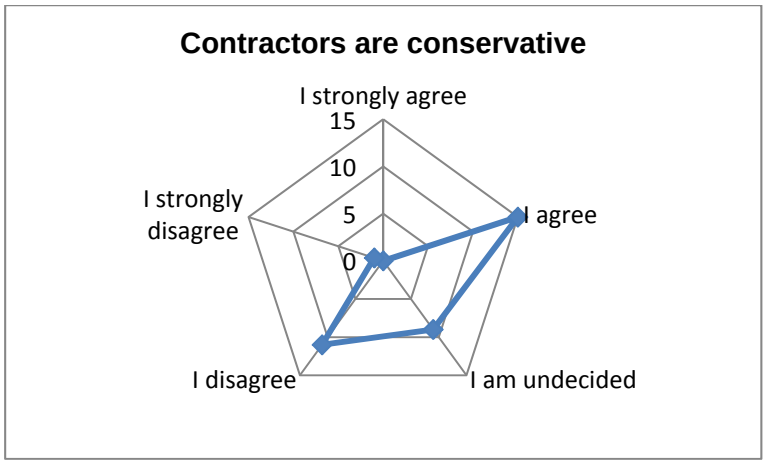


Figure 5.8 B

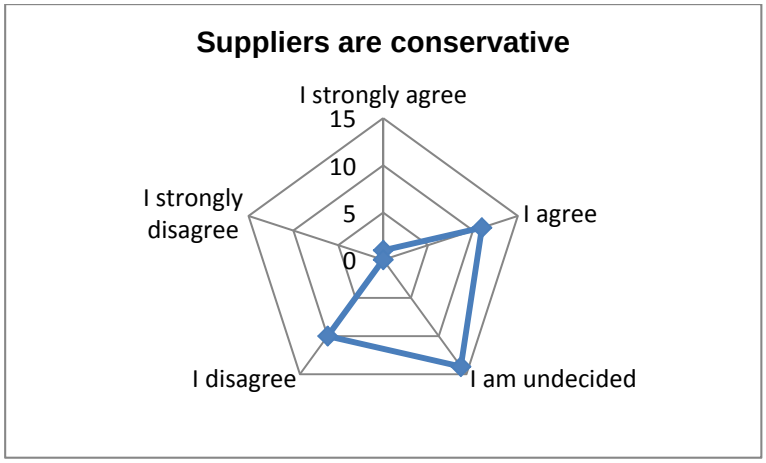


Figure 5.8 C

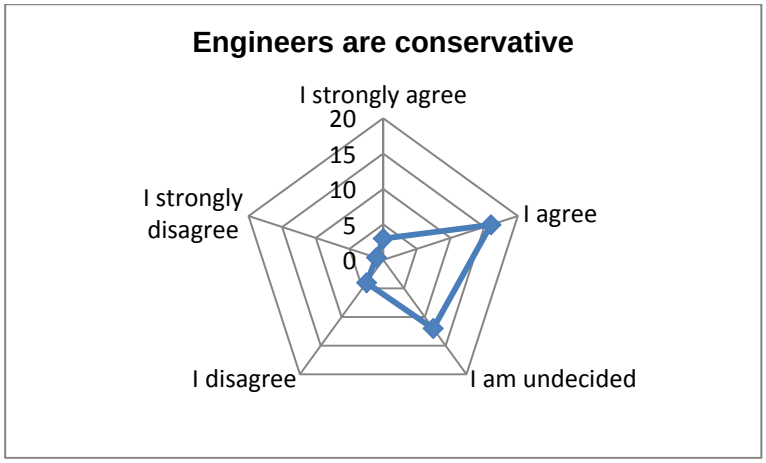


Figure 5.8 D

Fifty four per cent of respondents are of the opinion that clients are conservative, as opposed to 14% who feel that they are not. 42% feel that contractors are conservative, while 33% feel that they are not. 53% feel that engineers are conservative while 14% disagree. 33% feel that suppliers are conservative, while 28% disagree. It would thus seem that suppliers are the least conservative, followed by contractors, with clients and engineers being the most conservative. This would seem to indicate that the lower down an entity is in the supply chain, the less conservative it becomes. This may not be a matter of choice, but of necessity. Clients are the ones who initiate a project, prescribing the standards and rules, as well as stipulating the required outcomes. They have to fund the project, and as such are responsible for sourcing the funding and ultimately ensuring that the project is delivered within certain parameters. Generally, clients would not have as much experience as, for instance, contractor or suppliers. Therefore, clients may be more prone to being conservative. Engineers have reputations and legal as well as professional liability to consider when deciding on certain design aspects. Therefore, they may also be prone to being conservative. On the other hand, contractors and suppliers have to compete in a market with relatively low entry barriers, low margins, and high degrees of competition. The

cyclical nature of the industry also means that contractors have to be able to survive boom as well as lean periods. This means that contractors and suppliers have to be less conservative, often having to think out of the box and take risks in order to secure work and to survive. Being less conservative often means that these parties are more open to innovation.

5.8.2 Levels of innovation of role-players

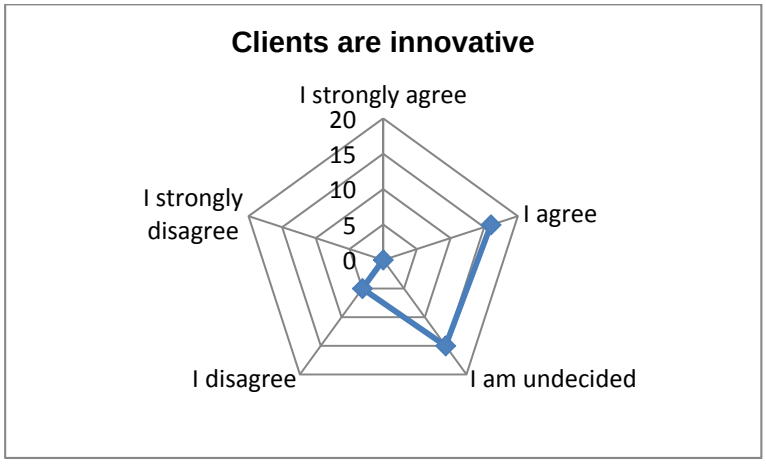


Figure 5.8 E

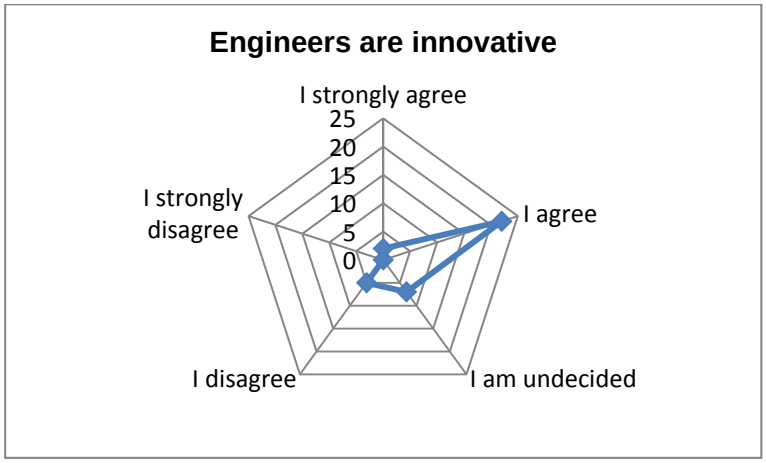


Figure 5.8 F

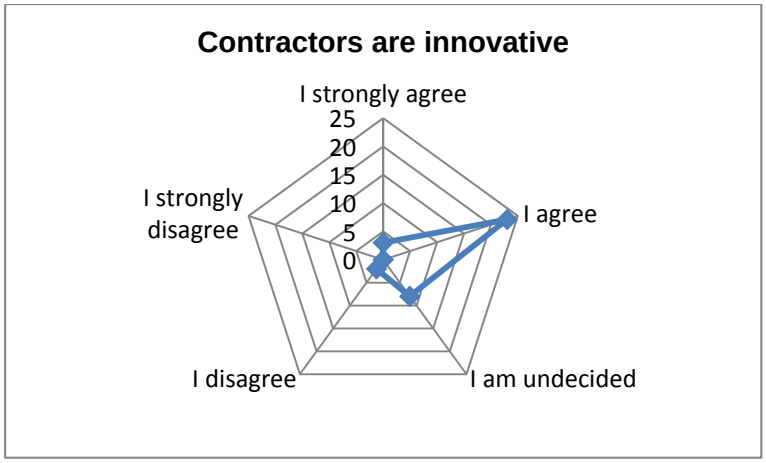


Figure 5.8 G

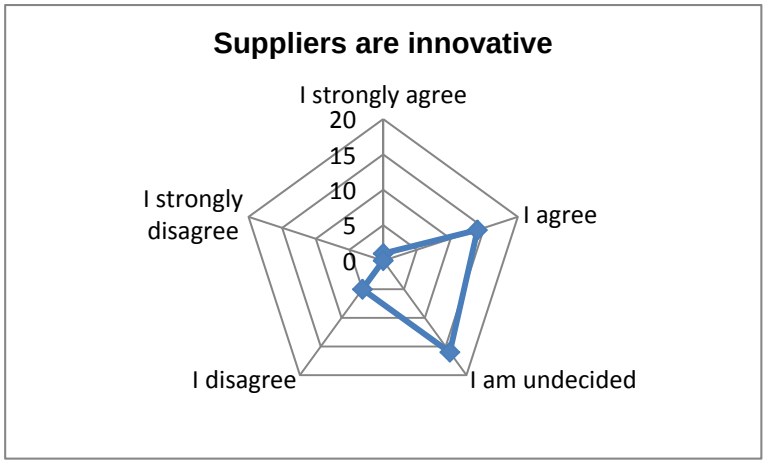


Figure 5.8 H

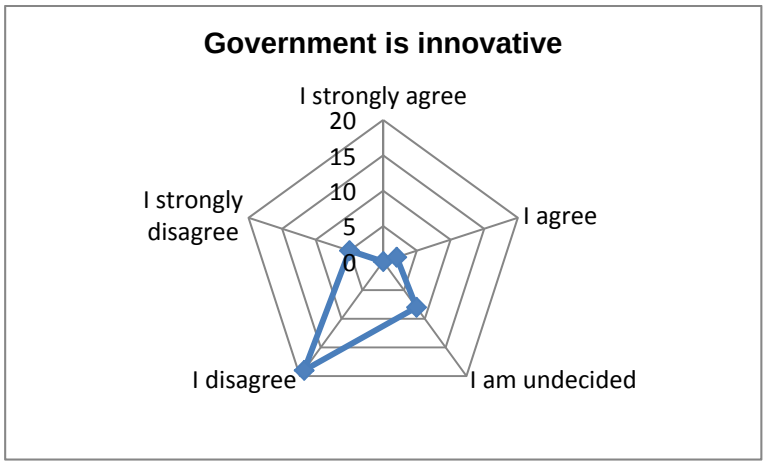


Figure 5.8 I

44% feel clients are innovative, 67% feel engineers are innovative, 72% feel contractors are innovative, 42% feel suppliers are innovative and 6% feel government is innovative. Government is thus clearly considered the least innovative, followed by suppliers and clients, then engineers, with contractors being considered the most innovative. Surprisingly, engineers, although considered risk averse, are seen as reasonably innovative. Perhaps this could be attributed to the fact that, even when engineers incorporate new technology or

methodologies in their designs, they could mostly ensure that risks are kept to a minimum with regards to the structural integrity of the design. If certain unforeseen events occur due to the nature of the design, it would mostly be related to the constructability, which would impact on the contractor or client. Thus, engineers could afford to incorporate innovative ideas while maintaining a low level of risk. Engineers are also motivated to incorporate new technology in designs, in order to promote their reputation and standing in the community.

The notion that government is not innovative correlates well with the findings of the interviews. Government is viewed by many of the interviewees as being too focused on price and other goals, such as Broad Based Black Economic Empowerment (BBBEE) in its procurement rules, which means that it does not consider the ability of contractors or engineers to innovate when appointing these parties. As a legislator, government is also accused of not promoting innovation through labour and other legislation. It is also thought that government should perhaps play a bigger role in setting up artisan training schemes and ensure that secondary and tertiary education standards comply with international norms.

With clients and suppliers falling short of the 50% approval rating on innovativeness, there is clearly some work to be done by these parties. Clients could perhaps consider alternative tendering procedures, and ensure that they consider the innovation history of prospective contractors. They should also ensure that they are not too prescriptive in their construction methods, but rather focus on the outcomes. Suppliers, although they are mentioned in the literature as being in a better position to invest in R&D due to the more stable operating environment than contractors, also operate in a very competitive market, with many competitors and high degrees of specialisation. Most suppliers seem to focus on incremental innovation, with the occasional radical innovation coming through.

5.8.3 The role of clients in innovation

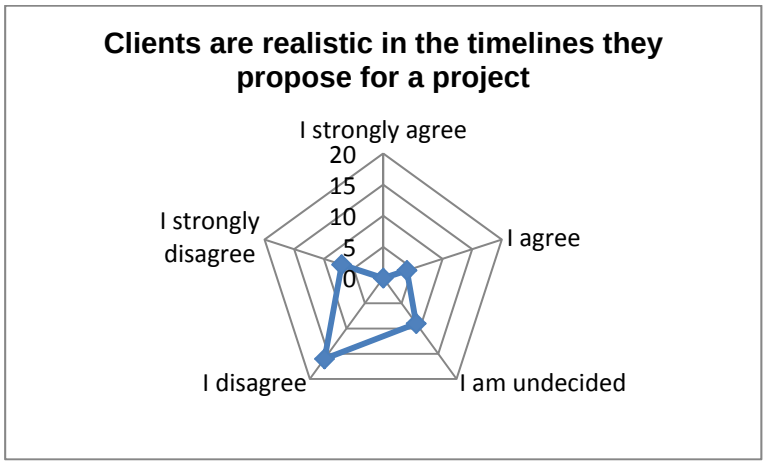


Figure 5.8 J

64% feel that clients are unrealistic in the timelines they propose for projects. This is a very important determinant of the success of a project. While pressure to adhere to tight timeframes would force contractors to be innovative in order to meet the objectives, it may also hamper innovation. If contractors are under time pressure from the early stages of a project, they may not have adequate time to investigate alternative methods and products. The contractor's ability to adequately plan would also be negatively affected. On top of this, clients may not consider alternatives put forward by contractors, which may have resulted in cost and time savings, or even delivery of a better end product, because too much time may be spent investigating the alternatives. If clients are too unrealistic in their proposed timelines, it may result in responsible contractors not tendering, or putting in very high tenders, which may lead to less knowledgeable or less reputable contractors being awarded the contract. The outcome would almost inevitably be that there would be less innovation on the project, along with a general loss of trust between all parties involved. This may negatively affect the approach of the client towards future projects.

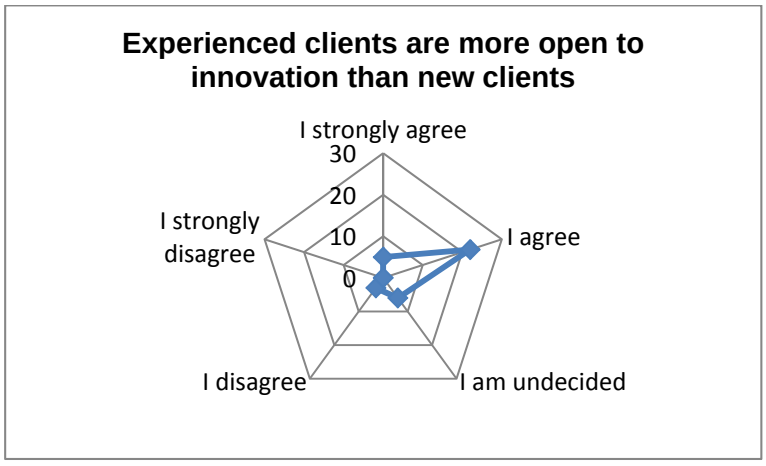


Figure 5.8 K

75% of the respondents feel that experienced clients are more open to innovation than new clients. Although it was mentioned in the interviews that experienced clients may be rigid due to their having developed very strict rules and specifications over many projects, it seems that contractors prefer working for experienced clients.

5.8.4 Levels of knowledge among role-players

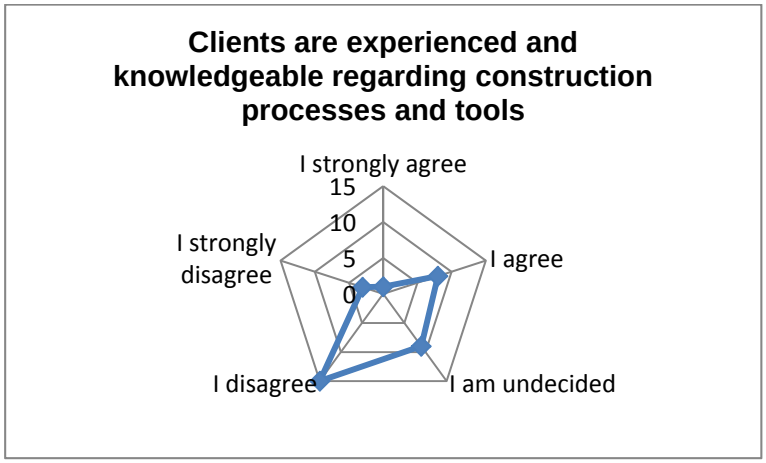


Figure 5.8 L

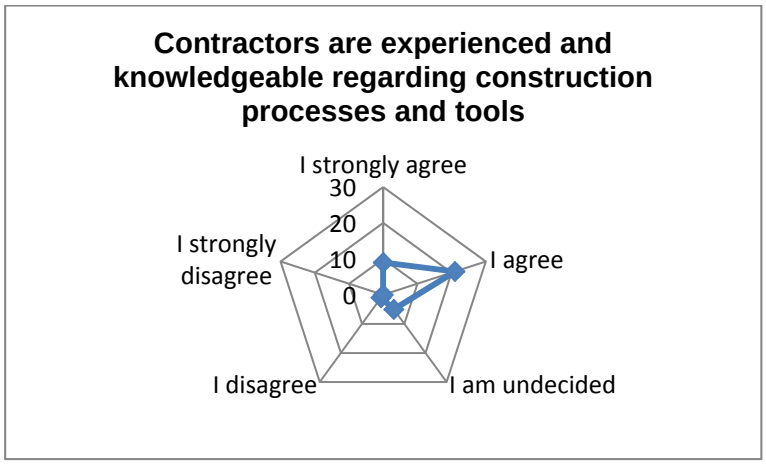


Figure 5.8 M

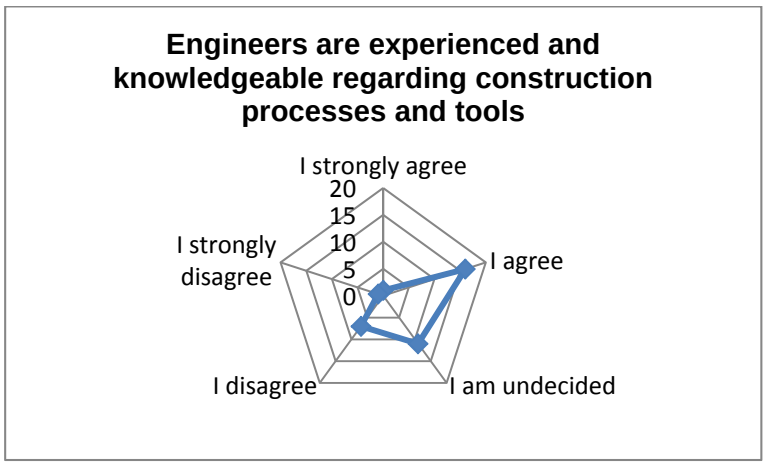


Figure 5.8 N

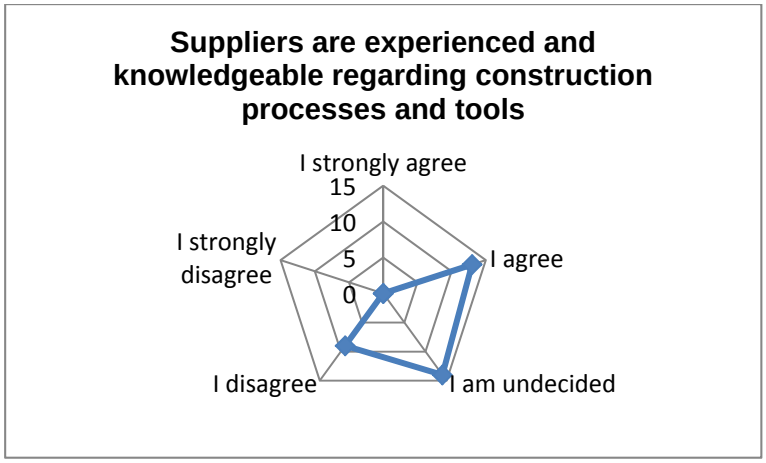


Figure 5.8 O

50% feel that clients are not experienced and knowledgeable regarding construction processes and tools, as opposed to 25% who feel they are. 83% feel that contractors are experienced and knowledgeable. 47% feel engineers are experienced as opposed to 22% who feel that they are not. 36% feel suppliers are experienced, as opposed to 25% who do not agree. Thus, contractors are considered the most experienced, followed by clients and engineers, with suppliers being the least experienced. As the question revolves around experience and knowledge regarding construction processes and tools, one might have expected contractors to be the most experienced as they work directly with the tools and carry out the physical work. However, it was mentioned during the interviews that, due to the high demands and stress levels, a large number of people eventually migrate out of contracting, electing to become engineers, clients or even suppliers. This would account, to a degree, for the relatively high level of knowledge of processes and tools amongst clients and engineers. It bodes well for the industry that clients and engineers are seen as having a relatively high level of knowledge, as it is crucial for these parties to understand the requirements and constraints experienced by contractors. While engineers are responsible for designing workable solutions, clients should be realistic in their expectations relating to structures, finishes and timelines, not to mention costs. Perhaps suppliers do not have to be as knowledgeable about all types of tools and processes, due to the high degree of specialisation amongst suppliers. One would, however, expect suppliers of products and tools to be very knowledgeable regarding the specific tools or products which they sell, as they are often responsible for training and convincing the contractor, engineer and client regarding the advantages of using specific tools, products and techniques.

5.9 STANDARDS AND PROCEDURES

5.9.1 Role of standards in restricting innovation

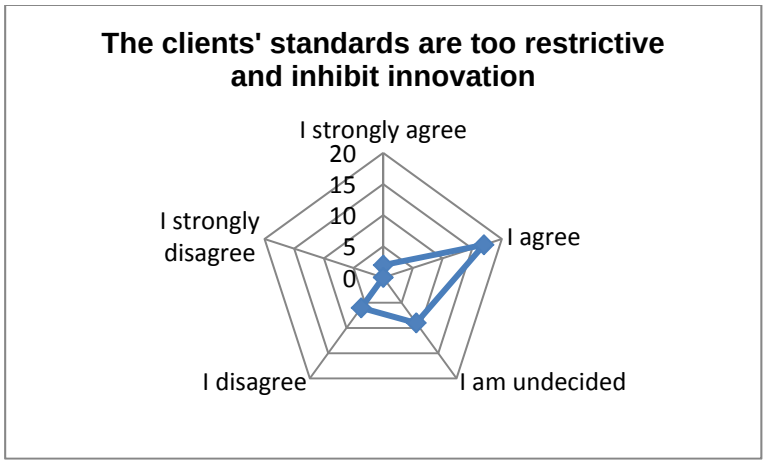


Figure 5.9 A

56% feel that standards inhibit innovation as opposed to 18% who disagree. While interviewees and participants in the focus group pointed out that standards are important in as much as they inform the contractor of the expected outcome and assist during tender and construction phases, it was pointed out that there is a fine line between being too prescriptive and not giving enough guidance. There is no denying that a project could not function in the absence of norms and standards. However, clients and engineers should be careful not to be too prescriptive, to such a degree that contractors lose the ability to innovate. Standards should also be reviewed and updated regularly, as these should keep abreast of technological advances as well as new knowledge stemming from research.

5.9.2 Type of standards which aids innovation

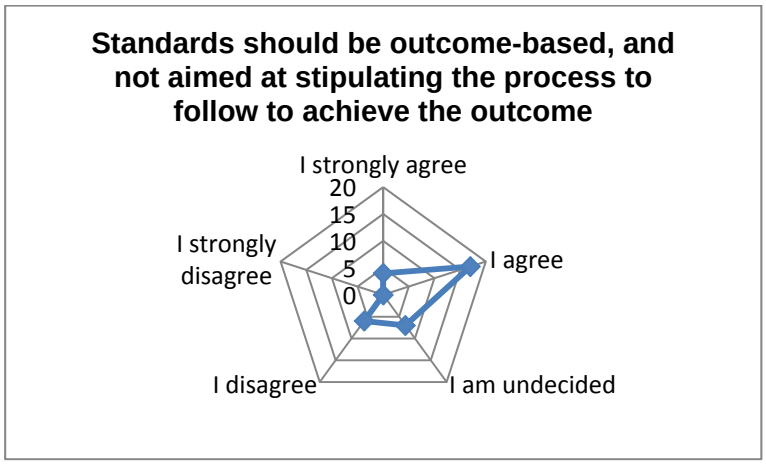


Figure 5.9 B

62% feel that standards should be outcome-based, as opposed to 18% who feel it should not. There seems to be a trend to focus overtly on the processes followed to achieve a specific outcome, rather than concentrating on the eventual outcome. In this way, the ability to innovate is negatively affected, in that it is difficult to go against the prescriptive standards and norms.

5.9.3 Role of administrative requirements in hampering innovation

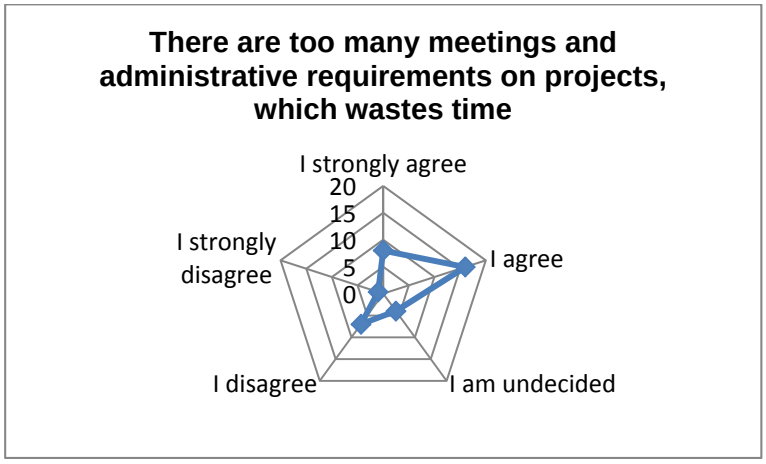


Figure 5.9 C

67% of participants feel that time is being wasted by too many administrative duties and meetings, as opposed to 22% who do not agree. This point was raised during the interviews as a result of participants feeling that the expectations of clients regarding the number of meetings to be attended, is inordinate. The administrative burden placed on contractors, especially those working on mines, due to requirements of the clients and the Mine Health and Safety Act is also said to be a potential hindrance to innovation. Due to the perceived lack of skilled and experienced employees on site, it is noted that senior personnel are relied on to innovate, while at the same time being involved across the spectrum in functions on site. This means that senior personnel become pressed for time and are not able to allocate sufficient time to knowledge management, effective communication and innovation.

5.10 SKILLS AND EXPERIENCE IN THE CONSTRUCTION INDUSTRY

5.10.1 The level of skills in government and private clients

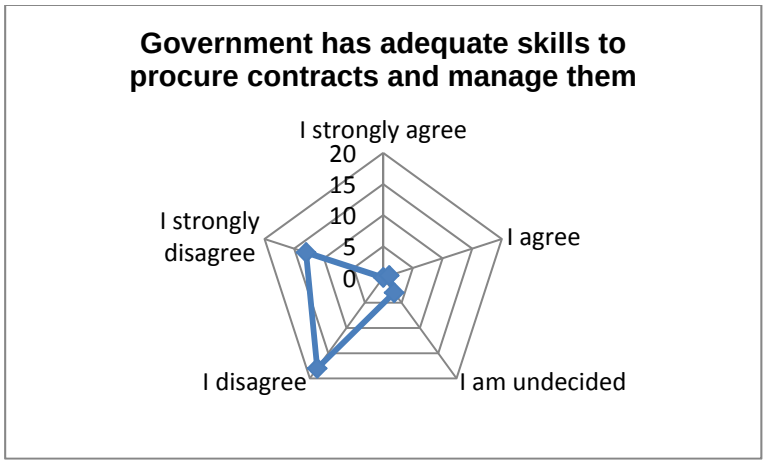


Figure 5.10 A

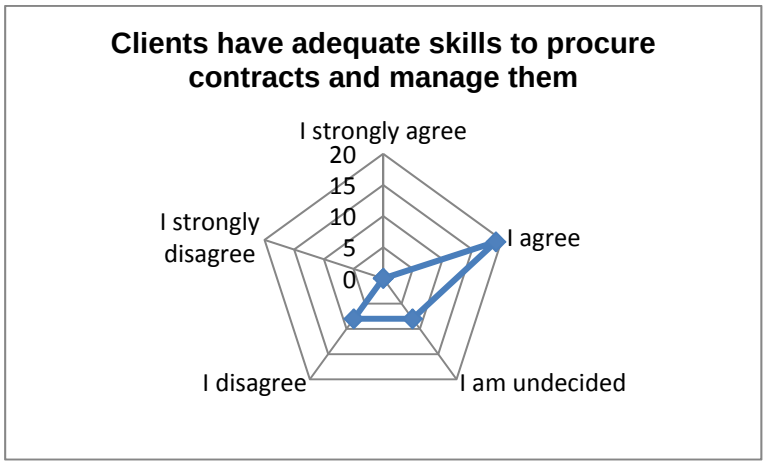


Figure 5.10 B

89% of respondents feel that government does not have enough skills to procure and manage contracts, while 54% feel that clients have these skills, as opposed to 23% who feel that clients do not have enough skills. There is thus a marked perceived difference between the skill sets of private sector clients and their public sector counterparts.

5.10.2 Levels of skills amongst engineers and suppliers

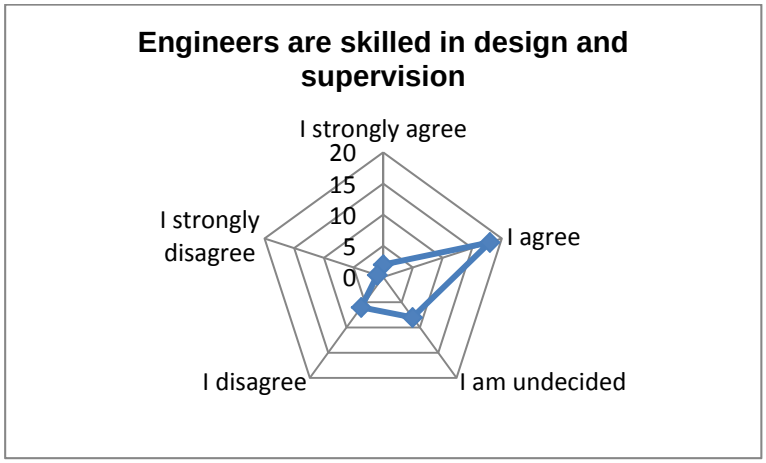


Figure 5.10 C

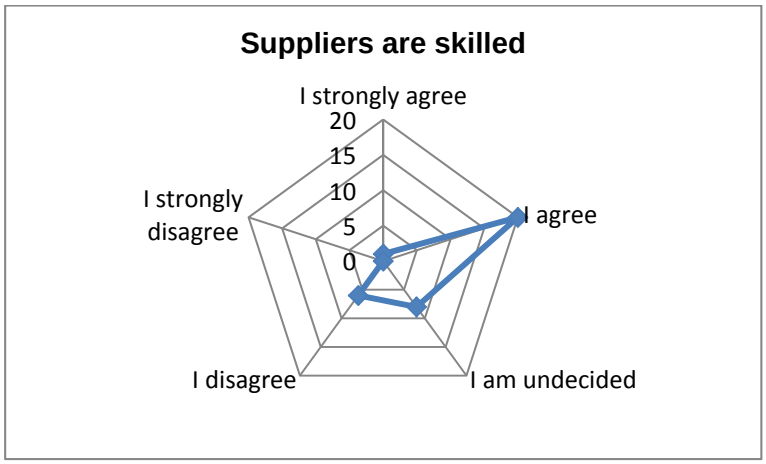


Figure 5.10 D

57% of respondents feel that engineers are skilled, 20% disagree. 60% feel suppliers are skilled, 17% disagree. This is a positive sign, although it also correlates with the 31% of respondents who feel that tertiary education of engineers and technicians are not on par with the rest of the world.

5.10.3 Levels of skill of contractors

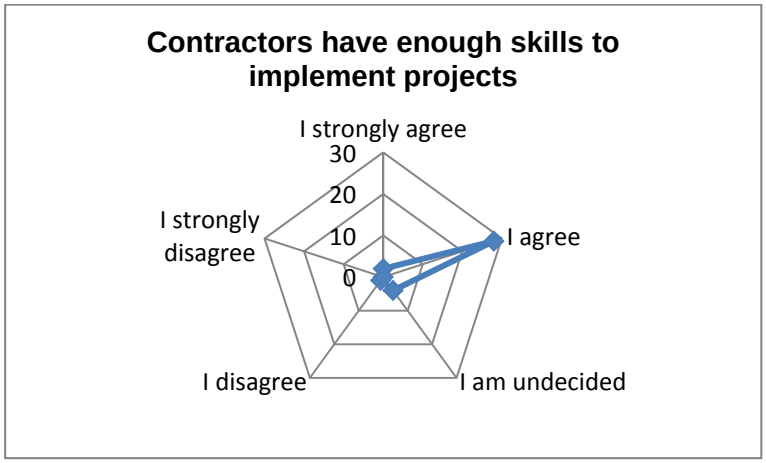


Figure 5.10 E

86% of respondents feel that contractors have enough skills to implement projects. This high rate may be a bit biased, but it indicates that contractors feel that there are still adequately experienced and suitably qualified personnel in the industry to complete projects successfully.

5.10.4 Adequacy of numbers of engineers and artisans

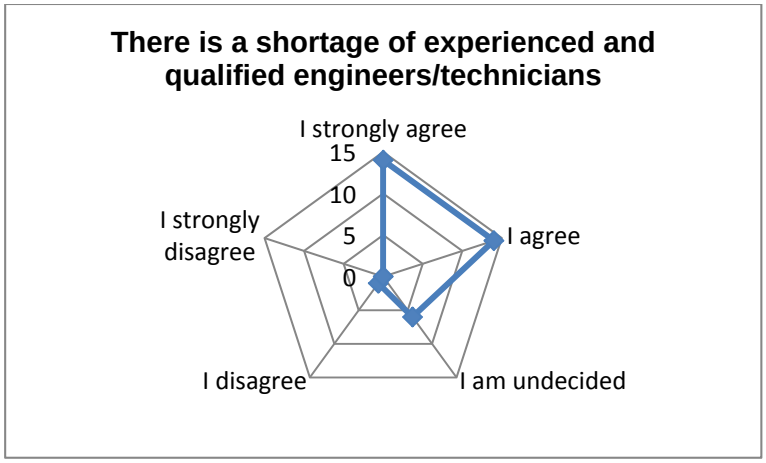


Figure 5.10 F

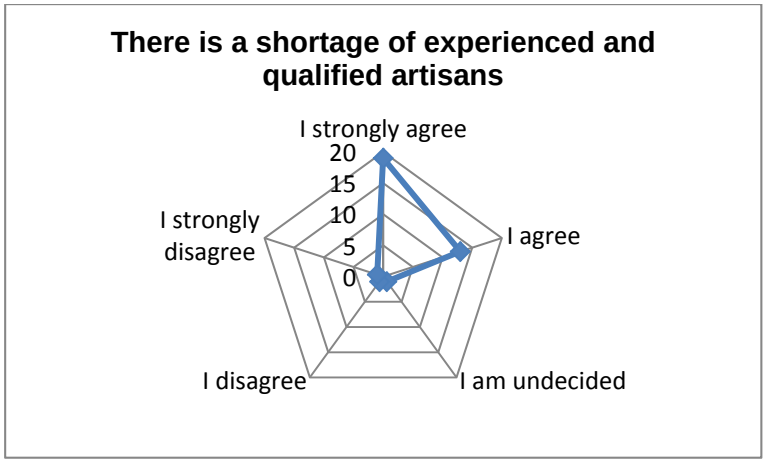


Figure 5.10 G

80% of respondents agree there is a shortage of experienced technicians and engineers. This correlates with 92% who feel that there are not enough experienced and qualified artisans.

5.10.5 Number of skilled people in organisations

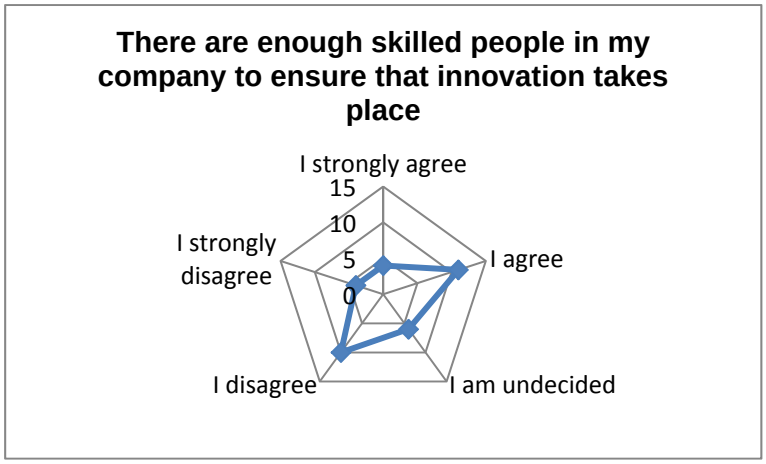


Figure 5.10 H

Respondents are almost equally divided over whether there are enough skilled people in their company to innovate. Obviously this is less than ideal, as one would have hoped that most companies would have enough skilled people to innovate. However, it was pointed out during the interviews that the lack of proper skills at the artisan and ganger level means that everyone has to take a step back in order to fill this gap. This means that foremen have to do artisans' work; technicians have to do foremen's work; engineers have to do technicians' work, and so on. This means that less time is available to do proper planning and to implement innovative systems and methods. Legislation regarding training, as well as lack of direction from government, is blamed partially for this problem. Labour laws, and particularly the strong onus on local employment, are blamed for the inability to transfer skills adequately, as semi-skilled workers cannot be transferred to subsequent projects, resulting

in unskilled people having to be trained at each new project, resulting in the skills never being properly transferred.

5.10.6 The role of labour laws in restricting innovation

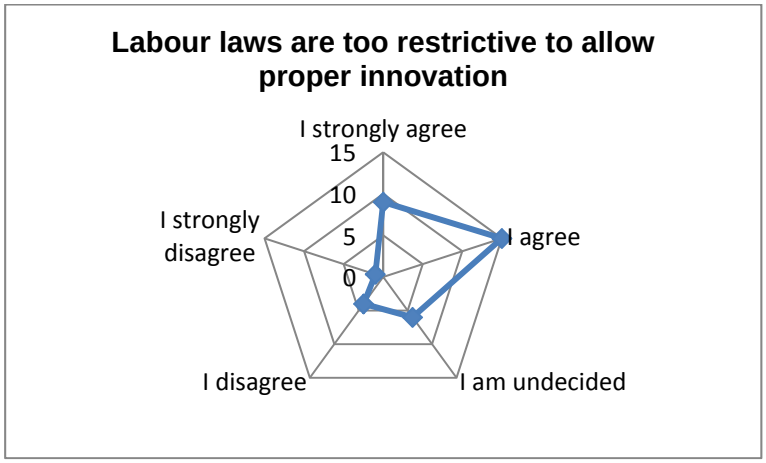


Figure 5.10 I

69% of respondents feel that labour laws are too restrictive and only 14% are of the opinion that they are not. As mentioned above, particularly the inability to transfer semi-skilled labour to new projects due to local labour requirements means that some skills are never properly transferred. The relative difficulty of dismissing underperforming personnel also means that companies are reluctant to take on apprentices, as it is perceived as being difficult to dismiss underperforming apprentices. Thus, it is perceived that current labour laws and practices play a role in preventing proper transfer of knowledge, which is required for innovation.

5.11 EDUCATION AND TRAINING

5.11.1 The standard of training at universities

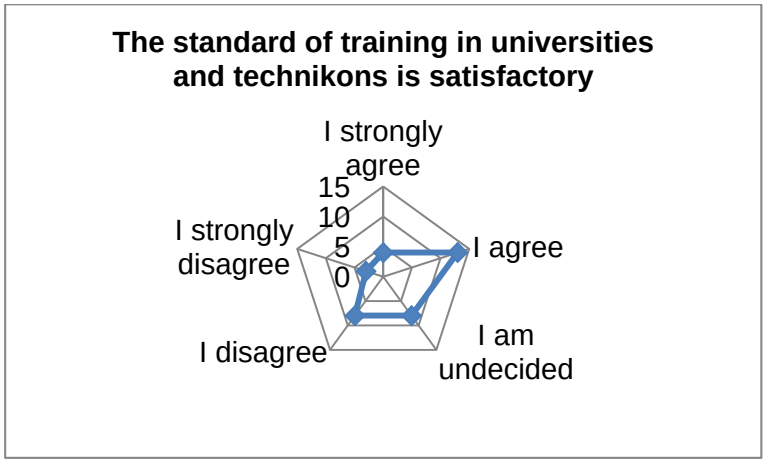


Figure 5.11 A

47% are satisfied with the standard of training at universities and technikons, while 31% are not. While it should be acknowledged that not all universities and technikons are equal, it is worrying that only 47% of participants are satisfied with the standard of training at these institutions. It was stated that the training at tertiary level is too theoretical.

5.11.2 The standard of artisan training

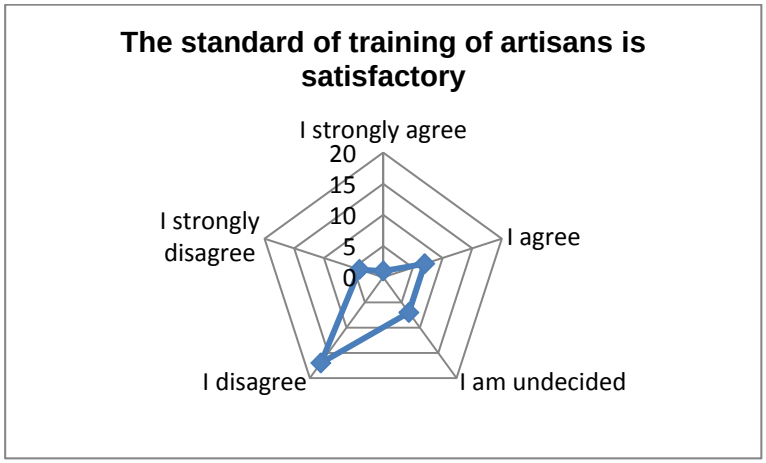
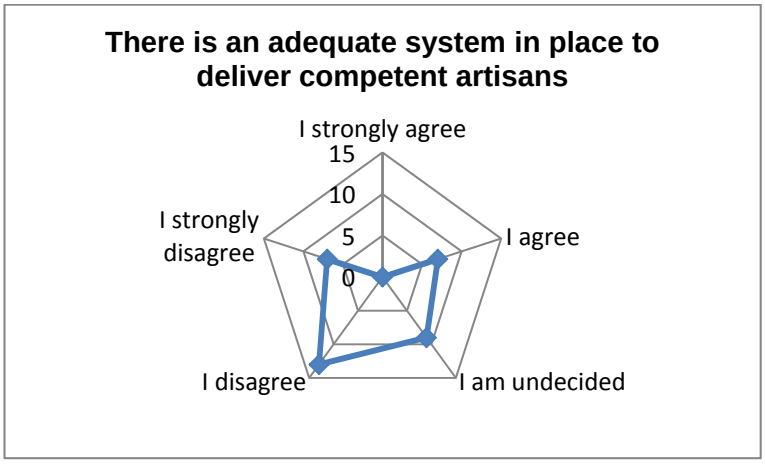


Figure 5.11 B

22% are satisfied with the standard of training of artisans, while 58% are not. It was pointed out on several occasions during the interviews and focus group that the standard of training of artisans has deteriorated over the years.

5.11.3 The system to train artisans



. **Figure 5.11 C**

19% of respondents agree that the system to deliver competent artisans is adequate, while 56% disagree. There appears to be widespread misunderstanding of the current system. Companies seem reluctant to invest in long-term training schemes, despite the possibility of getting rebates from government for doing so. It is alleged that restrictive labour laws, which

do not contribute to an environment where underperformers could be dismissed, is partially to blame. It is understood that in the past para-statals such as the Railways, Eskom and other bodies were responsible for large numbers of artisans through proper artisan training schemes, while these bodies have to a large extent halted their involvement in artisan training. The culture in the country, where physical labour is no longer preferred, also contributes to a lack of interest in artisan training. The general opinion seems to be that government and the private sector would have to collaborate if the situation is to be reversed.

5.11.4 Investment in training by companies

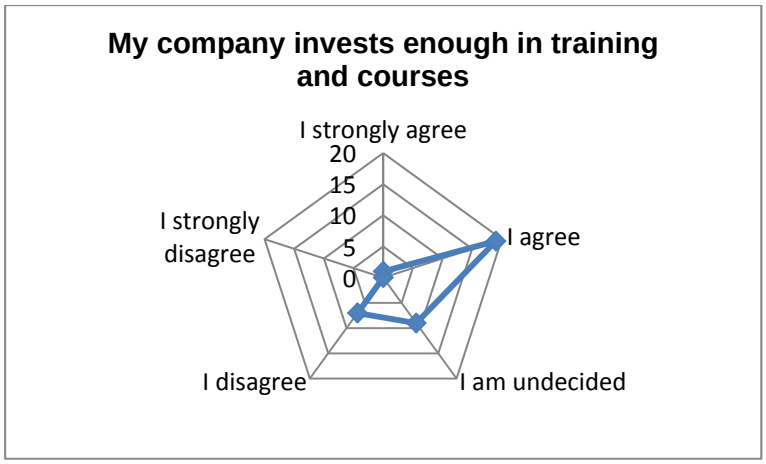


Figure 5.11 D

56% feel that their company invests enough in training, while 19% are not satisfied. This is encouraging, as investment in continuing education and training is viewed by most as pertinent if the industry is to be innovative.

5.12 KNOWLEDGE MANAGEMENT AND INNOVATION SYSTEMS

5.12.1 Prevalence of systems in companies

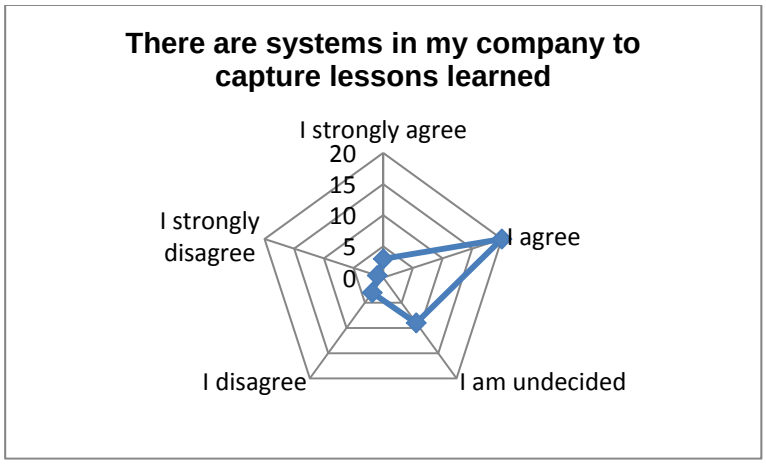


Figure 5.12 A

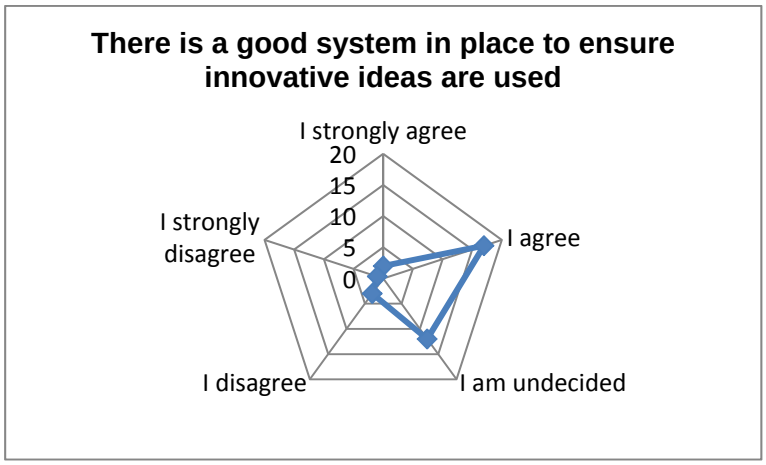


Figure 5.12 B

64% have systems in place to capture lessons learned, while 54% have systems in place to ensure that innovative ideas are used. This relatively high percentage indicates that contractors realise that in order to be competitive, they need to ensure that knowledge is managed, especially due to the project-based and fragmented nature of construction. It is also vital to ensure that innovative practices are communicated effectively. To this end most companies have either electronic or manual systems, or both, in place to ensure that innovative ideas are captured and re-used across various projects.

5.12.2 Incentive schemes to aid innovation

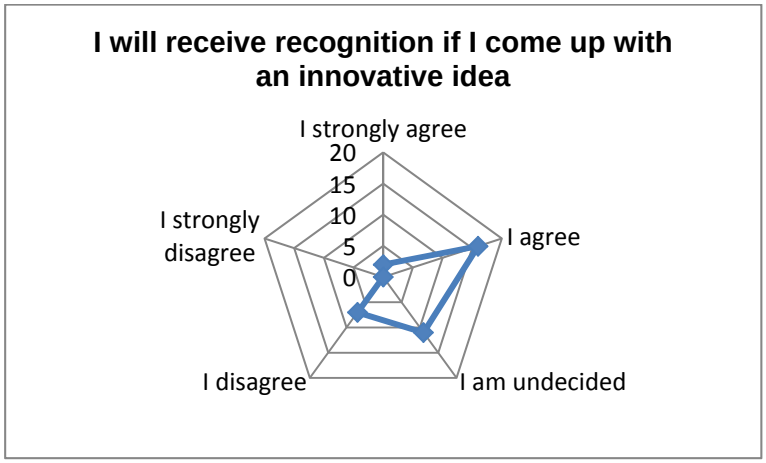


Figure 5.12 C

50% of respondents feel that they would get recognition if they come up with an innovative idea, while 19% say they would not.

5.12.3 The prevalence of innovation champions and formal systems

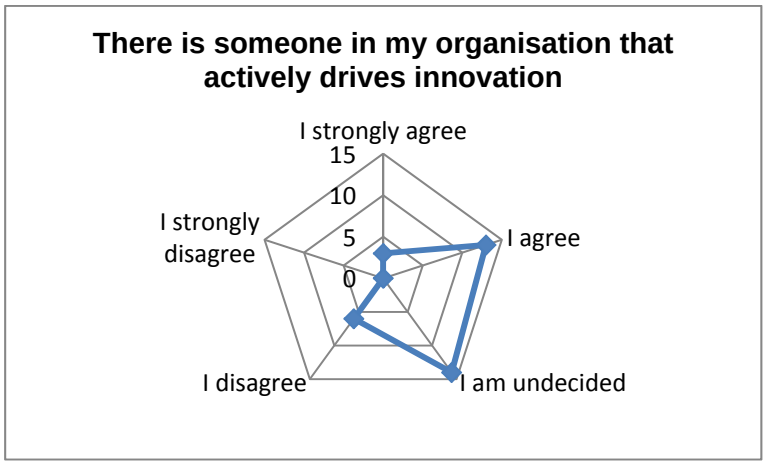


Figure 5.12 D

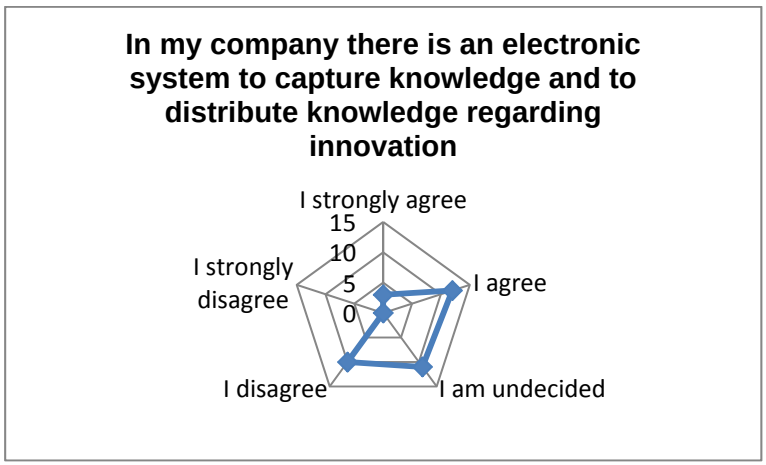


Figure 5.12 E

44% of respondents note that there are innovation champions in their organisations, as opposed to 17% who do not have these. 42% have electronic innovation systems in place, while 28% do not. The two statistics correlate very closely, and seem to indicate that knowledge champions in organisations realise the requirement for a system to capture and distribute knowledge.

5.12.4 The availability of experts

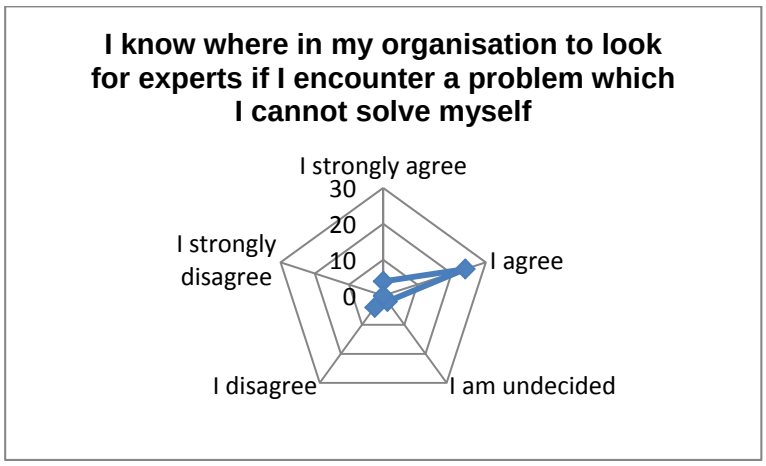


Figure 5.12 F

82% of respondents know where in their organisation to contact experts. This very high rate bodes well for contractors. By being able to locate keepers of knowledge easily, effort and time to reinvent the wheel are saved, which means that problems could be solved quicker than would be the case if individuals had to solve problems on their own. By making electronic databases of details of relevant knowledgeable individuals available throughout the organisation, companies can ensure that the minimum time is wasted in looking for the relevant experts. If certain key competencies are not available in a specific organisation, external experts should also be available to consult.

5.13 ORGANISATIONAL CULTURE

5.13.1 Openness of culture

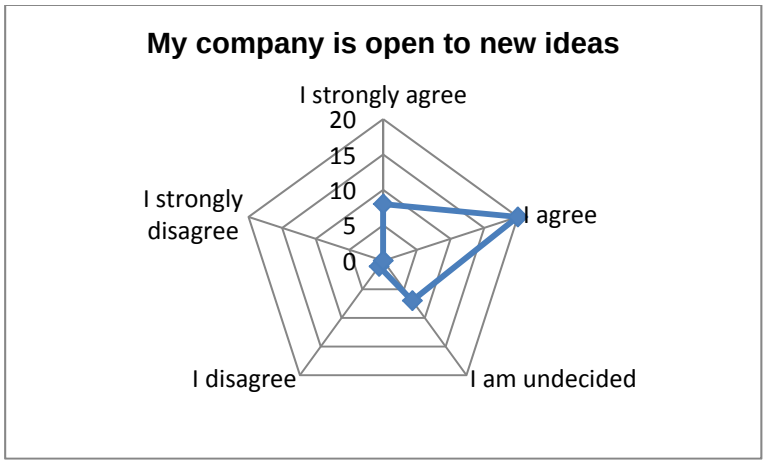


Figure 5.13 A

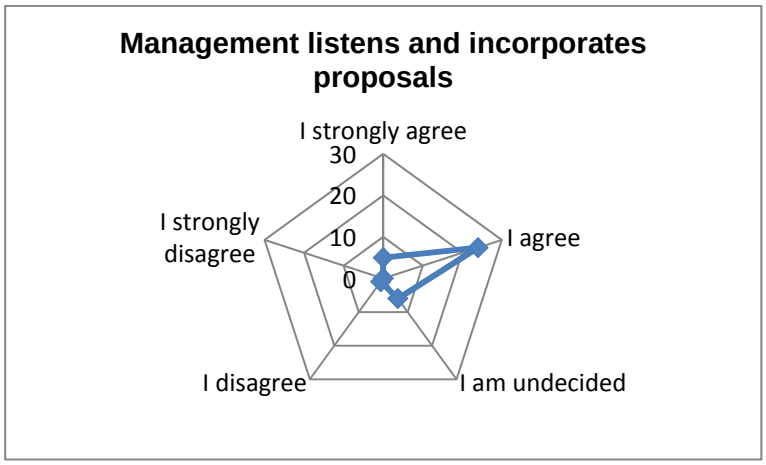


Figure 5.13 B

78% feel that their company is open to new ideas, and 81% are of the opinion that management listens and incorporates proposals. These are both very positive statistics, as it indicates that contractors have managed to create a generally open and innovative culture. Perhaps this was born from necessity, but it is nevertheless a good sign.

5.13.2 Ability of a company to make employees feel part of the organisation

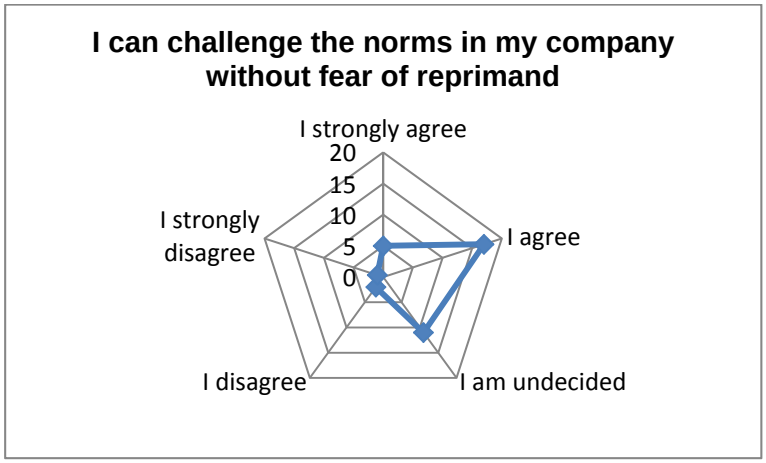


Figure 5.13 C

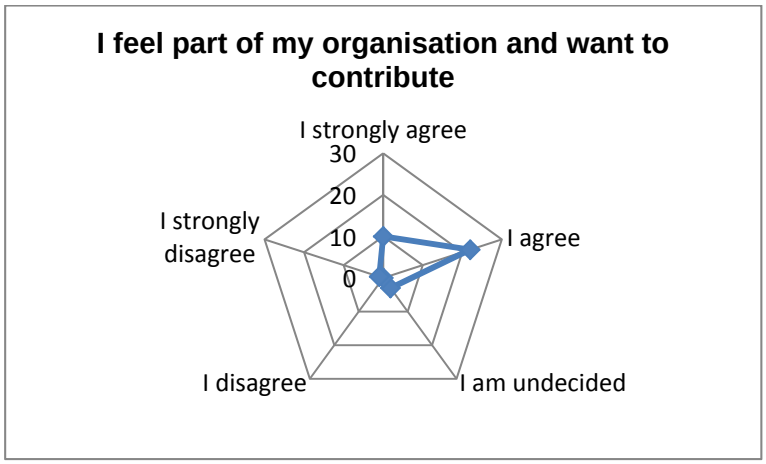


Figure 5.13 D

61% feel that they can challenge the norms without fear of reprimand as opposed to 3% who feel that they cannot. 89% feel part of the organisation and want to contribute. Rules and procedures are essential in any organisation, but only as long as they are open to criticism and change. If employees do not feel that they can effect change through positive suggestions, there is a strong possibility that they would stop participating, which would in all likelihood result in sub-par performance of the contractor.

5.13.3 Ethics

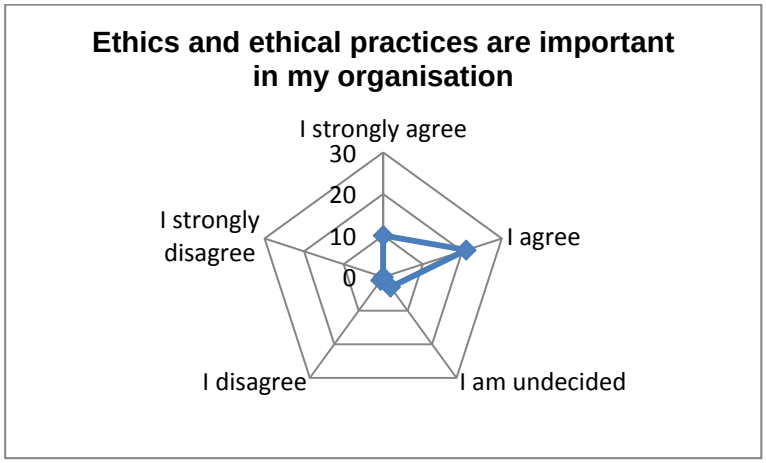


Figure 5.13 E

89% of respondents feel that ethics are important in their organisation. It was pointed out in the literature review that a strong correlation exists between employees' perception of the ethical standards of a company, and the employee's commitment to the company. This is reinforced by the findings of this study which found alignment between these two factors. By removing the barriers which prevent people from wanting to share knowledge and take initiative, a company could lay the foundation upon which a truly innovative organisation could be built.

5.14 GOVERNMENT'S ROLE

5.14.1 Governments role in training

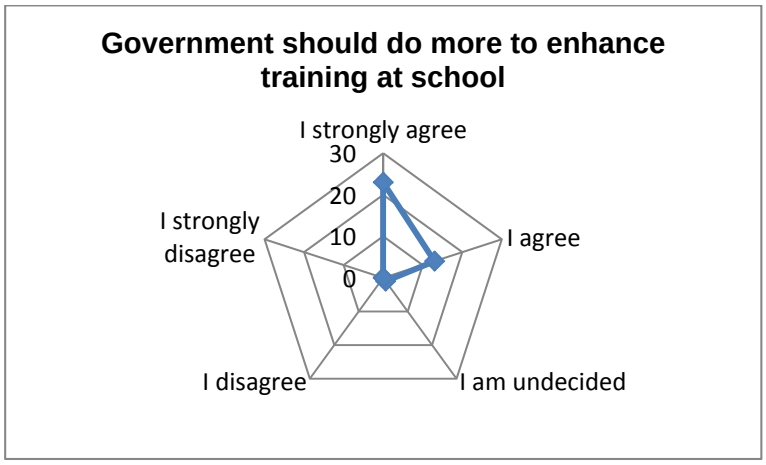


Figure 5.14 A

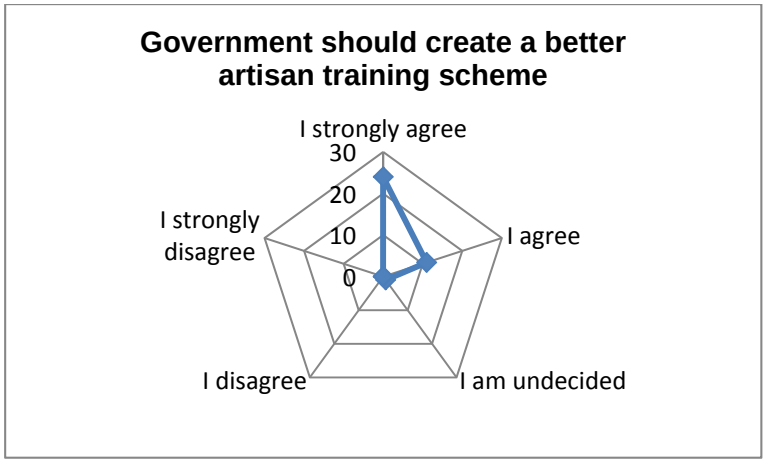


Figure 5.14 B

97% feel that government should enhance training at primary and secondary school level. 97% also agree that government should be involved in creating a better artisan training scheme. This almost perfect score sends a strong signal that all is not well with education in the country. A certain skill set is required from school leavers in order to produce competent engineers and technicians. It was pointed out that not enough people with these skills exit schools to supply the construction industry, as well as a number of other industries. There are also concerns regarding the abilities of school leavers in subjects such as mathematics and science. Another concern raised during interviews and the focus group is the way in which pupils are taught, and specifically their inability to carry out work independently. While there is supposedly an outcome-based curriculum in schools, many feel that students are not taught how to achieve a specific outcome, but are rather spoon-fed, which does not lead to independent thinking.

With regards to the artisan training scheme, most complaints mentioned in the interviews revolve around the current system being widely misunderstood.

5.14.2 Government's role in R&D and ensuring work abroad

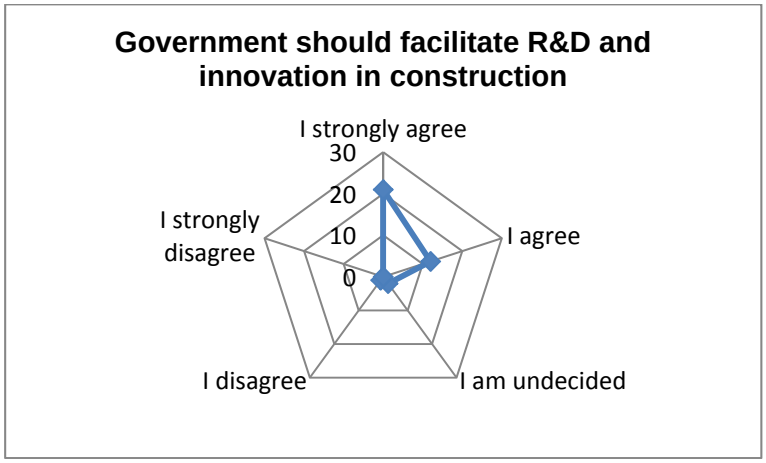


Figure 5.14 C

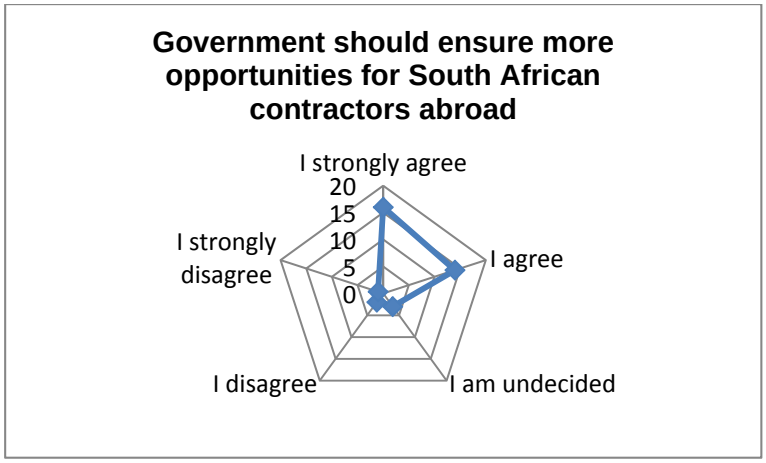


Figure 5.14 D

92% of participants feel that government should facilitate R&D and innovation in the construction industry. It is noted that, internationally, there are various approaches by governments towards involvement in R&D and innovation. While the governments of some countries play a leading role in facilitating R&D and innovation in the industry, others choose not to participate. The South African approach aligns closely with the market-driven approach followed by the USA and Australia. While these are mature economies with strong private sectors, South Africa's economy is relatively small, with perhaps not as many resources available. It seems clear from the responses that government (and perhaps some of the industry bodies and universities) should play a more leading role in facilitating R&D.

83% feel that government should ensure more opportunities for contractors abroad. It is recognised that construction is a cyclical sector. By helping to ensure work abroad for contractors, government may help even out the cycle a bit, which would mean that companies may be better able to do long-term planning. This could lead to more investment in R&D and other systems which are required for innovation, as companies may be more inclined to do so if they had a more positive outlook. By competing with more companies abroad, knowledge sharing and competition may also stimulate innovation.

5.14.3 Procurement practices

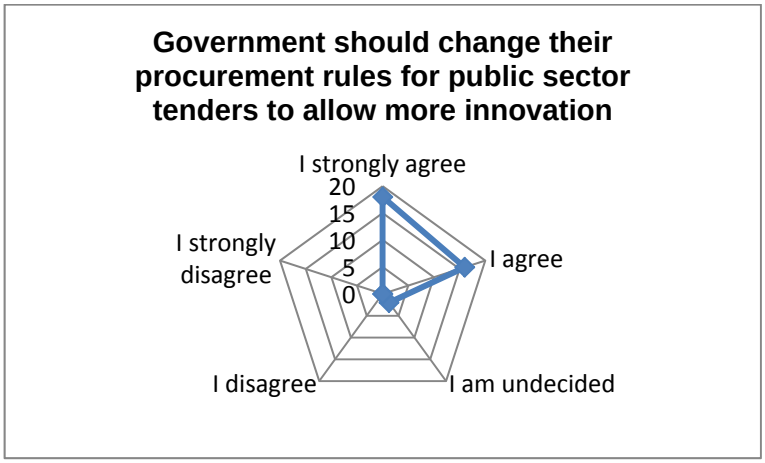


Figure 5.14 E

94% are of the opinion that government should change the procurement rules for public sector tenders to ensure more innovation. There is a widely-held belief that government procurement is corrupt. In addition, most participants in interviews feel that innovation capacity and the general abilities of contractors to perform work, count very little when public sector tenders are evaluated. It is felt that the experience of a potential contractor, along with past performance, does not carry enough weight during the tender stage. In this way innovative, capable contractors are not rewarded for their efforts, and young, less qualified, and inexperienced contractors are appointed. This leads, not only to a continuous re-inventing of the wheel, but also to a negative perception of the construction industry as a whole, as well as a missed opportunity for knowledge transfer.

5.15 CONCLUSION

In this chapter, the second part of the primary data gathering process, namely the survey which was sent out, is discussed. The findings from the survey are also discussed. Where appropriate, this is explained by adding comments which were made during the interviews and focus group.

The main findings from this chapter are:

5.15.1 General

Innovation is important, both to secure contracts, and to be profitable. The construction industry is seen as innovative, both globally and locally, although it is viewed as being less innovative locally.

5.15.2 Research and development

Investment levels in research and development is below par in the industry, and respondents feel that, although levels in their own companies are slightly better, there is room for improvement.

5.15.3 Relationships in the industry

Relationships between role-players are generally good, but the levels of trusts are not what they should be. Alternatives proposed by contractors are not always considered, but in general there are encouraging signs that engineers and clients do value the inputs of contractors.

5.15.4 Distribution of risk

The contractor is seen as carrying most of the risk, followed by the engineer, the client and then supplier. By spreading the risk more evenly, all parties may be more willing to look at innovative ways of minimising risk.

5.15.5 Tender processes

The method used by clients to procure projects is seen as beneficial to innovation. Competitive tendering is more beneficial to innovation than, for instance, long-term agreements or other methods. Contractors should be involved from an earlier stage than is currently the norm. Design and build contracts are better for innovation than traditional contracts. Clients do consider a contractor's competence and innovation history when adjudicating tenders.

5.15.6 The role of various role-players in innovation

Clients and engineers are seen as more conservative than contractors and suppliers. Government is considered least innovative, followed by suppliers and clients and then engineers. Contractors are considered most innovative of all the role-players, although there may be some bias involved. Clients are seen as unrealistic in the timelines they propose for projects, and experienced clients are considered more open to innovation than new clients. Contractors are seen as having the most experience regarding construction processes and tools, followed by clients and engineers, and then suppliers.

5.15.7 Standards and procedures

The standards imposed by clients are seen as too restrictive, and inhibit innovation. These standards should be more outcome-based and focus less on prescribing the method to be followed to achieve the outcomes.

5.15.8 Skills and experience in the construction industry

It is felt that government does not have enough skills and experience to procure and manage contracts. Most private sector clients do possess these skills. Suppliers, engineers and contractors are considered skilled and can, therefore, fulfill their roles in a project. There is generally agreement that there is a shortage of experienced and qualified engineers, technicians and artisans. There is no agreement as to whether there are enough skilled people among contractors in order to be able to innovate. Labour laws are seen as too restrictive to allow for proper innovation, as they prevent transfer of skilled people between projects, and make it difficult to discipline underperforming apprentices and other learners.

5.15.9 Education and training

Although the standard of training at universities and technikons are seen as satisfactory, the standard of training of artisans is not. The perception is that there is also not an adequate system in place to deliver competent artisans. Most contractors are perceived as investing enough in training.

5.15.10 Knowledge management and innovation systems

Contractors have systems in place to capture lessons learned and to ensure that innovative ideas are used. While the majority of participants feel that they would receive recognition if they come up with innovative ideas, there is room for improvement. There are knowledge champions in most contracting organisations, and there are electronic systems in place to capture and distribute knowledge. Employees know where to find experts if they encounter problems which they cannot solve themselves.

5.15.11 Organisational culture

Most construction contractors were considered open to new ideas, and management listens and incorporates proposals. Employees feel part of the organisation and want to participate. Employees can challenge the norms without fear of reprimand. Ethics are perceived as being important in most contracting companies.

5.15.12 Government's role

Government should do more to enhance training at primary and secondary school level and create a better artisan training scheme. It should also facilitate research and development, and innovation in the construction industry. Government should also assist in ensuring more opportunities for local contractors abroad. Government should change their procurement rules to allow for more innovation.

Along with the other sources of primary data (the interviews and focus group) and the secondary data gathered during the literature review, the entire data gathering process was covered in the preceding chapters. What remains is to further discuss the findings from the study in an attempt to answer the research questions posed in Chapter 1. This will be done in the next chapter.

CHAPTER 6 – FINDINGS

6.1 INTRODUCTION AND AIM

In the preceding chapters, the data gathering process was dealt with. The data gathered during the literature review, interviews and focus group, as well as in the surveys, were discussed. In this chapter the findings of the study will be discussed in order to answer the research questions posed in Chapter 1. In addition, a number of recommendations will be made based on the summary of findings of the study.

The following questions need to be answered:

- What is the state of innovation among contractors in the South African construction industry?
- What are the shortcomings in the South African construction industry with regards to innovation?
- What are the areas where the South African construction industry is doing well with regards to innovation?

6.1.1 The characteristics of innovation and of the construction industry in South Africa and the rest of the world

The construction industry is fragmented, with large numbers of role-players operating in a very cyclical industry. There is often very little to distinguish between various contractors. There are high levels of competition, and low entry barriers. .

The industry is characterised by complex relationships between clients, contractors, suppliers and engineers. By challenging the contractor to deliver complex structures at low cost and within tight timelines, clients force contractors to be innovative. At the same time suppliers develop new technologies and methods, which they try to sell to contractors. In the middle are the engineers who act as gatekeepers or brokers. Because consultants want to enhance their own reputation, they have to convince clients to attempt innovative technology on projects.

The demands from customers are moving away from traditional construction. Clients are exploring new options in design and location. The focus tends to be more on renewable resources and energy saving.

Levels of investment in research and development (R&D) are generally lower than in other sectors due to the fragmented nature of the industry, as well as the short-term duration of most contracts, which does not always allow for sufficient time and budget to invest in innovation.

6.1.2 The state of innovation in the South African construction industry among contractors

From the study, it has become apparent that the South African construction industry is generally seen as being innovative, although less so than the international construction industry. While construction both locally and internationally is seen as being hampered by weak collaboration between industry and academics, low levels of investment in R&D and the nature of projects, the South African construction industry is viewed as being particularly affected by the levels of experience of role-players, insufficient skills and lack of proper training, and procurement strategies. While contractors and engineers are viewed by most participants to be innovative, clients are ranked somewhat lower, along with suppliers. Government is generally seen as not very innovative.

In the construction industry, it would seem that radical innovation is normally brought about by specialists who operate in a very small but highly technical field, while incremental innovation tends to be the domain of more generalist fields, which may require less of a specialised skill set.

6.1.3 The shortcomings as well as areas where the South African construction industry is doing well with regards to innovation

Shortcomings

A number of shortcomings concerning innovation were identified among all role-players in the industry.

The level of investment in R&D is traditionally low. This could be attributed to the fragmented nature of the industry, as well as the relatively short duration of projects. Government's disinvestment from R&D as well as tight timelines and pressure on costs, are also believed to be possible contributing factors. The level of collaboration between industry and academics is also found to be sub-optimal. This means that the ability to outsource skilled work such as R&D is not utilised to the full extent by contractors and clients.

Levels of trust between the various parties could be better, and means that clients and engineers are less inclined to accept alternatives proposed by contractors.

Contractors are seen as carrying a very large share of the risk in a contract. If innovation is to flourish, one would expect a better distribution of risk between the various parties.

Clients and engineers are seen as being conservative, which means that they are stuck with tried-and-trusted methods and may be less inclined to investigate alternative methods of overcoming difficulties encountered during construction.

Government is seen as not innovative, both in its legislative role and its role as a large client. As a client government tends to focus on price and other determinants, such as Black Economic Empowerment (BEE) status, and not on innovative history, experience and other factors which may contribute to innovation on a project. As a legislator, government's policies regarding labour laws and training are seen as restrictive and inadequate.

Clients are seen as being unrealistic in their proposed timelines for projects, which means that contractors often battle to adhere to schedules. Time pressures also mean that clients are unwilling to consider alternative and innovative methods, as there is often simply not enough time to do so.

Clients are also seen as not having enough experience regarding construction processes and tools. This means that clients may not be in a position to champion innovation, or to properly adjudicate innovative proposals from other role-players.

Standards and procedures focus too much on specifying the methods to be used, and not enough on the outcomes. In this way the ability of the contractor to innovate is inhibited.

Clients impose too many administrative duties on contractors, which wastes valuable time.

There is a general lack of skills in certain sections of the industry, particularly in government. Technicians and engineers, as well as artisans, are viewed as being in short supply. Specifically the artisan training scheme is viewed as being unsuccessful in producing adequate numbers of suitably qualified personnel. It is alleged that the current system is based on numerous short courses, which make it a long and tedious process and which is mostly not understood by employers or potential artisans. On the one hand potential artisans thought that they could do a one-week course and become a qualified artisan, while in fact numerous modules are to be completed. In the process the apprentice has to gather enough points to be able to become qualified. This means that many potential artisans become disillusioned along the way and stop their training before achieving the qualification. This also leads to friction between employees and employers, as employees expect artisan

salaries, while not yet being competent. Employers are also reluctant to employ apprentices, firstly because of the perceived inability to exit underperformers from apprenticeship programs, but also due to the perceived difficulty in relocating trainees between projects, should the need arise. Often an apprenticeship program would last longer than a specific project, and due to the focus on local employment, it is frowned upon if unskilled workers are transferred to subsequent projects. Employers do not always understand the current artisan training scheme, which means that they are hesitant to implement it. It is noted by almost all participants that the previous system, where an apprentice would go through a very formal training system, incorporating both theoretical and practical modules, and culminating in passing a trade test, is superior to the current system. If nothing else, perhaps government should consider bringing back this system. Incentives have to be created to prompt companies to engage in these schemes in order to produce the required number of artisans.

Although there is mostly some type of system to capture lessons learned and to disseminate this information, a number of respondents feel that their company does not have an adequate system in place.

Positive aspects

The following areas in which the South African construction industry appears to be doing well could be identified.

In general the South African construction industry is viewed as being innovative. The relationships between contractors, engineers and clients are viewed as being good. The manner in which projects are procured by clients is seen as being mostly beneficial to innovation. Clients tend to consider a contractor's innovation background when adjudicating tenders.

All the role-players, except government, are seen as being innovative. Contractors, engineers and suppliers are considered as being knowledgeable regarding construction processes and tools. In general clients appear to possess the skills to successfully procure and manage projects. Engineers, contractors and suppliers are also seen as being skilled.

The standard of training at universities and technikons is viewed by the majority of participants as satisfactory, although there appears to be room for improvement. Contractors seem to invest enough in training.

Lessons learned are captured and there are systems in place to ensure that innovative ideas are used. Most participants feel that they would receive recognition if they contributed to innovation. Contractors know where to find experts if they require specialised guidance. The cultures of most organisations are open and management is eager to incorporate new ideas. Most employees also feel that they want to contribute to their organisation. Ethics are regarded as important in most organisations.

6.2 RECOMMENDATIONS AND CONCLUSIONS

Based on the study, a number of initiatives and processes which could further enhance innovation can be suggested. These include:

Continuous improvement processes should be implemented by contractors. The focus should be to base research on needs identified by industry, and on how to integrate innovations in construction processes.

Contractors should focus on changing their culture in order to focus on exploring continuous incremental innovation.

The nature of relationships in the industry needs to be re-examined and the setting of these relationships needs to change in order to allow a better distribution of risks, and to promote higher levels of trust and collaboration during projects. This would call for the tender process and entire project lifecycle to be reconsidered. Contractors should be involved in the project from an earlier stage in order to call on their unique perspectives regarding constructability and to identify possible constraints. Partnerships need to be established between academics, contractors, clients, government and suppliers in order to facilitate sustainable investment in R&D. As part of this initiative, companies should consider outsourcing R&D and partnering with external parties, should they not possess the particular experience required.

Companies need to ensure that a formal system is in place to promote innovation. This should include top management's visible buy-in. There should be innovation champions, as well as electronic systems to capture and share experiences and knowledge. Lessons learned during projects must be maintained and made available, while various initiatives must be put in place to ensure that all employees participate. These initiatives could include getting knowledgeable employees to present courses, inter-site visits, and facilitating informal knowledge sharing by creating situations where knowledge seekers can meet those

who possess the knowledge. Reward and recognition systems need to be tailor made for a specific company.

By ensuring greater integration between the various role-players in a project, role-players could ensure that knowledge is shared effectively across company borders, allowing for quicker decision-making regarding innovative proposals. This could include adopting a win-win approach and adopting Enterprise Resource Planning (ERP) software across all participants in a project, and across supply chain processes.

In this chapter the main research questions are answered using the findings of the study. In the process the various sources of data are used to gain insight into the manner in which innovation can be stimulated in the construction industry.

In the next chapter concluding remarks will be made regarding this study. The method and rationale behind the study will be explained. The main findings will be highlighted. The way forward, including potential additional research into the matter, will be proposed.

CHAPTER 7 – CONCLUSION

7.1 INTRODUCTION

This research was prompted by the apparent lack of innovation in the South African construction industry. The aim of the study is to obtain a better understanding of the state of innovation among contractors, as well as to discover which factors hamper or contribute to innovation. The strategy involves engaging construction contractors at various levels in order to better understand contractors' perceptions regarding innovation in the construction industry. The study focuses particularly on innovation among contractors working in the mining industry.

7.2 RESEARCH STRATEGY

Both qualitative and quantitative methods are utilised to gather and analyse data. This mixed-method approach comprises interviews, a focus group and questionnaires along with a literature review. This approach was chosen to ensure a broad understanding of the issues, as well as to maximise the ability of participants to interact with the researcher.

The interviews and focus group were conducted as semi-structured interviews. Although there was a set of questions, participants had the freedom to expand on questions or deviate from questions where required. In this way additional information could be gathered.

7.3 RESEARCH PROBLEM AND QUESTIONS

Because of the large role that the construction industry plays in providing employment and contributing to the economy, it is essential that the characteristics of the construction industry as they relates to innovation be understood, so as to arrive at a better understanding of the manner in which the construction industry needs to be reformed, if it is to contribute optimally to the development of national goals. The problem is how to stimulate innovation in the South African construction industry. To resolve this problem it is necessary to understand what the level of innovation is among the various role-players in the industry; what are the contributing factors which hamper innovation in the industry; and what contributing factors could potentially aid innovation in the industry.

The following questions, therefore, need to be answered:

- What is the state of innovation amongst contractors in the South African construction industry?
- What are the shortcomings in the South African construction industry with regards to innovation?
- What are the areas where the South African construction industry is doing well with regards to innovation?

7.4 RESEARCH FINDINGS

The main research questions are answered as follows by the findings of the study:

7.3.1 What is the state of innovation in the South African construction industry among contractors?

The South African construction industry is considered innovative, although less so than its international counterparts. Contractors and engineers are considered innovative, with clients and suppliers viewed as slightly less so. Government is viewed as the least innovative of all role-players in the industry.

7.3.2 What are the areas where the South African construction industry is falling short with regards to innovation?

Some of the shortcomings identified include low levels of investment in research and development (R&D), government's non-involvement in R&D, and tight timelines for projects along with pressure on costs. Academics are not viewed as adequately involved in the relationships with industry, and specialised work such as R&D is not sufficiently outsourced to academics and other external institutions. There is also not enough investment in research and development by contractors and other role-players. Lack of skills, particularly amongst artisans, is seen as a big problem for contractors. The lack of a proper training scheme for artisans is also seen as contributing to this lack of skilled personnel. It is widely held that skilled individuals contribute more to innovation than less skilled people.

Although the relationships between the various role-players are generally perceived as good, there is not enough trust between the various role-players. This means that alternatives proposed by contractors are not always considered as easily as it might have been, had there been a better relationship.

Contractors feel that they carry a disproportionate part of the risk in a contract. In order to promote innovation, there has to be a better apportioning of risk on a project. Although

contractors are willing to try new approaches, clients and engineers are seen as too conservative, which could hamper the adoption of innovative approaches.

Government is considered neither innovative as a legislator, nor as a large client. Its procurement rules are too restrictive, and focus too much on price and other objectives, such as Broad Based Black Economic Empowerment (BBBEE), and not enough on the competency and innovation history of potential contractors. The lessons learned by government during projects are also not seen as being adequately incorporated in follow-on projects. The labour and other laws imposed by government also potentially detract from contractors' ability to innovate. The training system for artisans, for which government is to a large extent responsible, is not seen as delivering the required outcome. This means that people who may not possess all the skills required to innovate enter the market. The impression is that clients often do not have adequate levels of experience and knowledge regarding construction processes and tools to evaluate innovative proposals.

There is a generally perceived lack of skilled personnel in the country, due to emigration and substandard training systems. This is viewed as being compounded by the problems in the training schemes for artisans, and to a lesser degree at university.

Most contractors can do more to ensure that a proper system is in place to capture and distribute knowledge regarding innovation.

7.3.3 What are the areas where the South African construction industry is doing well with regards to innovation?

Among the positive aspects arising from the study, some of the findings include the view that the South African construction industry is innovative, and that the way in which projects are procured, is generally conducive to innovation. Private sector clients appear not to focus only on price when evaluating tenders, but also to look at the competence and innovation history of contractors.

All the role-players, except government, are seen as innovative, and that they have the experience and knowledge to participate meaningfully in construction projects.

Standards of training at universities and technikons are generally seen as sufficient, and there is adequate investment in training.

Lessons learned are captured, and employees want to participate in innovation initiatives. They also know where to look for information, should the need arise. The organisational culture of most contractors is viewed as open to new ideas and proposals, and ethical behavior is valued.

7.4 RECOMMENDATION

Contractors should strive to continuously improve their processes and systems. The focus should be on addressing shortcomings which are identified by employees, and on implementing innovations in a practical manner.

Because relationships in the industry are mostly based on an adversarial approach, dictated by very strict contractual stipulations, there is a disproportional distribution of risk which negatively affects the contractor. This needs to be re-examined in order to change the approach to, and tone of, these relationships. Tender processes and the entire lifecycle of a project have to be reconsidered in order to involve contractors from an earlier stage of the project. In this way they could contribute by sharing their unique views on constructability and timelines. Academics and industry have to establish better partnerships to facilitate sustainable investment in R&D. Companies should consider outsourcing R&D.

Contractors need to make sure that their corporate culture reflects their eagerness to be innovative. To achieve this, a top-down approach is proposed which means that management should be seen as buying into the innovation drive by being open, and by recognising the inputs of employees. Having an electronic system in place to disseminate information relating to innovation, and to allow knowledge sharing, along with champions to drive the initiative, is very important. Reward and recognition schemes could also be used to cater for this drive towards innovation.

While it is recognised that government has certain social goals, such as uplifting previously disadvantaged categories and BEE, this should not be done at the cost of innovation and quality. Perhaps it would be advisable to make provision in tenders for joint ventures or other partnering arrangements between established and upcoming contractors. In this way there could be proper knowledge sharing. Government would have to reconsider its approach to tenders, by being more flexible, and considering other criteria than strictly price, if it is to stimulate innovation and achieve some of its other goals.

7.5 WAY FORWARD

This research focuses on a subsector of the construction industry, namely contractors working in the mining industry. To a large degree, the findings of this study share the views of these contractors concerning innovation. Certain aspects could be subject to bias. These include the relative levels of innovation among the different role-players, the perception of the standard of education and training among the role-players, and the view on the best methods to ensure innovation in the construction industry.

In order to get a more comprehensive and inclusive view, a similar study, which includes more of the role-players in the industry, is suggested. The questions in the interviews were general, and could potentially be made more specific. For example, the question regarding which party carries the most risk in a contract, did not distinguish between the various types of contracts, which could be beneficial to a study of this nature.

Other research could potentially also flow from this study, including an in-depth examination of the role of some of the identified factors which contribute or detract from innovation. Some of these factors, such as distribution of risk, relationships in the industry or procurement processes, as they relate to innovation, can potentially be the subject of a research report.

Several potential hindrances and aids to innovation in the construction industry were identified during the research. By taking note of these, the various role-players can implement a number of suggested strategies to ensure that the South African construction industry becomes more innovative.

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ANNEXURE A -LIST OF QUESTIONS USED DURING INTERVIEWS

- Do you think the South African construction industry is innovative?
- Do you think that innovation is important for a construction contractor, and why? Refer to:
    - loss of credibility with clients,
    - dynamic nature of projects,
    - competitive advantage,
    - productivity and
    - growth potential
- What are factors hampering construction innovation in South Africa? Refer to:
    - nature of projects,
    - fragmentation,
    - relationship between role players (regulators, supply network, project based firms, users and technical support infrastructure),
    - R&D investments,
    - role of regulations and government,
    - interaction between academics and industry,
    - continuous improvement vs. radical innovations,
    - the types of tender processes and their effect on innovation,
    - specialisation vs. generalisation,
    - number of role players,
- Which factors aid / contribute to innovation in the construction industry? Refer to the same factors as mentioned in previous question
- What role do you think the following plays in stimulating innovation:
    - Procurement system
    - Standards and regulations
    - Clients and manufacturers
    - Structure of productions
    - Relationships in the industry
    - The nature of resources (culture, skills, processes and strategy)
- Do you have "champions in your organisation who drive innovation?
- Do your company / the industry have an adequate system in place to ensure that knowledge regarding innovations and new methods are communicated effectively? What suggestions would you have in this regard?

- What other motivators do you see to foster innovation in the industry / your company?
- Which types of innovations do you see in the construction industry?
    - Refer to radical, incremental and modular innovations.
    - Refer to technical and organisational innovation, and the state of these in the construction industry.
- Which role player do you think is the most / least innovative, and why?
- Do you think there is a lack / oversupply of skills in the construction industry, does this contribute to innovation, why, and what can be done to change this?
- Does the lessons learned during a project / over several projects, get captured and communicated effectively throughout your organization, and what can be done to ensure this happens?

ANNEXURE B – EXAMPLE OF QUESTIONNAIRE

Background

1	What type of contractor do you represent ?	Earthworks	Civil	SMPP	Electrical / Instrumen-tation	Other (specify)
2	What is your role on site?	Artisan	Foreman	Engineer / technician	Manager (2.6.1)	Other (specify)

To what degree do you agree with the following statements?

		I strongly agree	I agree	I am undecided	I disagree	I strongly disagree
	General					
3	It is important for a contractor to be innovative					
4	Innovation is required in order to secure contracts					
5	Innovation is important in order to be profitable					
6	The construction industry is innovative globally					
7	The South African construction industry is innovative					
8	In construction, innovation tends to be radical (big new ideas)					
9	In construction, innovative tends to be incremental (small changes)					
	Research & Development					
10	There is enough investment in Research & Development in the construction industry					
11	There is enough investment in Research & Development in my company					
12	Universities, government and contractors work together to innovate in the construction industry					

To what degree do you agree with the following statements?	I strongly agree	I agree	I am undecided	I disagree	I strongly disagree
Relationships in the industry					
13 The relationships between clients, engineers, contractors and suppliers are good					
14 There are high levels of trust between clients, engineers, contractors and suppliers					
15 Alternatives put forth by contractors are accepted by clients and engineers					
16 The attitude of a single critical person can mean the difference between success or failure of innovation on a project					
17 The people involved are more important than the type of contract, in ensuring success of a project					
Distribution of risk					
18 The Client carries most of the risk in a contract					
19 The Engineer carries most of the risk in a contract					
20 The Contractor carries most of the risk in a contract					
21 The Suppliers carries most of the risk in a contract					
Tender processes					
22 The way in which clients procure projects is beneficial to innovation					
23 Competitive tendering is better for innovation than other type of contracting					
24 Contractors should be involved in the project from an earlier stage than what happens currently					
25 Design & build contracts are better for innovation than traditional contracts					

To what degree do you agree with the following statements?	I strongly agree	I agree	I am undecided	I disagree	I strongly disagree
26 Clients consider a contractors competence and innovation history when adjudicating tenders					
Various roleplayers					
27 Clients are conservative					
28 Clients are realistic in the timelines they propose for a project					
29 Clients are experienced and knowledgeable regarding construction processes and tools					
30 Experienced clients are more open to innovation than new clients					
31 Contractors are conservative					
32 Contractors are experienced and knowledgeable regarding construction processes and tools					
33 Engineers are conservative					
34 Engineers are experienced and knowledgeable regarding construction processes and tools					
35 Suppliers are conservative					
36 Suppliers are experienced and knowledgeable regarding construction processes and tools					
37 Clients are innovative					
38 Engineers are innovative					
39 Contractors are innovative					
40 Suppliers are innovative					

To what degree do you agree with the following statements?	I strongly agree	I agree	I am undecided	I disagree	I strongly disagree
41 Government is innovative					
Standards and procedures					
42 The clients' standards are too restrictive and inhibits innovation					
43 Standards should be outcome based, and not aimed at stipulating the process to follow to achieve the outcome					
44 There are too many meetings and administrative requirements on projects, which wastes time					
Skills & experience in the construction industry					
45 Government has adequate skills to procure contracts and manage them					
46 Clients has adequate skills to procure contracts and manage them					
47 Engineers are skilled in design and supervision					
48 Contractors has enough skill to implement projects					
49 Suppliers are skilled					
50 There is a shortage of experienced and qualified artisans					
51 There is a shortage of experienced and qualified engineers / technicians					
52 There are enough skilled people in my company to ensure that innovation takes place					
53 Labor laws are too restrictive to allow proper innovation					

To what degree do you agree with the following statements?	I strongly agree	I agree	I am undecided	I disagree	I strongly disagree
67 I feel part of my organisation and want to contribute					
68 Ethics and ethical practices are important in my organisation					
Government's role					
69 Government should do more to enhance training at school					
70 Government should create a better artisan training scheme					
71 Government should facilitate R&D and innovation in construction					
72 Government should ensure more opportunities for South African contractors abroad					
73 Government should change their procurement rules for public sector tenders to allow more innovation					