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DEVELOPING PROJECT MANAGEMENT COMPETENCIES IN GRADUATE ENGINEERS IN THE CONSTRUCTION INDUSTRY

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Abstract

Graduate engineers are often thrown in at the deep end when they start a career in the construction industry and they may be expected to manage a team of workers almost from the day they start. This could be a problem because of a lack of management education in their undergraduate degrees, compounded by the fact that there are few structured development programmes they can follow. In many cases, engineers from a mostly technical background are promoted into project management positions without any formal development or structured training in team or project management. One of the biggest effects of this is the poor management of construction projects.

The study aimed to establish the most relevant project management competencies that graduate engineers in the construction industry need to be exposed to prior to leading large sections on a construction site. This aim was met by interviewing seven graduate engineers within two years after joining the construction industry, two human resources senior managers, and eight senior project managers, directors and managing directors of a large South African-based construction company. The data from the interviews were combined with data from a literature review to design questionnaires, which were distributed, and more data were obtained from 29 graduate engineers, 16 human resources professionals, and 42 senior project managers, directors and managing directors.

The study identified seven competencies deemed the most important ones to be developed in graduate engineers – no significant difference in opinion on these competencies were found between the various respondent groups. The study also identified six methods that would be well suited to develop these, but found a significant difference in the opinions of the different respondent groups on which methods would be best suited. It seems that one of the main differences between the views held by the graduate engineers and those held by the more senior personnel is their opinion about physically working on a construction site and gaining experience in that way, as opposed to receiving formal training early on in their careers.

Key Words

- Project Management
- Graduate Engineers
- Project Management Competencies
- Project Management Development

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Stefan Frans Bothma

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CHAPTER 1: Introduction to the Research Problem

1.1. Background

Construction project managers play a vital role in the construction industry. They are responsible for the planning and execution of a construction project from start to finish. A typical project manager would spend up to 10 years working on different projects, gaining experience in a vast array of competencies that are required for a person to be regarded an experienced project manager.

In a typical construction company, young graduate engineers are employed in supervisory positions almost immediately after graduating from university as site engineers forming part of a construction project's management team under the project manager. The rapid pace of the development in the construction industry often leads to young engineers' being promoted to junior management positions within the first five years after graduating. The current curriculum at universities supplies very little exposure to leadership or management training (Cox, Berry, & Smith, 2009). This is one of the reasons why companies which employ such young graduates need to invest in their further development.

This study focuses on the engineering and construction industries, where most of the staff comes from a very specialist environment. In many companies that provide a specialist service, typically engineering, the business environment has evolved rapidly over the last couple of years. With more competitors, both local and international, and with the global marketplace playing an ever-increasing role, the pace of the evolution of the construction industry has increased considerably. Project profit margins are low, so there is no room for error. Thus, the tried and trusted practice of learning from one's mistakes can no longer be adopted in this extremely competitive industry (Edum-Fotwe & McCaffer, 2000). This is one of the important reasons why it is no longer acceptable to promote someone into a managerial or leadership role based on technical capabilities alone (Skipper & Bell, 2008).

To solve this problem and to develop project managers who are ready for senior positions in the construction industry and who have sufficient technical knowledge, management and leadership characteristics, companies need to look at their younger staff members for potential candidates for further development from an early stage in their careers.

Companies invest large amounts of time and money in training programmes, mentorship programmes and the development of future managers and leaders (Alam, Gale, Brown, & Kidd, 2008). It is based on this investment and the importance of such development that it is imperative for the study to ask the question whether or not young graduate members of staff, human resources professionals, senior managers and executive committee members have the same perceptions of project management development in graduate engineers. If they do not have the same perceptions of the issue at hand, there is a strong possibility that a company might focus on the wrong areas in its training programmes, and that despite all the time and money invested, these initiatives might fail. This could lead to high staff turnover, demotivation and poor performance among young graduate staff members (Doh, Smith, Stumpf, & Tymon, 2011; Raiden, Dainty, & Neale, 2008).

In the literature, a very broad array of competencies is attached to project management, and it is identified that competent project managers are needed, because of the complex nature of the projects in the construction industry. Hence, a company may ultimately have to decide between employing young graduate engineers and developing them into competent project managers or simply employing more senior, already competent project managers by making the recruitment process for employing senior project managers more rigorous (Dainty, Cheng, & Moore, 2005). However, the latter option is not sustainable in the long term, because the majority of the most competent and more senior project managers currently employed will only be working for the next 10 to 15 years. Thereafter they will retire, and a serious shortage of skilled project managers will develop if continuous development of project managers from among the ranks of younger engineers is not pursued.

1.2. Research Problem

Considering the vast array of competencies required to be successful as a project manager and that it can take up to 10 years to acquire these skills, three questions arise. First, which of these skills are the most relevant in the working environment of graduate engineers during their first five years in the construction industry? Second, which methods would be best suited to develop these competencies in graduate engineers in the construction industry? Thirdly, is there any difference in the perception or opinion on either the competencies or the development methods between the actual graduate engineers and the senior personnel that would be responsible for the development of the competencies in the graduate engineers?

The first problem that the study therefore attempted to answer was which project management competencies companies should focus on when they plan to develop or train their graduate engineers in the area of project management to best suit their current working requirements.

Once a company has determined which project management competencies are most relevant to its specific requirements, it needs to consider different methods to develop these competencies in graduate engineers. Various methods are used individually or in different combinations by different companies and different industries – methods range from learning by doing, induction programmes, formal training programmes, mentorship programmes and self-study programmes. The second problem that the study therefore attempted to answer was to identify the most appropriate ways to develop these competencies to ensure that all the new graduate engineers gain the maximum amount of experience in these competencies best suited to the construction industry.

The final problem that was looked at is based on the possibility that, because of the extent to which the industry has changed over the last 10 to 20 years, the perceptions of senior management and those of current graduate engineers may differ with regards to career and project management development. This is a concern because, in most cases, training, development, mentorship or similar programmes are designed and implemented by senior managers, who may potentially not see the matter of the development of the graduate engineers in the same way as the young engineers that attend these development initiatives see it. Alternatively, such programmes may be developed by human resources professionals who do not have the same background as the engineers. This could create an environment in which graduate engineers are not stimulated sufficiently, and the possibility of their resigning from the company can become a reality.

1.3. Research Rationale

Rwelamila (2007) argues that, as in most countries, most of the people who become project managers do so by accident – in other words, they do not undergo any professional training in the field, but are left to gain experience by themselves. He also confirms that the usual career path in the construction industry starts with a technical background such as training in civil engineering, quantity surveying or architecture. However, the technical aspect of most construction projects is quite small in

comparison to the larger overall scope of the project. Hence, many projects are mismanaged, because the accidental project manager possesses mainly technical knowledge. This finding indicates that the demand for training in construction project management in South Africa is beyond debate (Rwelamila, 2007).

Rwelamila (2007) focuses on the various training institutions and what they offer the construction industry in South Africa. It seems that the courses offered address the needs of the more senior members in the construction project management environment, paying no attention to how the required competencies can be developed in graduate engineers from a young age in the company environment.

Another South African study done by Olatunji (2010) looked at the conditions that can affect the delivery time of construction projects in South Africa. His literature review noted the following conditions as most likely to influence the world-wide delivery time of construction projects: political, economic and physical factors, as well as developments in technology, the management style and the construction techniques of a specific project. He concluded that, in the South African context, a lack of planning, the poor motivation of workers, management styles, the quality of management during the construction phase, the constructability reviews of the project and economic policies played a major role in the time delays experienced on the delivery of South African construction projects (Olatunji, 2010). Of these problem areas, the first four are directly related to construction project management. Like Rwelamila (2007), Olatunji (2010) suggests that a possible solution is to revisit the curricula of the universities and other training institutions, suggesting that they include more management subjects.

None of the prior studies reviewed focuses on or specifically suggests the continuing development of graduate engineers in respect of the competencies of project management. They look only at the training of candidates in project management. Hence, the current study is particularly relevant, because it examines the training void encountered by young engineers after graduating and before becoming experienced and fully competent as project managers.

1.4. Scope of the Research

In this study, the views of graduate engineers, human resources officials and senior managers in a large construction company on project management development needs of graduate engineers in the construction industry were compared. A small group of

people from each respondent group in a large South African-based construction company were interviewed to elicit typical views, which were in turn used to design a questionnaire that was sent to a larger group of employees in the same construction company to collect sufficient data for statistical analysis. The company employs about 60 engineers with between one and five years' experience, about 40 engineers with between five and 10 years' experience and 40 full-time project managers with varying amounts of experience (between 10 and 30 years).

1.5. Research Objectives

The main questions that this study aimed to answer were, first, whether employees in a construction company with different levels of experience and seniority hold different views on which project management competencies should be developed in graduate engineers in the first five years after they graduate and, second, how these competencies should be developed and the engineers should be exposed to the required skills.

To answer these questions, the main objectives of the study were the following:

- Objective 1:
  To determine the project management development needs of graduate engineers, based on the views of graduate engineers in construction with less than five years of experience.
- Objective 2:
  To determine how the young graduate engineers think they should get exposure and experience in these project management competencies.
- Objective 3:
  To determine the project management development needs of graduate engineers, based on the views of senior managers and human resources officials in the construction industry.
- Objective 4:
  To determine how the senior managers and human resources officials think young graduate engineers should get exposure and experience in these project management competencies.
- Objective 5:
  To compare the views of the graduate engineers, human resources professionals and senior managers in order to identify the differences and commonalities.

1.6. Outline of the Study

Following on from this introductory chapter, the next chapter of this study focuses on the academic literature on the topic of project management, and looks at project management in the construction environment. It investigates the background of graduate civil engineers and their place in the construction industry. Finally, it discusses various different competencies that the international literature attributes to successful project managers and ways of exposing graduate engineers to these competencies.

Chapter 3 sets out the research questions that were researched by means of qualitative interviews and quantitative questionnaires, as discussed in the explanation of the methodology used in the research (as set out in Chapter 4). The findings of these two phases are presented in Chapter 5.

The discussion of the findings is presented in Chapter 6, looking at the analysis of the data from the two phases of the research in more detail. Finally, Chapter 7 concludes the study and summarises the findings.

CHAPTER 2: Theory and Literature Review

2.1. Introduction

The literature review in this study is broken up into sections that relate to the research problem. The first two areas that were looked at are a definition of project management and how project management relates to construction as an industry. The focus then moved to engineering graduates, and the typical education that graduates receive at university and some of their career options after graduating were examined. The study then looked in more detail at typical career stages in the engineering and construction environment, with specific reference to engineers and project management, and compared these stages to what usually happens in the company that was used in the study.

After looking at engineering graduates and a definition of project management, the literature review investigated the typical content of project management and the development processes thereof, specifically in the engineering and construction industries.

An attempt was also made to find similar studies that might have been done on the different views or perceptions of project management development, based on the level of seniority in an organisation.

2.2. Graduate Engineers

Graduate engineers have typically completed a four-year Bachelor of Science in Engineering (BSc.(Eng)) or a Bachelor of Engineering (BEng) degree at a South African university or a three-year diploma course at a university of technology, with the option of a fourth year to obtain a BTech degree. The content of the typical engineering curriculum, like in the rest of the world, does not include a significant number of management, leadership, accounting or financial subjects (Cox et al., 2009; Cox, Cekic, & Adams, 2010; Edum-Fotwe & McCaffer, 2000; Farr & Brazil, 2009). This may be due to the fact that many people still see engineers as being only designers and not as responsible for the management of the construction of their designs. This attitude is borne out by the fact that many faculty members do not agree on the need for or a definition of leadership in engineering (Cox et al., 2010).

The actual career possibilities for graduates include working in a design office, but also include working for the government, either in design or management, becoming involved in education by becoming lecturers or professors, entering the engineering industry where they may go into technical sales or business development, and construction, where they are likely to end up as project managers and later on as part of the management team of a company (American Society of Civil Engineers, 2012).

In a construction company, graduate engineers start their careers as site or field engineers and form part of the site management team. Some of their responsibilities include the health and safety aspects of the section of work where they are working, assisting in organising and supervising people and material on that section, dealing with possible sub-contractors and setting out some of the work based on the study and interpretation of construction drawings (Career Structure, 2012).

2.3. Career Stages in Engineering and Construction

As the American Society of Civil Engineers (2012) explains, the career path for an engineer entering the construction industry has no direct trajectory. However, one of the paths that an engineer most often follows in the construction industry is becoming a project manager (Edum-Fotwe & McCaffer, 2000; Maloney, 1988). Engineers who choose to become project managers would typically start as site or field engineers, working on a large project, with one or more of the more senior engineers or site agents working between the engineer and the project manager. Thereafter they may be given the title of project engineer or, in South African terms, sub agent. Next, they would become assistant project managers (American Society of Civil Engineers, 2012), or site agents, in South African terms. This process normally takes up to 10 years, before an engineer is promoted to a project manager (Edum-Fotwe & McCaffer, 2000). However, it must be said that, despite these general career levels in the construction industry, there is no recognised development path for a project manager in construction (Thomas & Mengel, 2008).

Recent growth in the industry during the lead-up to the 2010 FIFA soccer world cup in South Africa and the growth in the rest of the world up to economic crises of 2008 caused a global shortage of experienced engineers and project managers in the industry. This led to the rapid promotion of engineers in the industry who showed leadership abilities and gave ambitious engineers an opportunity to accelerate their careers (Raiden et al., 2008; Skipper & Bell, 2008).

2.4. Project Management

2.4.1. What is a project?

In simple terms, a project refers to a temporary organisation. This means that the specific team and resources working on a project only work together for the duration of the project, and after completion of the project, the team will disband and move on to new projects (if they are permanently working on projects) or go back to their normal jobs (if they were only involved in project-work part-time). Each specific project is normally unique, and projects are unlikely ever to be repeated in exactly the same form, size and location. Any good project has a clear and well-defined objective, a defined budget with a specific set of resources and time constraints that have to be met in order for the project to be labelled successful upon completion (Jones, 2007).

For any company, a project can be compared to an investment. Funds and resources are allocated to the project, with the expectation of realising a profit from the project or ultimately improving an internal function for which the project was initiated. It would therefore make sense to get a specialist to run the project with financial, management and more specific competencies than the purely technical competencies which the average engineer or technician has (Heerkens, 2005).

2.4.2. Project management

Project management originated in the mid-1950s in the United States of America's (USA's) defence and aerospace industries, while the actual profession of project management started in the late 1960s and further developed in the early 1970s. It was during this period the Association for Project Managers and the International Project Management Association were formed. During the first 10 to 20 years, the impact of project management on large construction, defence and aerospace projects was quite weak, as the discipline was still very young and was not well articulated. After this initial phase, people began to appreciate the bigger picture of managing projects well and people began to look more critically at the training and development of project managers (Morris, 1997).

The main objective of project management is to coordinate a combination of resources with different specialities and tasks in an economical and timely way, so that the given project can be completed on time and within budget. Construction project

management more specifically can then be described as the coordination of resources on a construction site in a cost-effective and timely manner to achieve the successful completion of the given project on schedule and within budget (Kangari, 1993).

In the USA, the construction industry has one of the highest business failure rates of all industries. One of the main reasons for such failures has been proved to be poor management. Project management thus plays a large role in construction companies, as the main source of work is related to projects – to be specific, construction projects (Kangari, 1993). Although each construction project is unique, the underlying managerial process stays more or less the some in most projects (Isik, Arditi, Dikmen, & Birgonul, 2010).

“A project manager is a person formally appointed to manage a project with specific accountability for achieving defined objectives within allocated resources” (Jha & Iyer, 2006, p. 978). In doing this, the project manager should ideally have experience in a particular field, as well as competencies in leadership and planning (Jha & Iyer, 2006). The experience in a particular field can relate to the technical engineering skills and background of most project managers in the construction industry.

In the construction industry, it is therefore the responsibility of the project manager to see to the delivery of the physical infrastructure that the client has specified within the budget, time, quality and safety requirements specified (Edum-Fotwe & McCaffer, 2000). The project manager is the point of contact between the client and the contractor, and is therefore responsible for the relationship between the client and the construction company. This relationship is very important for the completion of the current project, but also for the possibility of receiving future work from the same client (Sculthorpe, 1994).

2.4.3. Project management competencies

Project management skills or competencies can be compared to general management skills. Two important differences between project management and general management skills are that each project that a company undertakes is unique and has a definite start and end date. A project is thus temporary in nature, as opposed to the management of a company that is managed as an ongoing concern (Birkhead, Sutherland, & Maxwell, 2000).

Project management can be broken down into a number of components, including planning, organising, implementing and controlling. Planning is required so that what needs to be done can be identified, in order for it to be organised to identify how it will be done. These plans must then be implemented and continuously controlled to ensure that the project stays on track with regard to the specification, quality, time scales and planned resources (Jones, 2007). To manage all these components, different competencies or skills are required of the project manager and the project team.

Construction projects are one of the most difficult areas in which to apply project management techniques, due to the typical nature of construction projects, which normally involve crises, uncertainty and suspense, which compound to present the ultimate test to the project manager in charge of the project. Project managers in the construction industry therefore need to combine their technical knowledge with effective teamwork and communication skills into areas of expertise known as core competencies. Correctly identifying, assessing and keeping up the competencies specific to the project and industry that the project manager operates in is fundamental to the success of a project (Dainty et al., 2005).

Project management competencies in the construction industry include general and management skills, over and above the technical skills of traditional engineering areas (Edum-Fotwe & McCaffer, 2000). The technical skills that a construction project manager requires are specific to the construction industry, whereas the other more general management competencies can be easily transferred between various disciplines of project management (Edum-Fotwe & McCaffer, 2000).

Some of the more general competencies or capabilities include leading people, communication, negotiation and problem-solving (Edum-Fotwe & McCaffer, 2000). The knowledge areas are substantially wider than the core skills or competencies. These knowledge areas include time management, cost management, procurement management, quality management, communication, risk identification and management, scope identification and management and human resources management (Edum-Fotwe & McCaffer, 2000). Other competencies listed by various authors include social competence, emotional intelligence and the importance of vision, values and beliefs (Thomas & Mengel, 2008), the ability to meet project objectives, the ability to make decisions (Lei & Skitmore, 2004) and the ability to manage change and recognise opportunities (Odusami, 2002).

Previous research has categorised project management skills into key skills or competency areas. These include communication, organisational, team building, leadership, coping and technical skills. In all these areas there are numerous specific competencies that would assist a project manager in achieving the unique defined objectives of a given project with its particular time and resource constraints (Dainty et al., 2005). Even though project managers do not need to be specialists in all these fields, it is their job to get things done using a large group of people, while having little direct control over what they are doing (El-Sabaa, 2001). Project managers thus need to develop a team that can work together in dynamic and changing environments to accomplish the goal of the project (Thomas & Mengel, 2008).

Some of the main skills and competencies that a project manager needs to complete a project effectively and successfully as mentioned in the previous paragraphs are listed and discussed in some more detail on the next few pages:

- Activity scheduling and resource and duration estimation

  In any company, deadlines, availability and productivity of resources and financial information are critical. In the project environment, this is equally important. Hence, the way in which all this information is communicated to the project management team is also important. By breaking a construction project down into a series of tasks and calculating the time, resources and dependency on each other for each of these tasks, a project manager will be able to answer all the questions on deadlines and the availability and productivity of resources to calculate the required financial information for the project. On large construction projects, there can be thousands of different tasks, with hundreds of different resources working simultaneously. It is therefore extremely important for a company to be able to continuously monitor these resources to make sure that every resource is being used to its full potential (Kangari, 1993). It is also very important to understand which tasks can be done in parallel with other tasks and which resources are allocated to all of these activities to ensure that no resource is needed in two places simultaneously, and also that tasks are completed as soon as possible (Madan, 1993).

  For the engineer or the project manager, it is important to understand what activities are required for the different tasks or stages of the project to be completed. An example of this in the construction industry would be the

construction of the foundations of a building, which requires surveying, excavation, insertion of piles and casting the concrete for the foundations (Jones, 2007).

A very important aspect of understanding the composition of the activity resources and scheduling is the ability to realise and admit that a particular section of the project or the project as a whole will not be completed on time. If a project manager understands the reasons for the predicted delay in the completion of the project, it becomes possible to consider other options or to warn the other stakeholders of the potential delay in advance. If a project manager is unable to foresee such a delay and agrees to unrealistic deadlines, the project could end up costing the company more money than if the potential delay is identified early on in the project lifespan (Heerkens, 2005). It is also the responsibility of the project manager to ensure that realistic timelines and dates are set for the various activities, as it would still be the overall responsibility of the project manager if the project is not completed on time. It does not help if the project manager gets someone to accept an unrealistic end date, knowing that the person will not be able to meet the deadline (Jones, 2007).

To ensure that project managers get buy-in into their schedules, it is important to involve the main players and contributors of the project in the planning and scheduling of tasks and resources. This also helps project managers to estimate the duration of the various activities accurately, as the manager may not have the required in-depth knowledge of all the underlying activities (Young, 2006). This point is also stressed by Jones (2007), who explains that one of the reasons for poor programme estimates is that the people that actually have to do the work are not involved in defining and planning it. Planning methodologies were also rated the most important core competency in a study done on core competencies related to project management in the South African context by Birkhead et al. (2000).

- Calculating team sizes and allocation of resources

When working on large multi-discipline construction projects, there are normally a number of overlapping modules of work, often performed by different companies focusing on the different specialist fields. When a contractor needs to start the next phase or module of the project, the date by which the previous contractor needs to complete a task is extremely important. In the same way, different tasks on the same project can be affected by a previous task, which may prevent subsequent tasks from being started. For such activities, milestone dates are created – this

means that the specific deadline needs to be met (the milestone must be reached) in order for the next activity to start. For project managers to calculate and allocate their resources on the project correctly, they need to have a thorough understanding of the internal milestone dates on the project and also of the milestone dates set in place by the client (Jones, 2007).

When calculating how many resources to allocate to a specific task and using this to develop a schedule, the project manager needs to understand the dynamics of working with large teams. One of the aspects that need to be considered is the actual availability of the resources required. It is a reality in the construction industry today that the project manager must take into account the overall time and impact of distractions such as training, team safety meetings, absenteeism, tea and lunch breaks and the time before and after each break that the team takes to get back to full production, idle time due to people's standing around chatting instead of actually working and time lost to holidays (Jones, 2007). All these factors need to be considered when planning the make-up of a team to complete a particular task by a certain end date.

When working predominately with large teams, it is also important to remember that although the majority of the team members may be responsible for similar tasks, some individuals may be responsible for a single task, and that there is no replacement for this individual (Jones, 2007). An example of this in the construction industry might be the operator of a specialist piece of equipment, such as a mobile hydraulic crane. When the operator is on leave or becomes sick for a week, any activity that requires the use of that specific resource either has to be postponed, or alternative plans have to be made to complete the task without the specialised resource.

Another important factor in the allocation of resources is the project manager's consideration of the company as a whole. For a company to plan and strategize effectively, it needs to be up to date with the availability and performance of all its resources. These resources of the company as a whole include all the capabilities of the construction company, including that of its project managers, financial resources, technical resources, the leadership and the experience of the company (Isik et al., 2010). It is important for a project manager not to retain resources unnecessarily on a particular project as a luxury, which could potentially harm other projects that the company may be engaged in (Jones, 2007).

- Problem solving and route cause analysis

  Together with risk management, day-to-day problem-solving requires a project manager to have very clear decision-making skills. Problems arise at all levels of a construction project, including production, managerial and health and safety issues. To ensure that the various problems do not delay the project, the project manager needs to analyse each problem, establish the risk associated with that particular problem and make a clear decision on the way forward (Dainty et al., 2005).

  In order to do this effectively, the project manager must have the ability to develop an understanding of the problem by breaking it down into its various elements and then developing an understanding of how each element will influence other tasks in ways that might not be obviously related (Dainty et al., 2005). The project manager's attitude must be to challenge statements such as "it can't be done". When faced with such a problem, a project manager must be able to understand why such a statement has been made, consider all the alternatives to the mentioned problem and think "out of the box" for solutions that have no additional time, money or practical limitations, and then adopt this solution to his current circumstances to best resolve the problem (Jones, 2007). Birkhead et al. (2000) ranked problem-solving as the fourth most important core competency in their South African research.

- Continuous learning and adaptation to different environments

  Given the likelihood that a single project will repeat itself is very slim, a project manager must be able not to take everything at face value and to understand and learn from new environments quickly, and then apply what was learned to the project. The project manager must also have the ability to learn from previous projects and mistakes made in previous projects to combine collective knowledge for use in the current project and to prevent past mistakes from recurring. This will also increase the project manager's knowledge and competence on an on-going basis (Dainty et al., 2005).

  It is also very important for the company to have project managers that have the ability to learn and build up a wide knowledge base of the construction industry that they operate in. To run any project efficiently the access to best practices, lessons learned, examples of historical schedules and other information is of vital importance to a company. Although it is not always possible for each project

manager and employee to have all the required experience, the company can put together an experienced team based on its collective experience over past projects (Isik et al., 2010).

- Financial and cost management

  Cost management refers to all the activities that, collectively, are responsible for ensuring that the overall project costs are kept to a minimum, but that all the requirements of the client are still met (Isik et al., 2010). One of the most important objectives for a company is to make money. It is therefore also extremely important that one of the objectives, either directly or indirectly, of the project is to either make or save money. It is therefore very important to realise that even if a project is able to finish on time and to the correct specifications, if it loses money or costs more money than it ultimately saves the company once completed, the project will be regarded as unsuccessful (Heerkens, 2005). Despite this challenge to complete projects at the lowest possible cost, project managers also need to have the ability to see opportunities for increasing profits or savings that a project was initially designed to yield by spending additional money, thus going over the original project budget, but ultimately realising a larger profit than initially planned (Heerkens, 2005).

  The use of and the understanding of budgets or forecasts is important for a project manager to plan how money will be earned and spent over the life of the project. This is important, because the rate at which money is spent and the rate at which money is earned are not always linked – sometimes one may have to first lay out capital to buy and install a machine, and only receives compensation some months after the work has been done. It is important to understand how such a spending/earning curve will influence the project's and the company's cash flow. To perform these tasks accurately, a project manager must understand how the money issues are linked to the different activities in the project schedule, as this will form the basis of how money is earned and spent (Harrison, 1993).

- Claims and contractual experience

  Due to the large number of parties involved in the construction industry and on a particular project, together with uncertainties linked to the environmental aspects of each individual project, the possibility of delays between parties and claims against parties is a reality. However, many claims and disputes between parties can be

prevented if a project manager is experienced in and able to state the contractual terms and conditions of the contract clearly, if possible problems between parties are communicated early and in a productive manner, and if the manager has a good understanding of what causes claims by both parties. It is in the interest of all parties to prevent such claims, as in any claim situation, there will always be losers (Isik et al., 2010).

In the past, project managers were expected to be more technically and industry-specific; today, they are expected to be more business-oriented. Project managers need to understand how their project influences the bottom line of their companies, when to apply different business tools and techniques, and what benefits the project and the company can gain from doing so (Heerkens, 2005).

- Leadership and managing different stakeholders – clients, subcontractors, foremen, unskilled workers and internal departments

  With a very broad range of personalities on a construction project, a clear, single-minded approach is needed from the project manager. However, the project manager must be flexible and able to adjust to the changing environment and the different levels of people dealt with on a day-to-day basis. An important part of managing all the different stakeholders and showing strong leadership capabilities is honesty and integrity (Dainty et al., 2005). The project manager needs to have the influence and assertiveness in the project environment to get the team to work together, and must direct teamwork and cooperation towards achieving ultimate project success (Dainty et al., 2005).

  In any project, various stakeholders, including the main contracting company, the project team, public or private clients, subcontractors, labour unions, suppliers and financial institutions are involved at some point, or for the duration of the contract. The relationships with all these stakeholders for both the duration of the project and the future are extremely important for a project manager and the construction company. The relationship between the client and the project manager needs to ensure that the client gets what he or she specified and that the contractor is paid what is owed to him or her. In the long run, it is also important for the construction company to secure future work from the same client. As the majority of the work is done by labour represented by labour unions, labour relations are also critical, because if there is a break in the relationship between the construction company and labour, it could cause delays, and the contractor would have no recourse from

the client. It is also important to realise that the same labour union represents the labour involved in all the other projects in the company, so that if strike action arises on one project, it is likely that the strike can spread to other projects, causing more delays and disruption. For the same reasons, the relationship with the main project suppliers is important, because a company tends to use the same major suppliers on other simultaneous and future projects (Isik et al., 2010). Most of the responsibility for maintaining these relationships rests with the project manager.

It is the responsibility of the project manager to identify and manage all the external stakeholders mentioned above, but also to identify and to manage the internal stakeholders. Various departments, including production, health and safety, quality, the accounts department and the human resources department are involved in the project either directly or indirectly. A project manager needs to know exactly what is expected of every stakeholder or department and what they expect of the project team. All these stakeholders must be managed for the duration of the project to ensure that every department fulfils its role in the project, takes responsibility for and is accountable for its obligations (Young, 2007).

- People and human resources management

One of the most important aspects of the overall project management is the managing of people on the project. The project is delivered by people from different skills sets, and these different people are responsible for completing different tasks (Isik et al., 2010). As the team on a construction project only work together for a single project, it is very important to ensure that all the members function effectively as a team. The project manager must manage the team's social dynamics to create and ensure an environment that leads to low staff turnover and increases stability (Dainty et al., 2005). Most projects are relatively short in duration compared to the lifespan of an organisation, and most tasks are only performed by one team member, so staff turnover can affect the overall project very negatively. A project manager must be able to motivate subordinates and to set an example to them as to how the work should be done (Birkhead et al., 2000). It is also very important to realise that it is an important aspect of a project manager's role not just to manage people and engineers, but also to act as a mentor to the young graduate engineers. This is a skill that needs to be developed in most project managers (Dainty et al., 2005).

- Understanding different cultures in the workplace

  When working on an international project, one of the most important factors to consider is understanding the various cultures involved on the project. This can also be the case when working on large projects in one's own country, when international suppliers or specialist subcontractors travel to the country to work on the same project (Madhavan, 1993). There are also some similarities between working in foreign countries and dealing with their various communities, and the interaction between the project teams and local communities on the one hand, and working in a country such as South Africa, where there are 11 official languages and various dialects in each of these and a concomitant range of cultures, on the other (Central Intelligence Agency of the United States of America, 2012). Project managers should be prepared to engage with the different communities that they work in to resolve potential issues between the local communities and the project objectives (Madhavan, 1993). It is equally important that project managers are able to assess the client during the first couple of weeks of the project in terms of any specific cultural or locational differences that may exist between the construction company and the client, to ensure that the project objectives can be met in terms of the client's specific needs (Madhavan, 1993).

  When project managers work in the international environment, or in an area of their own country where the company does not have a local office, it is also important to note that the company will probably employ some of the local people to form part of the project workforce. Managing different people and getting different people to adapt to one working environment is crucial if project managers wish to deliver a project successfully (Madhavan, 1993).

- Personal and project time management

  As many of the project staff look up at the project manager, it is very important that aspects related to self-motivation, enthusiasm, self-discipline, ambition and time management form part of a project manager's skill set, as this will have an influence on how the entire team take responsibility for their respective tasks (Dainty et al., 2005). The project manager must have the ability to identify and assess the current situations on the project to identify where to focus and how to divide the time available to ensure that the most important problems or issues receive the most time and the required attention (Jones, 2007).

It is important for a project manager not to confuse the development of a schedule with the overall time management of the project. In the project as a whole, the development of the schedule is only one of the aspects of time planning. Before the schedule can be developed, the project manager must understand the overall time frame of the project. This must include time for the schedule development, time to understand the schedule thoroughly, and to confirm that the schedule is indeed feasible, identify, acquire and allocate all the required resources as planned in the schedule and then do the actual work according to the schedule. It is also important to be aware that, although all activities are not on the schedule, they are still required and must be completed during the overall project timeline (Harrison, 1993).

- Health and safety, and quality management

When one is working with people in a very complex construction environment, it is possible that accidents can occur that can lead to damage to equipment, personal injury and/or fatalities. Almost all accidents have an indirect cost implication for the project. Each of the above kinds of accident can lead to insurance claims, specialist inspections by external parties, and the possible stoppage of the project to investigate the cause of the accident and to implement the necessary precautions to prevent future reoccurrences (Isik et al., 2010). A project manager must be fully informed of the relative health and safety requirements and the associated risks of the specific tasks involved on a project to minimise the likelihood that any such incidents will occur.

In today's complex construction project environment, quality management plays an extremely important role, as even minor defects can cause structures or elements of structures to be rejected by the client, which may mean that they have to be demolished and reconstructed. The corrections and reconstruction of elements will definitely have a cost implication, and may also have a negative impact on the programme as a whole (Isik et al., 2010). The project manager must set the example of implementing the quality system to ensure that the client's needs are met, the work is done correctly the first time, and no money is spent on corrective action (Banarjee, 1993).

- Industry-specific specifications

  When working on international contracts or contracts from different industries in the company's home country, it is very important to know which standards and specifications are relevant and are used to define technical boundaries. Before any equipment is ordered or manufactured, or anything is constructed, it is the responsibility of the project manager to ensure that he or she and the team are familiar with the specific technical specifications of the local country or the specific client. The project manager must also have sufficient technical knowledge to discuss the situation with the client or to convince the client where necessary that the specified technical specifications are not the best or are not appropriate for the local or project specific conditions (Madhavan, 1993).

- Progress measuring and scope management

  A very important behavioural trait is the ability to take the initiative. A project manager must be able to continuously assess the various tasks that are happening to identify potential problems and to take preventative action proactively to avoid the actual occurrence of the foreseen problems. The scope of a project does not necessarily stay unchanged during the lifespan of the project, so a project manager may need to be flexible to find or create new solutions to the project's potential problems (Dainty et al., 2005). This is confirmed by Heerkens (2005), who mentions that the initial definition of a project in terms of its schedule, budget, quality, scope and return on investment is likely to change throughout the project, based on the changing business, economic, political and other external factors.

  It is also important for a project manager to be able to analyse the current trend of the progress and to anticipate future problems because the cost of redoing tasks or activities when they have been done incorrectly is much higher than doing the tasks correctly the first time. The need to redo a task may arise because of errors by the construction team or changes in the initial design. By working together as a team and using the combined experience of the members, potential errors or delays can be avoided or mitigated in the shortest possible time (Madan, 1993). The project manager also needs to be able to use a trend analysis to assist in forecasting how money will be earned and spent in the future of the project (Harrison, 1993).

- Delegation skills and communication

  As the project environment is normally fast-paced, involving various disciplines and with various activities being conducted simultaneously, the ability to transfer knowledge effectively between the internal and external teams is crucial (Dainty et al., 2005). A project manager must make the responsibility of each team member very clear early on in the project to ensure that team members understand that the responsibility for the various tasks rests with them. The project manager must provide the necessary guidance, support, motivation and resources for all team members to fulfil their responsibilities. It is important to give team members ownership, and to show faith in them, by allowing them to do the different tasks on their own. Nevertheless, it ultimately remains the responsibility of the project manager to make sure that the different elements are completed, so it is important to continuously monitor all the team members and the various activities that they are responsible for (Jones, 2007).

- Risk identification and management

  In the current complex, dynamic and ever-changing construction industry, risk management forms an integral part of project management. For all practical purposes, risk in a construction project is unavoidable, as a project works with people, in an environment that is new to all the team members. The project is exposed to environmental factors such as rain, extreme temperatures and flooding. Risk affects the productivity and performance of the resources, the quality of the end product and the budget significantly. It is the responsibility of the project manager and the team to transfer the risk (by taking out insurance policies), to minimise the risk by implementing safe working procedures and proper planning, and to share the risk with the client, or to simply accept the risk and try to avoid it (Isik et al., 2010).

  As risk is almost unavoidable in construction projects, it forms part of the project manager's responsibility to allow certain contingencies in case certain risks materialise during the project. Two main types of risks exist, namely systematic risk and project-specific risk (Buertey, Abeere-Inga, & Kumi, 2012). Systematic risk can be identified at the beginning of a project and this is easier to allow for in terms of a contingency monetary amount. The second type of risk, project-specific risk, is the risk that the project manager needs to understand the best and be able to identify as the project progresses. These are risks that were not visible at the

beginning of the project, but that are identified later on due to factors associated with delivery delays, constructability, certain site conditions and other external factors. A project manager needs to understand these various project-specific risks and the possible effects thereof on the project to be able to allow a certain monetary value to the risk and to allow for such a monetary expense on the bottom line of the project financials as soon as the manager becomes aware of the risk. To be able to accurately forecast and foresee possible risks, the project manager needs to have a very clear scope definition of the project objectives. Without a clear and detailed scope definition, the possibility that unforeseen events will occur increases, and with these events, the likelihood of risks' materialising in terms of time delays or additional expenses also increases (Buertey, Abeere-Inga, & Kumi, 2012).

The competencies discussed above represent those that an ideal project manager should have after gaining experience in all these competencies over various years of working on different construction projects. Hence, each company will have to make strategic decisions about what is required specifically in its industry and the core business of the company (Dainty et al., 2005).

2.5. Project Management Competency Development

In most industries, career development and performance management form part of the human resources management function. This refers to a strategic and planned approach of how to improve the performance of people and teams by developing their capabilities in that specific industry (Raiden et al., 2008).

Because of the concern of the project manager community as a whole about the competence of project managers, a number of standards for project management knowledge have been developed (Crawford, 2005). The development of many of these standards was based on the collective experience of experienced project managers, and not on research (Crawford, 2005). This may be why Thomas and Mengel (2008) found that there was no conclusive evidence that trained or certified project managers were more successful than those who simply gained experience in the industry.

A large part of the development of project managers depends on their experiences in their working life (Edum-Fotwe & McCaffer, 2000). This dependence on experience, and the findings of Lei and Skitmore (2004) and Skipper and Bell (2008) that older

project managers have more competencies than younger project managers, can explain the findings of Thomas and Mengel (2008) on who is better – a trained and certified project manager or a fortuitously more experienced project manager.

One of the leading organisations in the world on project management is the Project Management Institute (PMI). It has developed standards, guidelines and generic areas of knowledge for project managers contained in the Project Management Body of Knowledge, or PMBOK (Project Management Institute, 2012). The Project Management Institute has also developed a knowledge test based on the PMBOK that can be used to rate the current effectiveness of project managers (Crawford, 2005).

Despite these standards that are acknowledged in the industry, there is a large "wish list" of required competencies of varying importance, as discussed in Section 2.4.3. This wish list does not address how to develop these skills – as Thomas and Mengel (2008, p. 306) point out, "[a]t present project managers are left to choose amongst these lists based on their own best judgement".

One of the risks of putting specific standards and competencies in place is that people are only taught how to behave in certain instances. The real challenge in project management is the ability to think and solve problems that the project manager has never come across before. Trained people tend to react only the way they have been trained to do, and fear change, as it may draw them out of their comfort zone (Thomas & Mengel, 2008). Project managers therefore need to be exposed and trained to handle change and adapt to different circumstances, something that formal training alone cannot always provide (Thomas & Mengel, 2008). Students should be enabled to understand the environment and the context in which they are operating before they start to apply general rules and standards that their formal training might have provided them with (Thomas & Mengel, 2008).

Banarjee (1993, p.171) raises a valid point when he argues that there is a definite difference between simply "raising awareness" regarding certain skills and actually "developing skills". Many institutions or companies provide training that only exposes project managers to situations that may arise, but fail to develop the skills required to deal with that specific situation or similar situations. There is a very large component of developing skills that official off-the-job training cannot develop; therefore it is essential to develop skills by means of on-the-job training and mentoring coaching (Banarjee, 1993).

2.5.1. Project management competency development in engineers

Project management development for engineers is in many ways similar to that of project management development in general. Some competencies can be learned in school or formal training, but others need to be learned on site by experience (Odusami, 2002).

Given that most engineering project managers receive mostly technical, mathematical and science education in their undergraduate years, they are well equipped to address the technical aspects of project management, but are not prepared to undertake the general management of projects (Edum-Fotwe & McCaffer, 2000). Many of the skills and the combination of the technical and the general management skills required are specific to the construction industry (Edum-Fotwe & McCaffer, 2000). Based on the changing environment and globalisation, engineering project managers must understand the need for a career of "lifelong learning" and continued development in the areas of both engineering and management (Farr & Brazil, 2009, p. 3).

As with project managers in general, there are distinct differences between the competencies of older project managers and those of their younger counterparts (Lei & Skitmore, 2004). The majority of project managers in Lei and Skitmore's (2004) study only became project managers after completing at least six years in more junior positions. Edum-Fotwe and McCaffer (2000) reported that this prior experience may be closer to ten years in more junior positions.

Skipper and Bell (2006) found that leadership is learned through the experience of being repeatedly placed in leadership responsibilities and that the top performing project managers were those who had the most experience. One of the problems of this learning by this trial and error method is that it takes time, and the more competitive time that the industry currently finds itself in, does not allow much room for error. This then necessitates the advancement of the learning and development of project management competencies in engineers.

The current state of affairs in the industry does not lend itself to this option. As Raiden et al. (2008) mention, most development activities are very informal or reactive. This means that either engineers are still being left to gain experience by trial and error, or that only once someone specifically asks for it does some form of development take place. The situation is exacerbated by managers who only drive their employees' development to the extent that it benefits a current project and by the fact that much of

the development is left to the operational line management, instead of being taken on by the company as a whole (Raiden et al., 2008). It is due to this, and the fact that mentoring plays such an important role in the development of young engineers that Dainty et al. (2005) also identified the need to develop the competency to develop others in engineers to ensure that when junior engineers become more senior, mentoring, coaching and development of others become second nature for them.

A final problem with the current systems is that there is limited proof of involvement of the employees in planning of their own development needs (Raiden et al., 2008).

2.5.2. Professional and career development

Living in the 21st century, one of the realities of the workplace is that globalisation and digital advances play a major part in how employees and organisations interact. During the previous century, it was quite normal for an employee to spend 30 years in the same organisation and thereby develop a career, advancing up the corporate ladder at a slow but more or less guaranteed pace in a sheltered space. By contrast, it has been predicted that employees who are now entering the working environment will easily occupy up to 10 jobs in their working careers (Savickas, 2012). This will force people to play a larger role in their own professional and career development than before, not relying solely on the employer, but becoming life-long learners (Savickas, 2012).

Looking at the social and working environment in South Africa today, a parallel can be drawn to a research paper by Creager (2011), who discusses how large a role different issues such as values, cultures, income groups, being women versus being men, age and disabilities play in what different people see as priorities and what is required for career development (Creager, 2011). In combination with the way in which globalisation and digitalisation have affected how younger workers see their career path as not necessarily being with one company for their whole career as before, these factors make it extremely difficult for employers and employees to find the perfect balance to suit each individual. This argument is in line with that of Shillingstad (2012), who found in her interview with a coordinator at a US university that the whole topic of professional development is seen as a very personal issue for an employee and that he or she needs to make decisions that the organisation cannot make for him or her (Shillingstad, 2012).

2.6. Project Management Competency Development Processes

It has already been mentioned that some project management competencies can be acquired by formal training and others are acquired from site experience. One of the most important steps in the development of project managers and leaders is that young engineers need to be encouraged to take on new challenges that will push them out of their comfort zones (Farr & Brazil, 2009). “An engineer will never improve their interpersonal, communication, managerial, etc., skills if they only stick to aspects of the project with which they feel comfortable with” (Farr & Brazil, 2009, p. 5).

Several sources in the literature suggest that one of the most important sources of development is having a mentor (Farr & Brazil, 2009). Below, mentoring and other ways of gaining experience and being developed are discussed.

2.6.1. Training and learning in adults

The word “learning” can be interpreted in different ways, depending on the individual. O'Conner and Cordova (2010) refer back to a definition of learning as “a process of making sense of life’s experiences . … Making choices and decisions as a means of obtaining feedback to confirm or disconfirm meanings and choices” (Mackeracher, 2004, p. 8). Other definitions also suggest that learning is affected by both the mind and the physical experiences of the body. This leads to the understanding that adults make choices and have different perceptions about the value of a specific topic of learning, and these will influence whether or not learning actually takes place. In short, if an adult decides that he or she does not want to learn something new, the person can be sent on all the courses available and still accomplish nothing (O'Conner & Cordova, 2010). Learning in adults and different methods of learning and development will be discussed under the following bullet points:

- Learning in adults

  An important part of learning in adults is the link between the context in which they operate and live, and what they expect to learn. The context that needs to be considered is not limited to the context of the work place, but also the context of where the learners fit into society. If something is explained in terms of something that learners have never experienced in their working or private life, the likelihood

of their understanding the issue is very low. Learning in adults involves not only the mind and memory function, but the whole body, emotions and spirit of the learner. For the brain to function at its best, it needs to make connections between what is being a learned and a physical experience that the learner can relate to (Merriam, 2008).

Some of the best methods that have been described in effective adult learning are the use of narrative and storytelling. It is also suggested that dialogue and time for reflection be encouraged, and not to simply treat adults like children in a classroom environment where they are told something and they have to accept it as the truth even if they have questions regarding the topic. Together with dialogue and discussion, the new learning topics can also be linked to old or previous experiences, so that the learners have something to relate to, which enables them to understand the current topic better (Merriam, 2008).

For learning to happen effectively, it needs to fulfil the needs of the individual in his or her personal environment and must be relevant to the person's work environment. The relevance of both these environments directly affects the learning process and experience (O'Conner & Cordova, 2010). This is illustrated in Figure 1 (overleaf), which is adopted from O'Conner and Cordova (2010, p.360).

Another view on adult learning is that of lifelong learning. Lifelong learning is based on the principle that adults continue to learn throughout their lifetime and thereby continuously develop their knowledge and skills. This continued development of skills and knowledge is not something that can be learned in a prescribed period, for example, going on a one-week or two-month course. This approach ultimately requires people to develop an open state of mind where they are open to any new ideas, have the motivation to challenge old or previous ways of thinking and realise that they do not always have to over-think a problem where there might be a simple answer. This process forces the person to continuously learn new things, from time to time relearn things that was already known and at some points in life, unlearn things that were previously relevant, but might not be so any longer (Lamb, 2011).

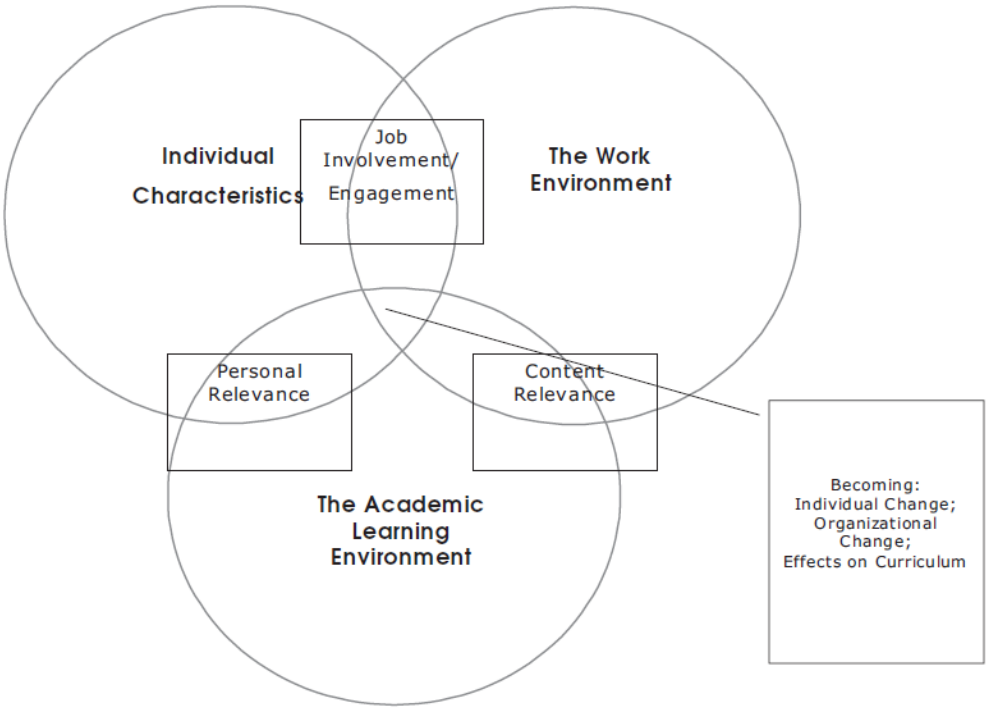

Figure 1: The Relationship of Individual Characteristics, the Work Environment, and the Academic Learning Environment on the Transfer of Learning
Source: O'Conner and Cordova (2010, p.360)

From all the research above, one important fact that stands is that adults need to make a choice to develop themselves – if they resist the likelihood of failure increases.

- Workplace learning

Learning that takes place in the workplace can be divided into learning by gaining experience from physically doing a task, or from training provided by the employer. It should be noted that in most cases, the employer only provides training that the company thinks is relevant to its operations. Hence, because the employer controls the time and resources spent on this, the employee has little control over this learning (Ball, 2011).

- Learning by experience

Learning by experience can also be described as informal learning. This refers to learning that is not structured, or has not officially been planned, and that people

predominately do on their own. This can be through the normal physical working experience or through the way that individuals live their normal lives (Jubas, 2011).

Another topic that falls into learning by experience is problem-based learning. The idea in problem-based learning is that once confronted with a problem, a person can break down the problem, and by then looking at the parts of the problem the person can use prior knowledge of similar or related problems to solve this problem. This works well in a working or group environment where the collective knowledge of the group can contribute significantly towards solving the problem (Schmidt, Rotgans, & Yew, 2011). This new knowledge is then retained in the person's experience for future use in his or her working or private life.

The individual has a responsibility to keep up with the technological and innovation advances in the industry to ensure that that he or she has sufficient expertise to advance his or her career. Keeping up with these changes and advances in technology and social changes allow a person continuously to improve his or her skills-base and also improve productivity and efficiency in the workplace, something that will assist the person in career development and promotions to new job positions (Gong, Chen, & Lee, 2011).

- Mentoring and coaching

"A mentor is generally defined as an experienced individual within an organisation who has attained a certain rank or achievement and who can provide career development support to less experienced individuals in that organisation" (Gong et al., 2011, p. 807). Positive relationships have been demonstrated in past studies between mentoring and the effect thereof on the remuneration, job satisfaction, promotion and career satisfaction of the employee or mentee. Considering that up to 70% of learning in the workplace takes the form of informal learning, the relevance and the important role that a mentor can play in an employee's career is clear (Gong et al., 2011).

Mentoring can also be used as a company strategy to advance the career development of employees at a higher pace than by simply letting them gain experience under normal working conditions. By improving job satisfaction, a company can ultimately improve the productivity of its employees, yielding better returns for the company (Gong et al., 2011). Companies also need to look at mentorship as not just being a kind of short-term role modelling. They need to

focus on the longer term and must ultimately be able to use this strategy in succession planning, where a mentee can take over the function of the mentor when the mentor steps down or retires (Subotnik, Edmiston, Cook, & Ross, 2010).

By learning from an experienced project manager and working closely with this mentor, young engineers can learn from the mistakes of others without having to make the mistakes themselves. A combination of formal training, on the job training and mentorship is the ideal combination for development (Farr & Brazil, 2009). One caveat with mentorship is, however, that it is important to find the right individual to be the mentor. Many middle and senior managers complain about the incompetence of young engineers, but it is typically those managers that are too busy to actually mentor and teach the younger engineers (Farr & Brazil, 2009).

- Induction programmes

With regard to induction programmes, four key points should be considered. The first point correlates with what was seen under the adult learning heading, namely that a good induction programme is interactive. The delegates that attend must have opportunities to take part in the discussions and ask questions on the various theories. The second point is the way in which the programme is tailored to the individual. It helps if the trainer has some background on all the attendees and if there are name tags for each attendee so that they can receive the necessary individual attention. It must be realised that for the majority of the delegates, the induction process is the first real interaction with the company and/or industry and this will create a lasting impression. For this reason, an induction programme must be well presented and the choice of trainer is very important. The last point is the importance of the structure of the entire programme. It needs to be set out logically, with enough time for the new delegates to get to know each other, the trainer and the new company, before starting to focus on the work that will be required (Blunt, 2010).

The following topics for discussion need to be included in an induction programme once the basic layout mentioned above has been finalised. Time must be allowed for discussion of the company's administration procedures. New delegates should understand details of pension schemes, working hours, rules and regulations and dress code. The programme should include the terms of the employment set out in the employment contract, covering issues such as annual and sick leave and grievance and disciplinary procedures. The health and safety policies of the

employer need to be discussed with regard to smoking, drug and alcohol use and minimum personal protective equipment that might be relevant. When these basic conditions and all introductions to fellow attendees have been completed, more detailed discussion on the specific work and working environment can proceed (Business Link; Department for Business, Innovation & Skills, 2012).

2.7. Perceptions of Management Development

Currently, organisational development needs are often established by senior managers without involving the potential participants (Hotho & Dowling, 2010). As a study by Muchiri, Cooksey, Di Milia and Walumbwa (2011) found, there are definite differences between the perspectives of managerial and non-managerial employees on what effective leadership involves. Considering that leadership is one of the key competencies of project management and the fact that engineers receive neither leadership nor management training, it can be assumed that similar differences in perceptions regarding project management might exist.

Crawford (2005) has also shown that project managers and senior managers hold different views on what the most important competencies of a good project manager are. One of the reasons for this might be that the fundamental focus in project management has changed significantly over the last few decades, from being very technically inclined to the more interpersonal and behavioural aspects, otherwise known as the soft skills, of managing projects (Heerkens, 2005).

2.8. Conclusion on the Literature Review

On the basis of the literature review, it is clear that there are a number of problems that relate to young engineers that enter the construction and project management industry. They start off with very little exposure to management, project management and leadership skills in their mostly technically oriented education, but are expected to become part of a site management team where one of their first tasks is supervising people and materials on a construction site.

The field of project management in general does not provide an easily identified guide to what competencies are required and how these competencies should be acquired. In the construction industry, it is evident that many development plans are left to operational line management. Where senior managers and other senior officials do have a set development plan, junior members of staff are not involved in making choices regarding their future development, and the development of such plans are usually based on the perceptions of the senior managing staff only.

There is also evidence that most training is *ad hoc* and often comes too late. Looking at the lists of requirements or competencies, it is clear that not all of these items are required by young engineering graduates during the first five years of their working experience, and moreover, there is no indication of which of these competencies are most relevant to their specific needs. This suggests that in most cases, young engineers are left to decide for themselves what development is needed, and the actual development is also left up to them.

The need for a study on project management competency development in graduate engineers and the different views on project management competency development from different levels of staff and different professions in the construction industry is therefore clear, and was addressed by the current study.

CHAPTER 3: Research Questions

Based on the literature review reported in Chapter 2, it is clear that although graduate engineers are often placed in the responsible position of supervising people and material, they get very little exposure to such tasks or formal training before being placed in this position in the construction industry. Various sources in the literature list the competencies expected of a project manager, but few discuss in detail the competencies required by a graduate engineer who is put in a supervisory position, forming part of a management team.

The research questions listed below are aimed at identifying those project management competencies that are required by graduate engineers during the first three years after they graduate.

Research Question 1: Who in a construction company is responsible for the early career development of graduate engineers?

Research Question 2: What are the project management competencies that need to be developed in young graduate engineers?

Research Question 3: Do the perceptions or views of which competencies are required differ among young graduate engineers, human resources professionals and senior managers?

Research Question 4: What is the best method or combination of different methods to develop these competencies?

Research Question 5: Do the perceptions or views of which methods are the most effective in developing these competencies differ among young graduate engineers, human resources professionals and senior managers?

CHAPTER 4: Research Methodology

4.1. Introduction

The research was conducted in two phases. The first phase was qualitative in nature, consisting of data elicited via open-ended interviews conducted to establish constructs for the quantitative second phase, which used electronic questionnaires, as recommended by Saunders and Lewis (2012).

4.2. Phase One

4.2.1. Research design

The research design for this phase of the research was qualitative (Saunders & Lewis, 2012) (Mouton, 2009). Data for this phase of the research were gathered by conducting in-depth semi-structured interviews with graduate engineers, human resources professionals and senior management from various levels in a large South African construction company.

The purpose of this phase of the research was to elicit information regarding what the different competencies of project management are that need to be developed in graduate engineers in a South African engineering construction company during the first five years of service after graduating, and how these various competencies of project management should be developed, based on the opinions of different levels of management in a typical South African construction company.

In the second phase of the research (see Section 4.3), the responses from these interviews were then used in conjunction with the competencies that were identified in the literature review set out in Chapter 2 to design a questionnaire that was distributed to a larger audience of graduate engineers, human resources professionals and senior managers in the same construction company to get sufficient responses for statistical analysis.

4.2.2. Population

The population (Saunders, Lewis, & Thornhill, 2009) for the research was civil engineers, human resources professionals and project managers in the construction industry in South Africa.

4.2.3. Sample

The sample (Keller, 2008) for the research was civil engineers, human resources professionals and senior managers from different management levels in one of the five largest construction groups in South Africa. The company has an annual turnover of R 8.9 billion and employs about 16 000 people. The company has around 60 engineers with between one and five years' experience, about 40 engineers with between five and 10 years' experience and 40 full-time project managers (from an engineering background) with varying experience between 10 and 30 years in their various business units across South Africa. A typical organogram indicating the reporting structure in a South African construction company is attached in Appendix 1.

The method of sampling used was non-probability quota sampling, because all the engineers and human resources professionals in the construction industry in South Africa were not available to the study, and only a certain number of individuals that fitted the correct profile were chosen from the construction company that was identified (Saunders & Lewis, 2012).

The company's head office is in Johannesburg, but the company also has offices in other parts of Gauteng, Durban, Richards Bay, Port Elizabeth, East London and Cape Town. To identify the individuals for the sample, the human resources managers of the various divisions were contacted, and they supplied an employee database with job title, years of service and email addresses. For the first phase, it was decided for practical reasons to restrict the quota sample to employees based in Gauteng or employees who visited the head office regularly, and the sample was taken from the employee database. One of the criteria was availability for an interview.

The sample sizes are set out in Table 1.

Table 1: Phase One Sample

Graduate civil engineers with less than five years' experience	Human resources professionals in the construction industry	Senior Project Managers, Directors and Managing Directors in the construction industry
7	2	8

4.2.4. Unit of analysis

The unit of analysis (Mouton, 2009) for the research was perceptions of individuals in the construction industry with an engineering qualification or in the human resources profession in the South African construction industry.

4.2.5. Data collection tool

The data collection tool for this phase of the research was in-depth, semi-structured open-ended interviews (Saunders & Lewis, 2012) with seven graduate civil engineers with between one and five years of working experience, three senior managers, five managing directors, one human resources manager and one human resources director.

In these interviews each of the candidates from the different level of management in the organisation was asked what the most important project management competencies are for the development of graduate engineers into effective and competent project managers in the construction industry. Some of the competencies from the literature that were reviewed in Chapter 2 were also discussed after the interviewees had listed the competencies based on their own experiences. The next question that was tabled was aimed at identifying what processes or methods each individual felt were the best suited to expose the graduates to and develop these competencies in the young graduate engineers. In most cases, a general conversation about the industry and the need for skilled employees also formed part of the discussion. (See Appendix 2 for the interview guideline and Appendix 3 for a sample of a consent form.)

4.2.6. Data collection

The data collection consisted of 17 face-to-face semi structured interviews with the identified individuals as set out in Section 4.2.3 and Table 1. The interviews were conducted over a period of two weeks, by making appointments ahead of time with the individual or their secretaries, in the cases of the directors and managing directors, and giving the individual a brief summary of what was to be discussed. The interviews lasted approximately one hour each. The interviews with the senior managers, directors, managing directors and the human resources managers were held in their respective offices in Johannesburg. The interviews with the engineers were held on

the construction sites where they were working and at the Johannesburg office, in the case of two individuals who were there for training. All the interviews were conducted in English, although some of the competencies were explained and discussed in Afrikaans with some of the respondents whose first language was not English.

All the respondents who have been working for two years or more seemed very relaxed and actively took part in the conversation. It was encouraging to see that almost all the senior managers and directors felt extremely passionate about developing future talent in the company. Two of the engineers had only been working for six months by the date that the interviews were scheduled, and it was noticeable that they were less comfortable with the process.

At the beginning of each interview, the interviewee was introduced to the topic and the reasons for the research were explained. Thereafter, the person was asked to sign the consent form. It was explained that the meeting might be recorded on an electronic voice recorder and that everything that would be discussed would be treated as confidential. The data were therefore collected by means of a recorded interview, using an electronic recording device, and by taking notes. The recordings would only be used if the content of the notes was insufficient.

After the interviews, most of the senior managers agreed that there was indeed a gap between the education that an engineer receives and what is actually expected of the engineer in the construction environment in terms of managing people and construction processes.

4.2.7. Data analysis

After each of the interviews, the various competencies were identified from the discussion and tabulated in a Microsoft Excel worksheet. After all the interviews had been completed, the various competencies were grouped together into similar topics to avoid duplication. The frequency with which each of the competencies was seen as being important by the various individuals was recorded and the competencies were ranked in order from the highest frequency to lowest.

The various methods of exposing graduate engineers to these competencies and developing them during the first five years after graduating were also tabulated in Microsoft Excel and ranked, based on the frequency with which each method was

suggested. A section of this worksheet is attached in Appendix 4. The data were then used in Phase Two.

4.3. Phase Two

4.3.1. Research design

The research design for this phase of the research was quantitative surveys (Keller, 2008; Saunders & Lewis, 2012). Data for this phase of the research were gathered by circulating electronic questionnaires to graduate engineers, human resources professionals and management from various levels in a South African construction company. An electronic survey was used, as the company has offices in Johannesburg, Durban, Richards Bay, Port Elizabeth, East London and Cape Town, and this was the fastest practical way to get responses from all the different offices.

The purpose of this phase of the research was to gather sufficient data to test the responses that had been recorded in Phase One and to answer the research questions. This was done by designing electronic questionnaires based on the responses from Phase One and the literature in Chapter Two.

4.3.2. Population

The population (Saunders, Lewis, & Thornhill, 2009) for the research was civil engineers, human resources professionals and project managers in the South African construction industry.

4.3.3. Sample

The sample (Keller, 2008) for the research was civil engineers, human resources professionals and senior management (previous project managers) from different management levels in one of the five largest construction groups in South Africa. The company has a turnover of R 8.9 billion and employs about 16 000 people. The company has around 60 engineers with between one and five years' experience, about 40 engineers with between five and 10 years' experience and 40 full-time project managers with varying experience between 10 and 30 years. See a typical organogram indicating the reporting structure in a South African construction company in Appendix 1. The method of sampling was non-probability quota sampling, because all the engineers, human resources professionals and senior managers in the

construction industry in South Africa were not available to the study, and only a certain number of individuals who fitted the correct profile were chosen from the one construction company (Saunders & Lewis, 2012).

The sample and response rates are set out in Table 2, below.

Table 2: Phase Two Sample

Graduate Civil Engineers with less than five years' experience	Human Resource Professionals in construction industry	Senior Project Managers, Directors and Managing Directors in construction industry
Questionnaires sent out		
49	31	104
Responses Received		
29	16	42

4.3.4. Unit of analysis

The unit of analysis (Mouton, 2009) for the research is perceptions of individuals in the construction industry with an engineering qualification and in the human resources profession.

4.3.5. Data collection tool

The data collection tool (Mouton, 2009) was originally planned to be three different questionnaires set up on a web-based electronic program (Survey Monkey) that could be e-mailed to the various respondents. There were different questionnaires set up for engineers, human resources professionals and senior management. The questions on project management competency development in the questionnaires were developed by analysing and grouping the responses received from the interviews in Phase One into main themes or topics, as set out in Table 6.

The main reason for developing three different questionnaires was to make sorting the responses from the three different groups easier, but there were also some questions that were only aimed at the particular target group. The web-based program (Survey Monkey) has a function that allows the compilation of all the data from the various questionnaires to allow for easy comparison of the data. However, after the questionnaires had been sent out, it was realised that, due to the different locations of

the various offices and construction sites, some of the recipients could not access the electronic web-based questionnaire because of slow internet connectivity or problems with internet firewalls on the various servers. It was therefore decided to distribute the same questionnaires to the non-responsive recipients in the form of a Microsoft Excel questionnaire by means of a mass e-mail message. This ultimately meant that the responses from the web-based and the Microsoft Excel-based questionnaires had to be combined manually.

The questionnaire started with some clarifications on the study and then asked for information on some basic demographics, such as the type of undergraduate education the respondent had, years of working experience, current management level and current job title. These questions were all based on multiple choice answers, with the option of a manual entry the recipient not fall into one of the preselected multiple choice categories provided.

The next set of questions tested the views of the various recipients on the need for the further development of graduate engineers, and also on who should be responsible for this. The purpose of these questions was to compare the responses from the different staff levels, and the responses from the operational personnel with those from the human resources personnel.

The next sections were based on the results from the interviews from Phase One of the study. The respondents were given the 18 various project management competencies that might need development that were deduced from Phase One and were also provided with an option to add additional competencies if they felt that some important competency was not represented by the 18 that were mentioned. They were then asked to rate the importance of each on a five-point scale that started with the option of *can be acquired at a later stage* as the least important and progressed to *absolute requirement during year one to five* as the most important.

The respondents were then given a list of 13 possible ways of how these competencies could be developed in graduate engineers, based on the response to the interviews in Phase One. They were asked to rate them on a five-point scale, starting at *not required* as being the least likely to work, to *best suited for development* as being the most suitable method of developing gradate engineers. The respondents were also given the option to enter other methods if they felt that all the possible options were not mentioned among the 13 provided.

The questionnaire ended with a section on possible career paths in the construction industry, because the failure to explain this issue to engineers at an early stage in their careers might also influence their view on project management development. The respondents were then asked to rate various aspects of the construction industry in terms of how it has changed over the last 15 years. This section ended with an open-ended question regarding the biggest challenges that graduate engineers face in the first couple of years after graduating. The purpose of these questions was to possibly explain some differences between the opinions of young graduate engineers and those of senior managers, based on the extent to which the industry has changed since the time that these senior managers were in the same position as the current graduate engineers are now.

4.3.6. Pre-testing of the questionnaire

The final questionnaire was presented to a project manager and a site engineer in the company to be tested to ensure that they were satisfied with the contents and that the questions were logical. After they had completed the questionnaire, it was discussed with them and some minor changes done to clarify some of the questions to ultimately receive better responses. The questionnaire was sent out for a second test, after which the employees were satisfied that the questionnaire was user-friendly.

After these initial tests, the questionnaire was sent to the supervisor of the study for further comments on the questions and layout to ensure that the optimal responses would be received, based on her experience in past research projects.

4.3.7. Data collection

With the assistance of the human resources department, an employee database was created consisting of all the graduate engineers and technicians with up to five years' experience, human resources employees and senior managers. This included the e-mail addresses of all the employees, so that the questionnaire could be distributed electronically.

The Information Technology department of the company assisted in sending out the questionnaire electronically via electronic mail to the various participants identified with the assistance of the human resources department. A period of five days was allowed for the respondents to complete the questionnaire, after which a reminder was sent to all those that had not completed the questionnaire. After the first reminder, it was

noted that some of the respondents were unable to access the web-based questionnaire due to problems with the server firewall and the slow connection speed at some of the various offices and construction sites. It was then decided to design copies of the various questionnaires in the form of a Microsoft Excel spreadsheet and to e-mail this, as well as the link to the web-based questionnaire, to all the respondents who had not already completed the questionnaire.

The data from the web-based questionnaire were exported to Microsoft Excel and the responses from the manually sent Microsoft Excel questionnaire were combined manually into one database for analysis.

4.3.8. Data analysis

The first step of the data analysis was to combine the data from the three different surveys into one dataset. This was done by exporting the data from the online survey program to Microsoft Excel. The results from Questions 1 to 5 were treated independently for the three different respondent groups, as this data was only used to describe the sample. Similar questions were used to gather information on experience and qualifications. These responses were converted to a percentage to see the split between the different options given in the various questions.

For the next section on career development, the responses from the different respondent groups were combined to obtain average rankings for the responses from the combined sample, as well as the different respondent groups. The responses were then ranked and compared to the combined average, using Microsoft Excel.

The section on different career paths gave the respondents open-ended areas for responses. These responses were tabulated and sorted alphabetically in Microsoft Excel and then grouped according to the main careers (see Table 30).

The section on the competencies and the methods for competency development was combined in Microsoft Excel, and the average ranking for all of the options was calculated for each of the different respondent groups, as well as for the combined responses. The various competencies and methods were ranked based on the combined average to determine the most important competencies and the most important methods of development. These are tabulated in Tables 31 and 32 respectively. To test for differences in opinions between the various respondent groups on each of the competencies and methods, a Kruskal-Wallis statistical test was

performed at a 95% confidence level (Keller, 2008). The p-values from this test were also tabulated in Tables 31 and 32, with values smaller than 0.05 highlighted in red. These competencies and methods were then subjected to a one-way analysis of variance (ANOVA) (Keller, 2008) to determine the underlying relationships between the different respondent groups. Samples of these statistical tests are set out in Appendices 6 to 17.

4.4. Research Limitations

The main limitation of this research was the fact that all the respondents were selected from one company. This may have led to sampling error (Albright, Winston, & Zappe, 2009) and that the results of the study might not be generalisable. The next limitation was that a non-response bias from the sample might cause the sample to have become too small for significant analysis (Albright, Winston, & Zappe, 2009). The responses came from participants who have worked largely in South Africa and the results were therefore not necessarily applicable to the international construction industry.

CHAPTER 5: Results

5.1. Introduction

This chapter presents the data collected during the two phases of the research. The first phase consisted of qualitative interviews conducted to set the baseline for the second phase, which consisted of quantitative questionnaires (Saunders, Lewis, & Thornhill, 2009).

5.2. Phase One: Qualitative Data

Based on the literature review set out in Chapter 2, it was realised that limited information was available on the topic of which specific project management competencies are important in the development of graduate engineers in the construction industry. Based on this need, it was decided to gather more data on the topic by means of qualitative semi-structured interviews with people from different levels in the construction industry. It was decided to conduct interviews with graduate engineers, human resources professionals and senior managers from different levels in a large construction company in South Africa.

5.2.1. Graduate engineers

The first set of interviews was conducted with graduate engineers with a working experience of between six months and three years.

The interviews were structured around Research Questions 2 and 4 (as set out in Chapter 3). There were some significant differences between the response of the engineers, based on the length of their working experience, but also the fact that the engineers who started with the company in 2012 had undergone an in-depth induction programme spread over six months to introduce them to the company and the construction industry. Although they had only limited actual experience, their level of understanding of the company and the construction industry was better than that of the engineers in their second year of working for the company, simply because there was no structured induction programme in 2011.

The general discussion around which competencies were required proved that all the engineers were extremely enthusiastic about learning more and equipping themselves

better for the work that they have to do. The top four competencies identified by the graduate engineers as being the most important to develop during the first five years in the construction industry were *Activity Duration Estimation, Activity Scheduling, Activity Resource Estimation* and *Understanding the Project & Construction Environment better.* The full list of competencies is set out in Appendix 4.

In total, 26 different competencies were identified. Of these, 10 were identified both by engineers with six months experience and by engineers in their second year of employment. This means that 39% of the responses were identified by both groups. It was noticeable that the competencies that were identified only by the less experienced group are much more theoretical, compared to the responses identified by the more senior engineers, who are more practically oriented, probably based on their experience of the skills they actually required on a construction site.

After the discussion on which competencies are the most important to develop during the first five years after graduating, the respondents were asked to look at various methods that would be best suited to gain the required experience in these competencies. The top four ways that the two groups of engineers felt that graduates would get the best exposure to the competencies that they identified were *On Site Experience – Physically doing different construction tasks, Mentoring, Internal and External training courses* and *A Structured Induction & Development programme in the company.* The full list can be seen in Appendix 4.

In total, six different methods of gaining exposure were identified between the two groups of engineers. Three were identified by both, meaning that 50% of the total number was identified by both groups. From this it can be seen that the engineers who had undergone the structured induction programme placed some value on the induction programme, in contrast to the engineers who did not go through a similar programme. A very promising finding was the fact that both groups identified physical on-site experience as one of the best methods of gaining experience. A concern was that the second highest method, namely mentoring, is not currently officially implemented in the company as a whole, but only in some business units.

5.2.2. Human resources professionals

Interviews were conducted with a human resources director and a human resources manager. Both of these respondents were active in the discussion regarding the development of engineers in general and were very willing to participate in the

research. Both these employees had been with the company for more than three years and they had extensive knowledge of the current and past induction and performance measurement programmes in the company.

After the general discussion on the development of graduate engineers, the research was explained in terms of Research Question 2 and 4 (see Chapter 3), and the respondents were asked to list and to elaborate on project management competencies that they felt were required to be developed in graduate engineers during their first five years in the construction industry. The competencies from the responses are tabled in Appendix 4. The top competency was identified as *Understanding the Project & Construction Environment.*

Ten different competencies were identified by the human resources professionals, compared to the 25 identified by the group of engineers. Of these 10, eight overlapped with the competencies identified by the graduate engineers. The difference in the total number may be ascribed to the fact that the group was smaller or that the human resources professionals are not actually aware of the different competencies, because they do not specialise in that field. The competencies mentioned are all relevant and were all used in the second phase of the research.

The human resources professionals identified six methods that they thought most relevant in gaining experience in the identified competencies (see Appendix 4). The most relevant method identified was *On-Site Experience – Physically doing different construction tasks,* with the other five all receiving equal votes. Only two of these were not identified by the graduate engineers, which implies that there was an overlap of 66% identified by both respondent groups.

The methods of gaining experience that were identified by the human resources professionals were also in line with those identified by the senior managers, except for the last option that the human resources professionals identified, which was *Working through case studies*. This method is a very theoretical way of exposing graduates to different construction site issues, but is still a very good suggestion, seeing that it can be used extremely well in conjunction with a structured induction programme. This was a good indication that if the human resources professionals were involved in the development plan, their ideas would complement those of the other staff members.

5.2.3. Senior managers and managing directors

The three senior managers who were interviewed were two senior project managers and a Chief Operating Officer respectively. All three had more than 20 years' experience in the construction industry. All the managers participated actively in the interviews and were very enthusiastic regarding the topic of the development of the graduate engineers in the company and construction industry. In the general discussion leading up to the main questions, all the respondents noted that the construction industry has changed significantly during the past 20 to 30 years, and that it is extremely important to consider this factor in the current and future development of graduate engineers.

The managing directors who were interviewed consisted of the managing director from the parent company and four managing directors from various business units that operate inside the company. All these respondents had more than 20 years' experience in the construction industry and most had been with the company for more than 10 years. All the managing directors were passionate about the topic of graduate engineer development, as all of them started out as site engineers and spent a long time on construction sites developing their own set of competencies and skills.

The competencies that were identified by the senior managers and the managing directors respectively are listed in Appendix 4. In total, 29 different competencies were identified between the two groups of senior managers. The top four competencies that the senior managers and managing directors saw as the most relevant for graduate engineers during the first five years in the construction industry were *Understanding Project & Construction Environment and Project Stages, Activity Resource Estimation, Problem-Solving & Root Cause Analysis* and *Activity Duration Estimation*.

Of the 29 competencies identified, 11 were identified by both groups. This gives a low overlap percentage of 38%. The longer list can probably be explained by the higher number of years of experience, and the fact that some of these competencies became second nature as the individuals' level of experience increased. The managing directors and senior managers had also been exposed to various different contracts and types of clients over the years, which would enable them to acquire more project management competencies than the graduate engineers were aware of. Hence, they identified more competencies than the graduate engineers, who had only limited actual experience and based their responses more on theoretical knowledge.

The second main question that was discussed was the various methods of gaining experience in these competencies on a construction site. Eight methods where identified between the two senior groups, with five of the eight methods being identified by both groups. The top four methods noted were *Internal / External Training Courses*, *On-site Experience – Physically doing different construction tasks*, *Mentoring* and a *Structured Induction & Training & Development Programme / Guide.* Six of the eight or 75% of the methods overlapped with those identified by the graduate engineers and the human resources professionals.

In the discussion of this question, it became very apparent that times have changed significantly from when most of these senior managers were graduates on sites, on average, more than 20 years ago. All the respondents discussed at length the physical training on site which they consider extremely important for the development of an engineer, and the importance of actually doing some of the work like manual labour, to ensure that engineers know what they are managing in the years to come.

5.2.4. Combined responses from the interviews

5.2.4.1. Competencies

After all the interviews had been completed, the responses from the various groups were combined into Table 3 to establish the overall frequency that each competency was identified by each group. As all the groups were not the same size, the frequency was converted to a percentage to be able to compare the responses equally. The frequency of the responses from the various groups was, in general, well balanced between the graduate engineer group and the senior manager groups. The responses from the human resources professionals were scattered over the entire range of competencies. One reason for this may be that only two individuals were interviewed, as opposed to the seven in the graduate engineer group and the eight in the senior manager group. Another reason could be the fact that the human resources professionals have no background experience in project management.

Table 3: Interview Responses Combined: Competencies

Competencies by Experience				
Competencies	**Total** Frequency %	**Graduate Engineers** Frequency %	**Human Resources** Frequency %	**Senior Managers** Frequency %
Understanding Project / Construction Environment and Project Stages	76%	57%	100%	88%
Activity Resource Estimation	65%	71%	0%	75%
Activity Duration Estimation	59%	86%	0%	50%
Activity Scheduling	53%	86%	0%	38%
Schedule Development	53%	57%	50%	50%
Communication to both Subordinates & Client	41%	43%	0%	50%
Problem-Solving / Root Cause Analysis	41%	29%	50%	50%
Financial Management	29%	57%	0%	13%
Managing Different Persons - Client, Subcontractors, Foremen, Unskilled workers	29%	14%	50%	38%
Personal Time Management	29%	43%	0%	25%
Safety Management	29%	29%	50%	25%
Leading People	24%	43%	0%	13%
Learning Basic Skills in Industry (Physical & Technical)	24%	14%	0%	38%
Quality Management	24%	29%	0%	25%
Understanding Company Systems (QA, Safety, Procurement, HR)	24%	29%	50%	13%
Understanding Standard Specifications	24%	57%	0%	0%
People Management	18%	14%	50%	13%
Personality - People-oriented	18%	0%	0%	38%
Progress Measuring	18%	29%	0%	13%
Project Time Management	18%	29%	0%	13%
Teamwork	18%	14%	50%	13%
Being a Change Agent	12%	0%	0%	25%
Being Able to see the Bigger Picture	12%	0%	0%	25%
Delegation Skills	12%	0%	0%	25%
Risk Identification & Management	12%	14%	0%	13%
Understanding Different Cultures in the Workplace	12%	0%	0%	25%
Claims & Contractual Experience	6%	14%	0%	0%
Conducting Disciplinary Enquiries	6%	0%	50%	0%
Cost Management	6%	0%	50%	0%
HR Management	6%	0%	0%	13%
Integration Management	6%	0%	0%	13%
Motivate Subordinates	6%	14%	0%	0%
Negotiation	6%	14%	0%	0%
Procurement Management	6%	14%	0%	0%
Scope Management	6%	0%	0%	13%
Understanding Own Responsibility	6%	0%	0%	13%
Calculating Team Sizes	6%	14%	0%	0%
Environmental Management	0%	0%	0%	0%

In general, it can be deduced that the differences in the frequency with which these competencies were identified where there was a higher number of responses from the senior managers can be attributed to the senior managers' experience. Having worked on various projects with various combinations of people and having the ability to look back at what would have helped them when they were in the position that the graduate engineers find themselves in currently, enables senior managers to assess the competencies better than the graduate engineers who are still early in the learning curve.

The responses that had a higher frequency than the responses from the graduate engineers can be ascribed to the fact that the engineers viewed some of the competencies they thought they needed from a more theoretical perspective, as opposed to the view of the senior managers, who looked at the issue from a more actual practical perspective. Some of the other responses were more technically oriented and could be explained by the senior managers' expectation that those skills should have been acquired at the various tertiary institutions, while actually they have not been acquired, and these were therefore only identified by the graduate engineers.

5.2.4.2. Development methods

The number of the responses received on the development methods or the methods of gaining experience was converted to a percentage frequency, as the groups were not of the same size. On the list of methods of gaining experience, the total, graduate engineers and senior managers' responses were similarly ranked, as can be seen from Table 4. This is a positive sign, because, although the different competencies identified are not 100% comparable among the different groups, all these groups felt similar on the methods of gaining experience or developing these competencies. The responses from the human resources respondents were more equally spaced over the various methods, possibly due to the smaller size of the group.

Table 4: Interview Responses Combined: Methods of Exposure

Training or Development Methods				
Methods of Exposure	**Total** Frequency %	**Graduate Engineers** Frequency %	**Human Resources** Frequency %	**Senior Managers** Frequency %
On-site Experience – Physically doing Different Construction tasks	94%	100%	100%	88%
Internal / External Training Courses	65%	43%	50%	88%
Mentoring	65%	71%	0%	75%
Structured Induction / Training & Development Programme / Guide	53%	43%	50%	63%
Job Rotation between Disciplines	29%	14%	50%	38%
Starting working with Estimator & Planner	18%	0%	50%	25%
Bi Annual get together of all young engineers in the company to discuss experience gained / exposed to	12%	0%	0%	25%
Spend 1st year measuring programme and productivity and run site services, Batch plant / Rebar / cast-in Items	12%	14%	0%	13%
Working through Case Studies	6%	0%	50%	0%

5.2.5. Construction of the questionnaire

After identifying, listing and ranking all the competencies from the Phase One interviews, the data were compared to those gathered from the literature review discussed in Chapter Two. A total of 37 competencies were identified by the interviewees, while only 14 of these were also identified in the literature. Table 5 below shows the various competencies that were identified in the literature and the Phase One interviews. It should be noted that some of the responses received in the current study were more technical and also more specific to project management in the construction industry than to project management in general.

Table 5: Competencies from the Literature and Interviews Compared

Competencies Identified by Source		
Competencies	**Literature**	**Interview**
Understanding Project / Construction Environment and Project Stages		✓
Activity Resource Estimation		✓
Activity Duration Estimation		✓
Activity Scheduling		✓
Schedule Development		✓
Communication to both Subordinates & Client	✓	✓
Problem-solving / Root cause Analysis	✓	✓
Financial Management		✓
Managing different persons - Client, Subcontractors, Foremen, Unskilled workers		✓
Personal Time Management		✓
Safety Management		✓
Leading People	✓	✓
Quality Management	✓	✓
Learning Basic Skills in Industry (Physical & Technical)		✓
Understanding Company Systems (QA, Safety, Procurement, HR)		✓
Understanding Standard Specifications		✓
Project Time Management	✓	✓
People Management		✓
Personality - People- oriented		✓
Progress Measuring		✓
Teamwork		✓
Being a Change Agent	✓	✓
Delegation Skills	✓	✓
Risk Identification & Management	✓	✓
Being Able to see the bigger Picture		✓
Understanding different Cultures in the workplace		✓
Cost Management	✓	✓
HR Management	✓	✓
Negotiation	✓	✓
Procurement Management	✓	✓
Scope Management	✓	✓
Claims & Contractual Experience		✓
Conducting Disciplinary Enquiries		✓
Integration Management		✓
Motivate Subordinates		✓
Understanding Own Responsibility		✓
Environmental Management	✓	
Calculating Team Sizes		✓

After identifying all the competencies, it was noted that several of the competencies were very similar and could actually be grouped together into similar themes. This was done in Table 6 below, before the list of competencies was used in the construction of the questionnaires for the second phase of the research.

Table 6: Grouping of Competencies from Interview Responses for Questionnaire Development

Main Competency Groupings for construction of Questionnaire	Similar Competencies grouped with Main Competency Groupings
Understanding the Project & Construction Environment and Project Stages	
Activity Scheduling and Schedule development	Activity Resource and Duration Estimation
Understanding Company Systems including Quality, Safety, Procurement, HR	Conducting formal Enquiries, incl disciplinary
Problem-Solving, Root cause analysis	
Managing different people - Client, Sub-Contractors, Foremen, Unskilled workers	Being able to understand and manage different cultures in the working place
Safety Management	Quality Management & Environmental Management
Financial and Cost Management	
Personal Time Management	Understanding their responsibility and taking responsibility
Project Time Management	
Learning the basic skills of your industry - Physical & Technical on-site	Learning the basic skills of your industry – Theoretical, Understanding Standard Specifications like SANS, COLTO, OSH Act, Mine Health and Safety Act
People Management	Leading People, Teamwork, HR Management, Motivation of Subordinates & Communication to Subordinates, Colleagues and Clients, Being a Change Agent
People-oriented Personality	
Risk Identification and Management	
Delegation Skills	
Integration Management - Managing the complete Scope, all disciplines and parties	Being able to see the bigger picture
Negotiation Skills	
Procurement Management	
Claims and Contractual Experience	

The items that were grouped together were all items related to scheduling and activity and resource estimation, all competencies on company specific systems, all competencies on managing people and cultures on a construction site, all competencies relating to quality, safety and environmental management, competencies regarding the basic skills of the industry, all competencies based on people management and, finally, all competencies based on integration management.

The list of 38 total competencies that were identified from both the Phase One interviews and the literature study were reduced to 18 competencies. These could then be used in the construction of the questionnaires for Phase Two.

On the topic of the various methods of how these competencies can be acquired, a total of 10 different methods were identified from the Phase One interviews, with only five of these also identified from the literature. This list of methods from the interviews and the literature can be seen in Table 7.

Table 7: Comparison of the Training or Exposure Methods from the Literature and the Interviews

Training or Exposure Identified by Source		
Methods of Exposure	**Literature**	**Interview**
On-site Experience - Physically doing different construction tasks	✓	✓
Internal / External Training Courses	✓	✓
Mentoring	✓	✓
Structured Induction / Training & Development Programme / Guide	✓	✓
Job Rotation between disciplines	✓	✓
Starting working with Estimator & Planner		✓
Bi Annual get together of all young engineers in the company to discuss experience gained / exposed to		✓
Spend 1st year measuring programme and productivity and run site services, Batch plant / Rebar / cast-in Items		✓
Working through Case Studies		✓
Training of current managers in training of graduates		✓

As some of the methods described by the interviews cover a wide range of sub-methods, it was decided to divide some of the methods into less complex groupings to make it easier to choose a specific method. Table 8 shows the 10 training/exposure methods split into 13 more direct methods that were used in the construction of the questionnaires for Phase Two.

Table 8: Exposure Methods Divided for Questionnaire Development

Training or Exposure Divided for Questionnaire	
Methods of Exposure from Interviews & Literature	**To be used in Questionnaire**
On-site Experience - Physically doing different construction tasks	On-site Experience - Physically doing different construction tasks
Internal / External Training Courses	Training courses provided by the group
	Training courses provided by external service providers
Mentoring	Being assigned a mentor that can assist and track development
Structured Induction / Training & Development Programme / Guide	Putting all graduates through a structured induction programme
	Establishing a continued Training and Development programme for graduate engineers
Job Rotation between disciplines	Job rotation between various disciplines during first year in the company
Starting working with Estimator & Planner	Working in Estimating and Planning department in the first year ensuring understanding of various activities
Bi-Annual get together of all young engineers in the company to discuss experience gained / exposed to	Bi-Annual conference for engineers from different Business units in the group to share experiences
Spend 1st year measuring programme and productivity and run site services, Batch plant / Rebar / cast-in Items	Measuring programme, productivity and site costing with a dedicated Site Agent during first year on site
	Running a “service” on the first project, e.g. running the batching-plant, scheduling all the plant
Working through Case Studies	Working through Case Studies of different construction projects
Training of current managers in training of graduates	Training of current managers to be competent in training of graduate engineers

5.3. Phase 2: Quantitative Data

The data that were collected from the questionnaire are discussed in five sections. The first section deals with the sample description of the three different respondent groups, namely graduate engineers, human resources professionals and senior managers. The next section looks at different aspects of career development in the construction industry. The third section looks at the various project management competencies that are required by graduate engineers during their first five years in the construction industry and compares the responses from each of the three respondent groups to those of the other respondent groups. The next section looks at the various methods that can be used to train or expose graduate engineers to these competencies. The last section looks at the construction industry that a graduate engineer has to face and how the industry has changed over time and what the biggest challenges are that the engineer has to face.

5.3.1. Sample description for questionnaires

Questionnaires were sent out to a total of 184 recipients in the construction company with the assistance of the human resources and Information Technology departments. This total consisted of 49 engineers, 31 human resources professionals and 104 senior managers. The engineers were identified by their grade of employment in the company. This grade is, on average, associated with a site engineer with between zero and five years' experience. A total of 29 responses were received from engineers, which is a 59% response rate. The human resources sample included human resources officers, managers and directors. A total of 16 responses were received, which is 52% of the questionnaires sent out. The sample for the senior managers was the largest, as a total of 104 questionnaires were sent out. These included all members of staff with an engineering background that were at a project manager level or more senior. This included various directors, executives and managing directors. Of the 104 questionnaires distributed, a total of 42 or 40% were received back.

5.3.1.1. Graduate engineers

- Year of graduation

Table 9: Year of Graduation for Graduate Engineer Sample

Year of Graduation	Response
2004 or earlier	10.3%
2005 to 2007	10.3%
2008 to 2009	24.1%
2010 to 2011	55.2%

As can be seen from Table 9, most of the responses came from engineers who qualified within the past three years and the second most responses came from engineers who qualified during 2008 and 2009. The responses from engineers who qualified in 2007 and earlier are spread, with only one respondent per year. This could possibly be explained by the fact that engineers who qualified in 2007 or earlier stood a large chance of being promoted to a more senior level than Site Engineer in the interim and would therefore not have received the questionnaire. In total, 79.3% of the responses came from engineers who qualified during 2008 or later.

- Degree or diploma obtained by the engineer

Table 10: Degree or Diploma Obtained by Engineers

Degree or Diploma Obtained	Response
National Diploma	24.1%
BTech Degree	10.3%
BEng or BSc Degree	51.7%
MEng or MSc Degree	0.0%
Other 1 BCom Business Management & Marketing 2 N Dip (Higher) Instrumentation & Process control 3 N Dip Electrical Eng. (instrumentation) 4 BSc (Hons) Construction Management	13.8%

From Table 10 it can be seen that the majority of the responses came from engineers who completed a BEng or BSc degree at a university. The second group can be divided into engineers who obtained a National Diploma or a BTech degree at a university of technology (technicon). The national diploma is a shorter course than the university degree and consists of more practical experience than the university degree. It can also be noted that the majority of the diplomas or degrees, both from universities and universities of technology were completed in Civil Engineering rather than Building or Construction Management, something that might need to be investigated in a construction company. The other qualifications that were obtained by some respondents may be attributed to a person with a different background who now finds him- or herself in the construction industry.

- Years of experience in the construction industry

Table 11: Years of Experience in the Construction Industry

Years of Experience	Response
Less than One year	31.0%
One to Three years	37.9%
Three to Five years	20.7%
Longer than Five years	10.3%

Table 11 indicates that almost two thirds of the graduate engineers' responses came from engineers that have three years or less experience of working in the construction industry. This compares well with the results from Table 9, which indicate that the majority of the respondents qualified in 2008 or later. The remaining responses are

spread very equally over three, four, five and longer than five years. This is well focused on the group of engineers with less than five years' experience in the construction industry. It would again seem that the majority of the engineers with the title of Site Engineer are being promoted to a more senior level around the fourth or fifth year after entering the construction industry, as there were very few respondents with more than five years' experience in the sample.

- Number of construction sites that the graduate engineer has worked on

Table 12: Number of Construction Sites Worked On

Number of Construction Sites Worked On	Response
2 or less	58.6%
Between 3 and 5	37.9%
6 or more	3.4%

Over 96% of the respondents have worked on five or fewer construction projects as indicated by Table 12. When considering the mean of all the responses from five years or less, a value of 2.3 can be calculated as the average number of projects that a graduate engineer is involved in within the first five years of working in the construction industry. This is related to the actual experience that the individual is gaining while working. As every construction project is different in terms of the client, the team, the actual location and the actual type of structure constructed, the more projects an engineer gets to work on, the more experience he or she can be expected to gain.

- Current job title of graduate engineers

Table 13: Job Title of Graduate Engineers

Job Title		Response
Junior Site Engineer or Site Engineer		75.9%
Sub Agent		3.4%
Project Engineer		0.0%
Technician		3.4%
Construction Engineer		0.0%
Other	Junior Construction Manager	3.4%
Other	Engineering Technologist	3.4%
Other	Workshop Manager/Technician	3.4%
Other	Green Building and Environmental	3.4%
Other	Mechanical Engineer	3.4%

Table 13 confirms that the majority of the respondents from the sample are currently employed as Site Engineers. Some of the other positions held are site engineers that have been promoted or follow more specialist functions in the construction industry, such as Technicians, Green Building and Environmental Engineer or Mechanical Engineer. This is the position that the majority of engineers start off in when they join the construction industry and then they progress up the ranks towards becoming a project manager.

5.3.1.2. Human resources professionals

- Year of graduation

Table 14: Year of Qualification of Human Resources Professionals

Year of Qualification	Response
Before 1990	31.3%
1991 to 2000	25.0%
2001 to 2010	43.7%

From Table 14 it can be seen that the year of graduation of the human resources professionals is slightly skewed towards the period after 2000 which would lead to a slightly younger team. There are, however, a significant number of human resources professionals in the sample who qualified before 2000 and even before 1990. This should result in a balanced team, with a mix of younger and older employees.

- Degree, diploma or certificate obtained by human resources professionals

Table 15: Qualification Obtained by Human Resources Professionals

Degree or Diploma Obtained	Response
BComm - Degrees	18.8%
BComm honours - Degrees	12.5%
BSc - Degrees	0.0%
BA - Degrees	18.8%
National Diplomas	25.0%
Other Certificates or Diplomas	25.0%

The qualifications that the human resources personnel have obtained are a mixture of commercial and arts degrees and diplomas. There are no qualifications in the science field, which makes sense, considering that the key responsibility of human resources professionals is dealing with people. There was also a balanced split between people who obtained degrees and people who obtained diplomas.

- Working experience in the human resources field

Table 16: Working Experience in the Human Resources Field

Years of Experience	Response
10 years or less	12.5%
11 to 20 years	56.3%
21 to 30 years	12.5%
31 to 40 years	18.8%

Table 16 shows that the majority of the human resources professionals in the sample have been working in the human resources field between 11 and 20 years. It would be safe to assume that, since 87.5% of the sample had more than 10 years' experience, the company employs capable people in its human resources department. The main concerns are whether this experience compares well with experience in the construction industry, and how the opinions of the human resources professionals compare to those of the respondents in other two areas. One of the last questions in the questionnaire highlighted the fact that the construction industry has changed significantly over the last 10 t0 15 years, which then raised the question of whether the human resources professionals who have been working in the field for such a long time have been able to adjust to the new ways of doing things in the construction industry.

- Working experience in the human resources field within the construction industry

Table 17: Working Experience in the Construction Industry

Years of Experience	Response
10 years or less	56.3%
11 to 20 years	37.5%
21 to 30 years	6.3%
More than 30 years	0.0%

Comparing the results from this Table 17 to those in the previous table, it can be seen that although 87.5% of the human resources professionals had more than 10 years' experience in the human resources industry, only half of them had the same amount of experience in the construction human resources industry. This can be viewed as either positive or negative. On the positive side, there is the possibility that professionals entering the industry from the outside come with new ideas and are not set in their ways, falling back on how things were done in the construction industry in the 1990s or 1980s. This can also be negative, because the construction industry is very specific in terms of how it deals with people, staff and labour issues.

- Current job titles of human resources professionals in the construction industry

Table 18: Job Titles of Human Resources Professionals in the Construction Industry

Job Titles	Response
HR or IR Manager	75.0%
HR or IR Officer	12.5%
HR or IR Director	12.5%

The split of the respondents in terms of their current job titles can be seen in the Table 18. The majority of the respondents were on the managerial level, with a small number of the sample coming from the director or officer levels. In the most cases, it is the managers who are responsible for solving problems and developing and implementing new programmes in the human resources fields. It is, however, the officer level employees that would have the most interaction with the engineers when they just enter the industry and it might be good to consider the impact that these employees have on young engineers. This might be a very strong medium to use in future to convey messages on career development to young engineers.

5.3.1.3. Senior managers and managing directors

- Year of graduation

Table 19: Year of Graduation of Senior Managers

Year of Graduation	Response
1970 - 1980	12.2%
1981 - 1990	22%
1991 - 2000	41.4%
2001 - 2010	24.4%

For the year of graduation of the senior managers, one of the respondents entered information in the *Other* column and entered the institution that he qualified from. For this calculation of the percentages, the total of the respondents was taken as 41 and not 42. All the other questions were completed by this respondent and thus the entire questionnaire was not disqualified. It can be seen from Table 19 that the highest number of the senior respondents qualified between 1991 and 2000 and the second highest number between 2001 and 2010. There seems to be a good distribution, considering that there are far fewer of the more senior positions such as managing director or director available than the more entry level senior positions. This finding

also corresponds well with the literature which states that the majority of project managers only become project managers after about 10 years in the field. This is in line with the grouping that qualified between 1990 and 2000.

- Qualification obtained by senior managers

Table 20: Qualification Obtained by Senior Managers

Degree or Diploma Obtained	Response
National Diploma	54.8%
BEng or BSc Degree	23.8%
BTech Degree	19.0%
MEng or MSc Degree	0.0%
Other 1 QEMON Degree	2.4%

It is interesting to see from Table 20 that the majority of the senior managers completed a national diploma, with some of them going on to complete their BTech degree. The total of 73.8% who studied at a technicon is completely different from the sample for the graduate engineers, where almost 52% completed a degree at a university. This is definitely something to be looked at in future as the development needs and expectations of diploma graduates and degree graduates might differ as the diploma course is a more practical course than the more theoretical degree course.

- Working experience in the construction industry

Table 21: Working Experience in the Construction Industry

Years Working Experience	Response
More than 30 years	26.2%
21 to 30 years	16.7%
11 to 20 years	45.2%
10 years or less	11.9%

Table 21 compares very well with that of the date of qualification. The majority of the group has between 11 and 20 years' experience and this should be the group with the most project managers, according to the literature. The almost 33% of senior managers that have more than 20 years' experience also augurs well for a large construction company.

- Experience in terms of construction projects involved in

Table 22: Number of Construction Projects Senior Manager has been Involved In

Number of Projects	Response
More than 20	40.5%
11 to 20	35.7%
Less than 10	23.8%

It is to be expected that the total number of projects increase significantly with seniority, as most of the directors have up to three projects under their supervision at any time. This would definitely influence the responses if they are directly compared to those of the graduate engineers, who on average have been involved in fewer than three projects. This can be seen in Table 22 above.

- Current job title of senior managers

It was to be expected that most of the sample of senior managers would be from the project manager pool, based on the literature and the previous tables on year of qualification and years of experience.

Table 23: Job Title of Senior Managers

Job Titles	Response	
Project Manager	7.1%	54.8%
Contracts Manager	26.2%	
Senior Contracts Manager	16.7%	
Construction Manager	4.8%	
Operations Executive	16.7%	26.2%
Contracts Director	9.5%	
General Manager	2.4%	11.9%
Managing Director	9.5%	
Chief Operating Officer	0.0%	
Other		7.1%
1 Proposals and estimating Manager	2.4%	
2 Site Manager	4.8%	

Table 23 indicates that the results from the questionnaire compare well with those of the literature and the previous findings, based on year of qualification and years' experience. The fact that more than 33% of the responses come from director level and above is a good representation of the people in the company that make the strategic decisions on the directions of the company.

5.3.2. Career development

- The importance of further career development for graduate engineers in the construction industry after obtaining a qualification and starting to work

Table 24: Importance of Career Development for Graduate Engineers

Working Discipline	Rating Average
Human Resources	3.69
Engineers	3.62
Senior Managers	3.33
Combined Average	**3.49**

Ratings Explained:
1 Not important
2 At some stage
3 Required
4 Absolute necessity

The importance of career development was investigated by asking the respondents to rate the importance thereof on a 4-point scale ranging from *Not important* to *Absolute necessity*. Based on the response, the average was calculated per respondent group and also for the overall sample. Considering that the maximum rating was a 4, it is clear from Table 24 that on average all the respondents saw career development as extremely important.

The graph in Figure 2 shows how important all the groups of respondents rated career development.

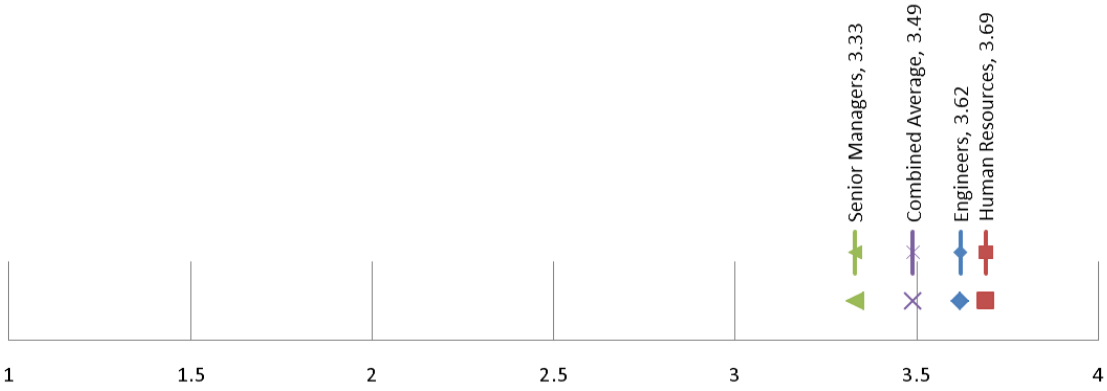

Figure 2: Comparison of the Responses of the Graduate Engineers, Human Resources Professionals and Senior Managers on the Importance of Career Development in Engineers

- Responsibility for the career development of graduate engineers

Table 25: Responsibility for Career Development of Graduate Engineers

Occupation	Rating Average
Human Resources	3.25
Engineers	3.03
Senior Managers	2.69
Combined Average	**2.91**

Ratings Explained:

1 100% Responsibility of Employee
2 75% Employee - 25% Company
3 50% Employee - 50% Company
4 25% Employee - 75% Company
5 100% Responsibility of Company

Having established that career development is of extreme importance, the next important question was who is responsible for the development of graduate engineers. In the literature, it was stated that an engineer must engage in life-long learning. Engineers must thus take a lot of responsibility for their own development. It is interesting to note from Table 25 that the senior managers are more aligned with the literature in this regard, that feels that the responsibility also lies more with the employee than the graduate engineers and the human resources professionals. This is definitely an important point, as it is the senior managers who are responsible for this development in the eyes of the engineers and the human resources professionals.

The graphic in Figure 3 clearly shows the spread, with the senior managers leaning towards the responsibility of the individual.

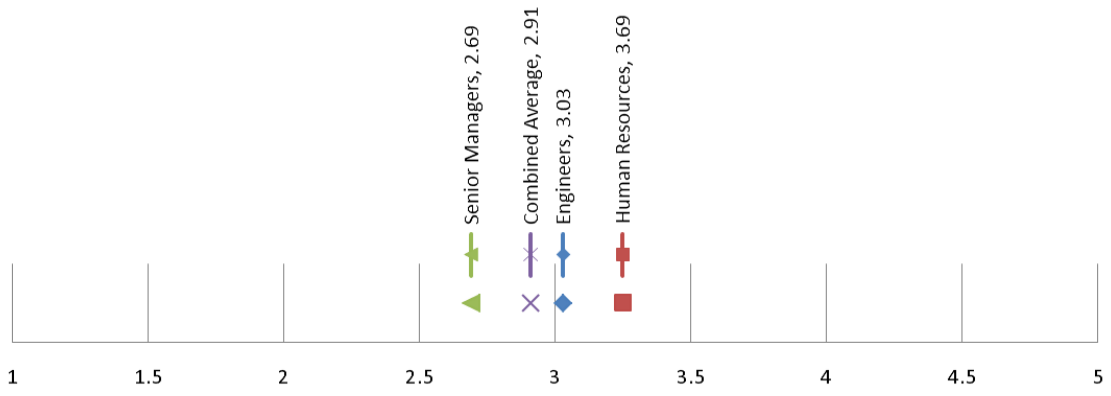

Figure 3: Comparison of the Responses of the Graduate Engineers, Human Resources Professionals and Senior Managers on Responsibility for Career Development in Engineers

- Percentage of undergraduate engineering education that is devoted to development of management skills as opposed to engineering skills

Table 26: Percentage of Management Development in Undergraduate Engineering Education

Occupation	Rating Average
Engineers	2.07
Human Resources	1.94
Senior Managers	1.83
Combined Average	**1.93**

Ratings Explained:

1 0% to 20%
2 21% to 40%
3 41% to 60%
4 61% to 80
5 81% to 100%

This question was a test of the literature, which suggests that almost no or very little management development is included in undergraduate engineering programmes. The respondents were asked to rate the percentage of management development that is included in the engineering education in terms of a 5-point scale, as indicated above. On average, Table 26 and Figure 4 shows that all the respondents agreed with the literature that very little management development is included in undergraduate engineering programmes. The human resources professionals generally concurred, even though they did not undergo any engineering training, unlike the other respondents. It is helpful that they concur, as it is also the responsibility of the human resources professionals to develop training programmes for the graduate engineers.

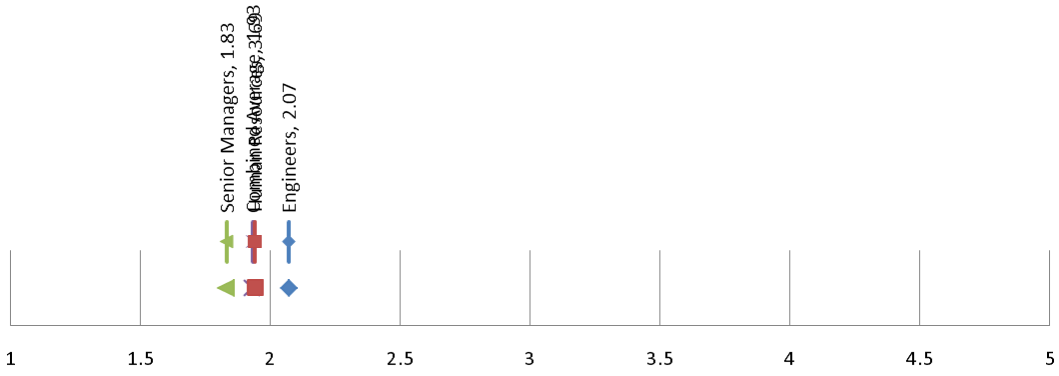

Figure 4: Comparison between the Responses of the Graduate Engineers, Human Resources Professionals and Senior Managers on Management Development in Undergraduate Education

- Responsibility for exposing graduate engineers to possible career paths

Table 27: Career Paths: Person Responsible for Exposure

Responsible Person	Combined	Engineers	Human Resources	Senior Manager
Contracts Director	**66.7%**	**62.1%**	**56.3%**	**73.8%**
Human Resources personnel	**59.8%**	**58.6%**	50.0%	**64.3%**
Project Manager	**57.5%**	**58.6%**	**81.3%**	47.6%
Other colleagues	17.2%	6.9%	37.5%	16.7%

As the question gave the option to choose more than one person who can be responsible for the exposure of the graduate to the various career paths, the percentage that is given is represented by the number of responses divided by the total number of the sample or sub-sample. Thus, out of the total sample of 87, a majority of 58 people suggested that the contracts director is responsible for this task, yielding the 66.7% noted in the table. The option was also given to the respondents to add any other people that they felt might be responsible for informing the graduate engineers about possible career paths. The ones identified additionally were the construction manager and the mentor, and a certain responsibility was given to the graduates themselves. It is clear from Table 27 that all the respondents across the various respondent groups agree that the contracts director has a big role to play in exposing engineering graduates to all the possible career paths in the construction industry. Given that most of the respondents rated all the options higher than 50%, it should be noted that generally regarded as a joint responsibility across the respondent groups of contracts director, human resources personnel and project managers to expose young graduate engineers to possible career paths in the construction industry. The *caveat* here is that the literature found that the majority of the project managers are not very focused on the development of engineers. This may explain why the senior managers rated the responsibility of the project manager the lowest.

- Clarity of definition of various career paths

Table 28: Career Paths: Clearly Defined or Not

Career Paths Clearly Defined	Combined	Engineers	Human Resources	Senior Manager
Could be done better	**57.5%**	**51.7%**	**62.5%**	**59.5%**
Not at all	40.2%	44.8%	37.5%	38.1%
Yes	2.3%	3.4%	0.0%	2.4%

The respondents were given three options to rate the clarity of the communication of all possible career paths for graduate engineers. Table 28 measures the percentage of

each of these options. On average, all the respondents agreed that the possible career paths are not clearly defined. This is a matter for concern, because, as the previous table shows, both the human resources respondents and senior management allocated a large portion of the responsibility to themselves to explain the various career options, but yet they also admit that it is not done clearly.

- Communication of possible career paths

Table 29: Career Paths: Communication to Graduate Engineers

Communication of Career Paths	Combined	Engineers	Human Resources	Senior Manager
Only if someone actually asked about some options	**43.7%**	**44.8%**	**50.0%**	**40.5%**
With some of the engineers	18.4%	17.2%	25.0%	16.7%
Only when someone threatens to resign	17.2%	13.8%	12.5%	21.4%
Never	13.8%	24.1%	0.0%	11.9%
It definitely gets discussed and explained	6.9%	0.0%	12.5%	9.5%

Table 29 above describes five options to test whether different career paths are discussed with graduate engineers. The table shows that only 7% of the total group of respondents agree that the topic is definitely discussed with the graduate engineers. The rest of the group were divided between the options of *never gets discussed* and *only if the engineer enquires about other career paths*. The groups did not rank all the answers the same, but is clear that all the groups agree that very little is done in this regard.

- Career paths other than project manager

This open-ended question with four fields to comment on was well used by all the respondents. A total of 246 responses were received from the 87 respondents, which equates to 2.83 responses per respondent. These were categorised into 14 areas, some of which are still linked to the career path of a project manager, but at different seniority levels. These included directors and site agents. The others are tabled below in Table 30 with the number of responses that each career path received. The different careers were ranked by using the combined total per career.

Table 30: Career Paths: Other than Project Manager

Careers	Combined	Engineer	Human Resource	Senior Manager
Planning Engineer	40	14	9	17
Commercial Manager or Claims expert	34	11	9	14
Design Engineer	32	13	6	13
Estimator and Proposals Manager	29	12	7	10
Quality Manager / Engineer	18	7	3	8
Construction Manager	8	1	3	4
Human Resources or Training Manager	8	2	3	3
Consulting Engineering	7	2	3	2
Health, Safety and Environmental Manager	7	2	3	2
Procurement Manager	4	1	2	1
Surveyor	4	1	0	3
Business Development	3	0	0	3
Production Manager	3	1	2	0

All the careers listed are applicable and appropriate in the construction industry. The top six careers are more directly related to the project management or engineering profession, whereas the others fulfil more of a support role to project management. With this many options available, it is really concerning that the options are not effectively communicated to the younger graduate engineers.

5.3.3. Project management competencies required by graduate engineers

Typical competencies that are generally associated with Project Managers (Contracts Manager) in terms of their relative importance to graduate engineers during their first three years after graduation were given to the respondents to rate on a 5-point scale to determine each competency's importance for the graduate engineer during his first five years in the construction industry. The results can be seen in Table 31.

Table 31: Project Management Competencies: Ranked on Importance with p-values

Competencies	Rating Average				
	Combined	Engineers	HR	Senior Managers	*p*-value
Spending physical time on site learning the basic skills & trades of the industry	**4.7**	**4.2**	**4.8**	**4.8**	**0.006**
Safety, Environmental & Quality Management	**4.6**	**4.3**	**4.9**	**4.7**	**0.008**
Personal Time Management	**4.3**	**4.4**	**4.3**	**4.3**	0.997
Understanding company systems i.e. Quality, Safety, Procurement, HR, Conducting formal inquiries	**4.2**	**4.3**	**4.3**	**4.2**	0.929
Activity Resource and Duration estimation, developing an Activity Schedule	**4.2**	**4.3**	**4.2**	**4.1**	0.310
Understanding the Project & Construction Environment and different Project Stages	**4.1**	3.9	**4.3**	**4.2**	0.453
Project Time Management	**4.1**	3.9	**4.5**	**4.0**	0.179
Problem solving and Root Cause analysis	**4.0**	**4.0**	**4.6**	3.8	**0.031**
Understanding and managing different cultures, including Client, Sub-Contractors, Foremen & Unskilled	**4.0**	**4.1**	**4.3**	3.8	0.277
Financial and Cost Management	3.9	3.7	**4.4**	3.8	0.157
Delegation & follow-up skills	3.9	3.9	**4.4**	3.6	0.071
HR Management, including Teamwork, Leading, Motivating and communicating to people	3.9	3.8	**4.3**	3.7	0.213
Having a People-oriented Personality	3.8	**4.0**	3.8	3.7	0.409
Risk Identification & Management	3.8	3.6	**4.3**	3.8	0.069
Integration Management - Being able to see the bigger picture and manage the complete scope	3.4	3.9	3.5	3.1	0.108
Procurement Management	3.3	3.6	3.4	3.2	0.374
Negotiation Skills	3.2	3.4	3.6	3.0	0.220
Contractual experience, e.g. compiling claims	2.9	3.1	3.9	2.4	**0.001**

Legend:

1 **Can be acquired at a later stage**
2 **Not very Important**
3 **Would be advantageous during year 1 to 3**
4 **Relatively Important**
5 **Absolute requirement during year 1 to 3**

The ranking for this question was done on a 5-point scale, as shown in the legend and thereafter the mean was calculated for each group and the entire sample. The competencies were ranked from highest (most important to the engineers) to lowest in terms of the combined mean. It is clear that nine out of the 18 typical responses were rated as a 4 or above, which suggests that these competencies are the most important to develop in graduate engineers during their first five years on a construction site.

To test the relationship of the means between the groups, they were tested as independent samples using the Kruskal-Wallis statistical test, with a 95% confidence interval. From this, the p-values were calculated and can also be seen in Table 31.

The p-values highlighted in red indicate competencies that the various groups regarded as significantly different. Four out of the 18 competencies were seen as significantly different between the various groups. This means that in almost 78% of the cases, there was no significant difference in the relative importance of the different competencies that should be developed in graduate engineers during their first five years in the construction industry. The results of the statistical tests are set out in Appendix 6.

The competencies that had a significant difference can be summarised as follows: the graduate engineers did not feel as strongly about spending physical time on a construction site learning the trade of the industry and do not feel that safety, quality and environmental management are as important as the more senior employees believed these competencies to be. The other significant difference is that the human resources group rated problem-solving and gaining contractual experience much higher than either the engineering graduate or the senior management groups. This might be due to a more theoretical knowledge of the engineering profession. The results of the statistical tests in these four competencies are set out in Appendices 7 to 10.

5.3.4. Methods for project management competency development

Various methods to develop the identified competencies based on their relative effectiveness in ensuring that these competencies are indeed developed in graduate engineers during the first five years after graduating were listed. The respondents were asked to rate all the methods on a 5-point scale, ranging from *not being required* to *Best suited for development*. The means of all the responses from each of the groups and the combined group were calculated and are listed in Table 32. The methods were ranked in terms of the combined mean.

Table 32: Development Methods: Ranked on Importance with p-values

Development Methods	Rating Average				
	Combined	Engineers	HR	Senior Managers	*p*-value
Being assigned a Mentor that can assist & track development	**4.6**	**4.7**	**4.8**	**4.5**	0.767
On-site Experience - Physically doing different construction tasks	**4.6**	**4.1**	**4.9**	**4.8**	**0.001**
Measuring programme, productivity and site costing with a dedicated Site Agent during first year on site	**4.5**	**4.4**	**4.9**	**4.4**	0.130
Job Rotation between various disciplines during first year in the company	**4.2**	**4.0**	**4.9**	**4.1**	**0.012**
Establishing a continued Training and Development Programme for graduate engineers	**4.2**	**4.3**	**4.3**	**4.0**	0.676
Putting all graduates through a structured Induction Programme	**4.2**	**4.3**	**4.4**	**4.0**	0.442
Running a "service" on the first project, e.g. running the batch-plant, scheduling plant	**4.0**	3.6	**4.3**	**4.2**	**0.018**
Training of current managers to be competent in the training of graduate engineers	3.9	**4.0**	3.9	3.8	0.670
Training courses provided by the Company	3.7	**4.1**	3.8	3.5	**0.014**
Working in Estimating and Planning department in first year ensuring understanding of various activities	3.4	3.1	**4.3**	3.3	**0.016**
Training courses provided by external service providers	3.4	3.7	3.6	3.0	**0.011**
Bi-Annual conference for engineers from different Business units in the group to share experiences	3.2	3.3	3.2	3.1	0.698
Working through case studies of different construction projects	3.2	3.1	3.7	3.0	0.105

Legend:
1 **Not Required**
2 **Small Relevance**
3 **Might be Applicable**
4 **Somewhat Suited**
5 **Best Suited for Development**

A total of seven of the 13 methods were rated as 4 or above, which indicates that these are considered the best methods for developing the project management competencies in graduate engineers. In general, all the respondents rated the same methods as being the best suited, with the exception two methods rated highly by the engineers and one rated highly by the human resources respondents. These are printed in bold in the Table 32.

To test the relationship of the means between the groups, they were tested as independent samples using the Kruskal-Wallis statistical test, with a 95% confidence interval (Keller, 2008). From this, the p-values were calculated, as can be seen in the right-hand column in Table 32. The p-values that are highlighted in red indicate competencies that the various groups viewed significantly differently. Six of the 13 methods had significantly different ratings between the groups. This indicates that the

different groups only agree on 54% of the methods to develop project management competencies in graduate engineers.

The methods that the engineering group rated lower than the other groups included spending physical time on site and being responsible for a service department on their first construction site. This can be read in conjunction with the methods that they rated significantly higher than the other groups, namely receiving training from external service providers and from the company itself. This can be interpreted as indicating that these young engineers do not want to gain experience by physically working on site, but prefer structured training.

The human resources group rated job rotation and working in other departments in the head office more highly for the development of project management competencies than either of the other groups. This might be due to the fact that in a multi-disciplinary environment such as a construction site, the more experienced senior managers felt that an engineer must be capable of handling all the competencies, as most of them are mutually inclusive.

5.3.5. The construction industry for the graduate engineer

The following points will look at the construction industry that the graduate engineer finds himself in today as compared to the industry that his seniors operated in when they just graduated from university and the challenges that the industry hold for the graduate.

- Changing of industry over time

The respondents were asked to rate the level to which the construction industry had changed over the last 10 to 15 years in terms of some specific criteria in their own opinion. Even though none of the graduate engineers had been working for this entire period, it was their perception that is important, as this can influence the way that they act in real life. The respondents were given a 4-point scale ranging from *the construction industry is less demanding now* to *it has changed fundamentally*. This is shown in the legend in Table 33.

Table 33: Areas of Change in the Construction Industry

Answer Options	Rating Average			
	Combined	Engineers	Human Resources	Senior Managers
Safety	3.55	3.34	3.50	3.71
Environmental factors	3.53	3.41	3.44	3.64
General pace of a construction project	3.26	2.97	3.50	3.38
Technology	3.21	3.24	3.38	3.12
Professionalism of industry	3.06	2.79	3.38	3.12

Legend:
1 Is less demanding now
2 Is still the same
3 Has become more demanding
4 Has changed fundamentally

The factors that were asked to be rated can be seen in Table 33.

From the combined responses in the table, it can be seen that the respondents believed that all the factors had become more demanding over the last 10 to 15 years, with safety and environmental factors changing the most. There are slight differences between the groups, but all agreed that the industry has become more demanding.

Some additional factors that respondents cited were the amount of work that happens behind the scenes in terms of additional paperwork and also that most clients expect their projects to be completed in record time. This increase in pace and the increase in non-engineering factors has significantly changed the industry over the last 10 to 15 years.

- Challenges that the graduate engineer faces

In an open-ended question, the respondents were asked to comment on what the major challenges currently are for new graduate engineers in the construction industry. A total of 37 responses were received from the sample of 87 respondents and the main challenges are summarised below.

The tertiary educational institutions do not really prepare engineers for what is happening in the construction industry. They do not make it clear enough to graduates that when they start to work, either in design or construction, that it is only then when they really start to learn and gain experience. Engineers need to accept the fact that they will have to work their way to the top and that they need to gain the necessary experience before they will be promoted. It is a hard reality that they will have to

choose between the technical or design part of engineering that they learned in the educational institution and the project management aspect of the construction industry, without really knowing either of the two options. All of this will often happen without clear guidance from their seniors or from the company.

One of the next big challenges is the physical environment that engineers are exposed to and required to operate in. They will have to work under difficult conditions, mostly away from their home, and they will have to learn to adapt to these new circumstances quickly in order to ensure that they can stay motivated and still take responsibility for their work.

The type of person that normally studies engineering is someone with great numerical competence and mathematical skills. This kind of person does not always respond well to what is needed in the construction industry. Because people management is one of the largest roles that engineers have to play in the construction industry, the personality of the individual will be tested far more than his or her mathematical competence. Thus graduates have to develop their people skills very quickly if they want to make a success of their careers.

CHAPTER 6: Discussion of the Results

6.1. Introduction

The data that were collected using the data collection tool described in Section 4.3.5 and discussed in Chapter 5 are used below to answer the research questions that were posed in Chapter 3. The relevant literature from Chapter 2 is referred to under each of these research questions to draw conclusions regarding each of these questions.

6.2. Research Question 1

Who in a construction company is responsible for early career development of graduate engineers?

The purpose of Research Question 1 was to identify who in a typical South African construction company is responsible for the early career development of young graduate engineers. The first test related to this question was to determine the actual importance of career development after obtaining an engineering qualification and starting to work in the construction industry. The results from this test can be seen in Table 24, where an average rating of 3.49 was measured out of a maximum of 4, which indicates that career development is really important, according to all the respondent groups in the sample. This is also graphically depicted in Figure 2.

The second test related to this question was aimed at determining what the ratio of the responsibility for career development is between the company and the graduate engineer. The results from this test can be seen in Table 25 and Figure 3. It is clear that with an average of 2.91 on a 5-point scale, the responsibility is basically shared equally between the engineer and the company, with about a 2% heavier responsibility on the engineer. This corresponds with the literature, which states that today project managers and other professionals have to take on a larger role in their own development and have to embark on a journey of lifelong learning (Farr & Brazil, 2009; Savickas, 2012).

In a more direct test, the respondents were asked to indicate which of the three senior staff members in Table 27 are responsible for exposing the graduate engineer to the various career paths in a construction company and in the industry. The results can be seen in Table 27. It is clear that on average the contracts director would take the most responsibility for the task of exposing the engineers to the various career options in the construction industry. However, it is important to note that project managers and human resources personnel are not far behind in the ranking. The literature makes the valid point that most project managers put the requirements of their current project before that of the further development of individual graduate engineer (Raiden et al., 2008). Traditionally, it is the responsibility of the human resources professionals to develop the young engineers (Raiden et al., 2008), but, based on the experience of the contracts directors, it would make sense that they take the largest responsibility for exposing graduate engineers to all the alternative career paths in the industry.

It was also identified in the data from Table 28 that the career path of the graduate is not clearly defined in the construction industry, and that the situation could be approached better. This finding is in line with the literature, which suggests that there is no direct career path for engineers in the construction industry (American Society of Civil Engineers, 2012) and that one of the career paths is that of becoming a project manager (Edum-Fotwe & McCaffer, 2000; Maloney, 1988), but that this career path also does not have a recognised development path (Thomas & Mengel, 2008). Table 29 shows that the various career options are generally only discussed with graduate engineers once they actually enquire about the different options. This is very dangerous, as this can lead to the third line in the table were people must first hand in their resignation before different career options are discussed, and in most cases, this would be too late.

When asked to provide other career paths for engineers than that of becoming a project manager, 13 other careers were identified by the respondents. These can be seen in Table 30. The top six results are all related to the project environment, with a more focused responsibility than the more general management responsibility of a project manager. This would make the engineer more of an expert in a specific field rather than the coordinator of many such experts. The bottom seven alternative careers are less related to the physical engineering side of project management and are more related to the business or support side of projects. Although these careers

are not the normal career choices to follow in the construction industry (American Society of Civil Engineers, 2012; Career Structure, 2012), it would be extremely beneficial to the project and construction industry if these support functions were filled by individuals who actually worked on a construction project and that would be able to understand the difficulties and time pressures that are common on most construction projects.

This would then support the notion that contracts directors, project managers and human resources personnel are all responsible for the early career development of graduate engineers, but that there needs to be a better, more structured approach to clarifying and exposing the various career paths to the graduate engineers between them.

6.3. Research Question 2

What are the project management competencies that need to be developed in young graduate engineers?

The purpose of Research Question 2 was to identify those project management competencies that are the most important to be developed in young graduate engineers working in the project management environment in the construction industry, because the literature only indicates what the competencies are that an actual project manager needs to possess, and not which of these should be developed in graduate engineers who are working their way up to becoming project managers.

The various competencies that are the most important for graduate engineers were identified by using the responses from the data collection tool described in Section 4.3.5. Table 31 in Chapter 5 combines the responses from the graduate engineers, human resources professionals and the senior managers. To answer Research Question 2, the column heading *Combined* in Table 31 was used. All the competencies in the table were ranked in order of importance on the combined responses and the following can be deduced from the table: the top seven competencies listed in the table were all rated above a 4, and can thus be accepted as being the most important. This group suggests that these competencies all have to do with physically doing the work of a site engineer on a construction site. The

understanding of how a construction project actually works is crucial, so it also forms the foundation for all further career advances in the industry, and it justifies this ranking of these competencies in the list. The literature also indicates that graduate engineers in the construction industry start their career on a construction site as a site or field engineer, where they would take some responsibility and assist the project manager in the running of the project (Career Structure, 2012). It can thus be deduced that the most important aspect in the career development of a graduate engineer in the construction environment is learning the basics of the industry to set the graduate up for further development later in his or her career.

The bottom five competencies in Table 31 can be seen as being much more advanced and would be used more when a graduate engineer has moved up the ranks, closer to becoming a full-time project manager. It is very important to note that these competencies require the knowledge that first had to be gained by working on a construction site and being responsible for the various competencies at the top of Table 31 and discussed in the previous paragraph. It can therefore be concluded that these competencies are not crucial for the development of graduate engineers during their first couple of years in the construction industry. However, it would be helpful to explain these competencies to them from an early stage, because, even though they would not be directly responsible for these competencies, the manner in which they perform and manage the top seven competencies in Table 31 will definitely influence the effectiveness with which a project manager is able to perform the five competencies at the bottom of the table.

The competencies in the middle of Table 31 between the two groups already discussed can be seen as the softer or more indirect competencies. These are competencies that can assist graduate engineers in becoming better and more effective at undertaking the top seven competencies in the table, and ultimately better at the bottom five competencies, becoming better project managers.

The literature identifies the various competencies that are required by project managers (Edum-Fotwe & McCaffer, 2000; Lei & Skitmore, 2004; Odusami, 2002; Thomas & Mengel, 2008), but neither specifies any order that these should be developed in for graduate engineers, nor a structured development path (Thomas & Mengel, 2008). Hence, it is important to note that this study provides empirical data to

prioritise the numerous competencies that are required for a successful project manager into practical groupings that can be used to develop young graduate engineers into successful project managers.

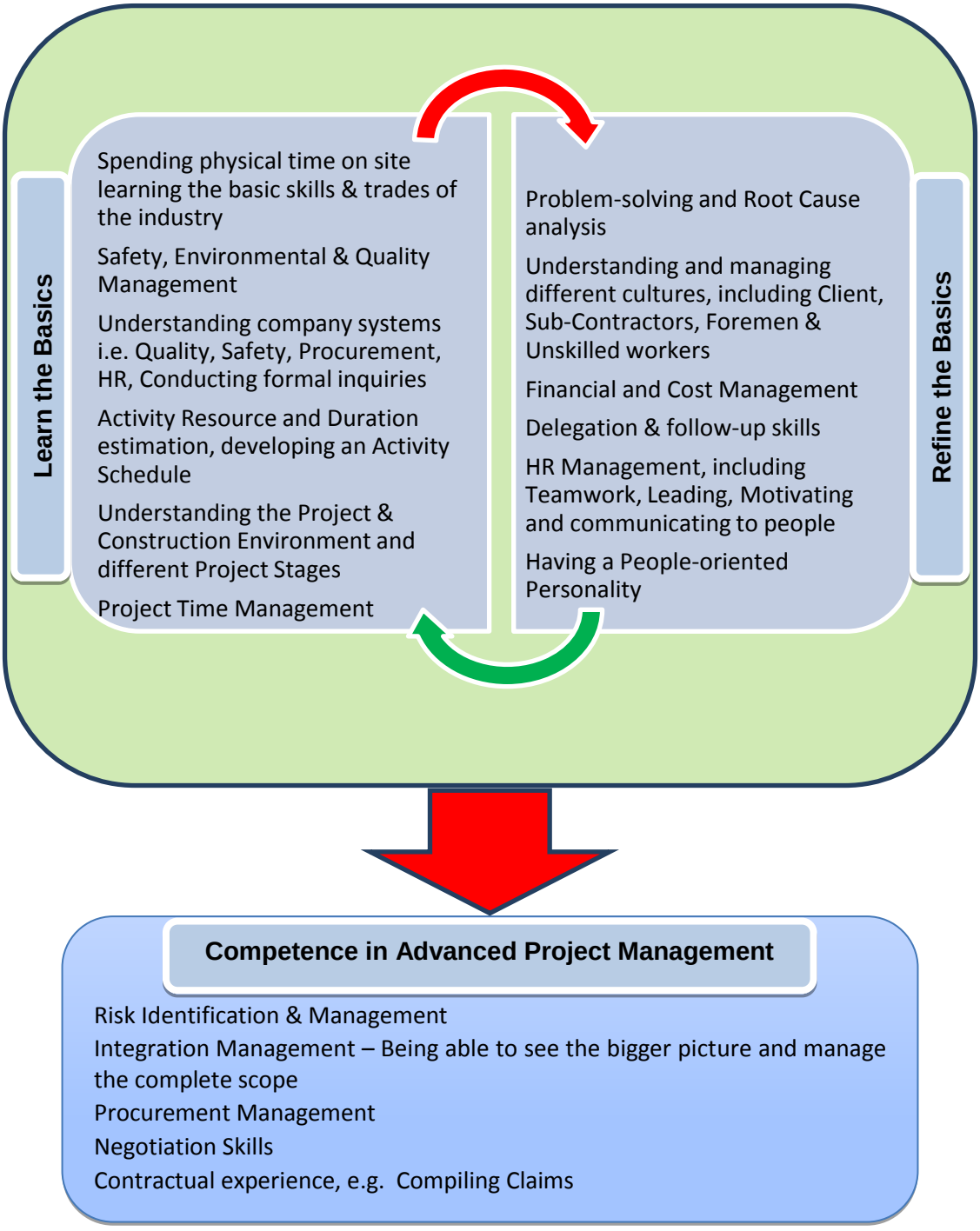

Figure 5: Order of Importance of Project Management Competencies in the Construction Industry

Figure 5 can be used to summarise the findings for Research Question 2 in terms of the competencies that should receive attention as soon as possible after a graduate engineer enters the construction environment, in other words, after learning the basics at a tertiary institution. The competencies that can be developed after these most important ones will allow an engineer to become better and more effective at the more important competencies. The red arrow indicates that the most important competencies on the left must first be mastered before moving on to the competencies on the right, and the green arrow indicates that the competencies on the right will complement the competencies on the left. Lastly the competencies that need to be developed as an engineer becomes more senior and closer to becoming a full-time project manager are also identified but require the mastering of the first two groups of competencies first before focussing on the more advanced competencies.

6.4. Research Question 3

Do the perceptions or views of which competencies are required differ among young graduate engineers, human resources professionals and senior managers?

The aim of Research Question 3 was to test whether the different groups of respondents in the sample held different opinions with regard to which competencies are most important for graduate engineers and should be developed first. To analyse this question, the data from Table 31 was used, focusing on the columns for the average ratings of the *Engineers*, *HR*, *Senior Managers* and the *p-values*. To compare the difference between the ratings of the various respondent groups, the p-values were calculated for each competency. This was done by testing independent samples using the Kruskal-Wallis statistical test with a 95% confidence interval. The p-values of this test are shown in the right-hand column of Table 31 in Chapter 5 with the significant values (smaller than 0.05) highlighted in red.

From Table 31 it can be seen that only four out of the 18 competencies displayed a significant difference between the responses of the various respondent groups which means that on 78% of the competencies, the respondent groups agreed on the importance and the ranking of the competencies. There is thus no significant statistical difference between the opinions of the graduate engineers, the human resources

professionals and senior managers on which project management competencies should be developed first in graduate engineers in the construction industry. This would prove that the findings of Muchiri et al.'s (2011) study, which found that there are definite differences in the perspectives between managerial (or senior) and non-managerial (or junior) employees, do not apply with regard to project management competencies in the construction industry between engineers, human resources professionals and senior managers.

Table 34: Project Management Competencies: Difference of Opinions

Competencies	Rating Average			
	Engineers	HR	Senior Managers	*p*-value
Spending physical time on site learning the basic skills & trades of the industry	4.2	4.8	4.8	0.006
Safety, Environmental & Quality Management	4.3	4.9	4.7	0.008
Problem-solving and Root Cause analysis	4.0	4.6	3.8	0.031
Contractual experience, e.g. compiling claims	3.1	3.9	2.4	0.001

Looking at the competencies where differences were observed, Table 34 highlights the respondent groups that displayed a statistical difference by means of an ANOVA. It is very interesting that in the case of the first two competencies in the table, it is the graduate engineers that rate these competencies as less important. Both these competencies require that the engineer get out to the construction site and start working and gaining experience, but this would suggest that the engineers do not feel that this is as important as the senior managers and human resources professionals believe this to be.

For both of the bottom two competencies, the human resources personnel rated these much higher than the other respondents did. These are very theoretical topics and the findings imply that some caution needs to be applied when asking the human resources personnel to develop engineers, without the assistance of engineering staff, even though on the majority of the competencies, there are no major differences.

It can then be said that the perceptions held on which competencies to develop in graduate engineers do not differ significantly between graduate engineers, human resources professionals and senior managers.

6.5. Research Question 4

What is the best method or combination of different methods to develop these competencies?

The purpose of Research Question 4 was to identify different methods for developing project management competencies in graduate engineers in the construction industry and which methods would be deemed the most appropriate or relative, given the construction environment. The data relevant to this question can be found in Table 32 (see Chapter 5) under the column heading *Combined*.

The various methods were ranked using the sample average of the 5-point rating scale in the data collection tool. Although the top six methods all ranked well above the 4-point mark and thus should all be the most applicable and appropriate in the development of project management competencies in graduate engineers, two different topics emerged from the group. The top three methods all involve being physically on the site and being developed through the work that an engineer does whilst on the construction site. This complements the findings from Research Question 2, where it was also found that the most important competencies require physically being on the site and learning the basics of the industry.

The second group of three in the top six involve a more theoretical development through structured programmes and exposing engineers to different activities in the company. If it is possible, the two groups should be used to complement each other in the development process. Exposing engineers to the right amount of theoretical knowledge would assist them to become efficient at the tasks on the construction site much faster. It would also prevent older managers and employees from misleading the engineers or abusing their time by keeping them busy with insignificant tasks. Too much theoretical knowledge should be regarded with caution, as Banarjee (1993) and Thomas and Mengel (2008) warn that there is a difference between actually developing competencies and simply raising awareness of these competencies. In most cases, the problems that will present themselves in a construction project would not have a textbook answer, so the ability to analyse the problem and come up with a solution combined from of the various competencies of which the project manager has gained experience in a working career is extremely important.

The bottom half of the table contains methods that involve more formal training in terms of external education and more theoretical methods such as using case studies. When one goes back to the results for Research Question 2, a link can be made between the results that were identified as being more important later on in the career of engineer when they approach becoming full-time project managers, and the more formal training listed in the bottom half of Table 32, which would refine the skills that have been learned on early on in an engineering career by physically doing work on construction sites.

These findings support those of Skipper and Bell (2008), who found that experience gained through being placed in leadership positions and learning from this yielded the top performing project managers. Edum-Fotwe & McCaffer (2000) similarly found that a large part of the competency development of project managers depends on and is driven by the experiences that project managers go through in their working life.

Farr and Brazil (2009) suggest that some project management competencies can be developed by formal training and others can be acquired by site experience. This makes the development of engineers more complicated, because different means of training need to be identified for different competencies. This can be made easier with the assistance of a mentor who can guide a graduate engineer through his or her career development and working career, and a proper combination of theoretical and on-site training.

The six most applicable methods as mentioned in Table 32 can thus be summarised as engineers' being placed on a construction site where they start to take responsibility for certain sections of the construction site and physically learn what the different methods of the various construction tasks entail, while working under an assigned mentor, who is able to assist and guide the engineers so that they will be able to learn from their experiences on site and add this to their career development. During this time on the construction site, graduate engineers must be exposed to measuring the productivity of the various teams and tasks once they have gained enough experience about what the different tasks involve, and then use this knowledge to measure financial productivity in terms of actual financial losses or gains for the various teams and tasks. One of the ways that this can be achieved is to assign each engineer to a dedicated site agent (a more senior engineer between the graduate and the project manager) to assist the

engineer in measuring these productivities and costing for the site agent's section of work, with the understanding that the site agent is able to interpret the results to the graduate engineer and correct him or her in places where mistakes may have been made.

As this on-site experience advances, the engineer can also be rotated to different positions in the construction company to expose him or her to all the different career paths and disciplines that engineers have to be able to decide if they want to become project managers or specialise in other fields. This can be achieved or enhanced by implementing a structured induction programme at the beginning of the year, where all the new graduate engineers are oriented regarding the workings of the company and the construction industry, and by establishing a continued training and development programme that can track the movement and progress of graduates during the first couple of years to make sure that they gain the necessary experience and exposure.

6.6. Research Question 5

Does the perception or view of which methods are the most effective in developing these competencies differ from young graduate engineers, human resource professionals and senior managers?

The aim of Research Question 5 was to test whether the different respondent groups held a different opinion with regard to which method is the most appropriate or effective in the development of project manager competencies in graduate engineers in the construction industry. The data from Table 32 were used, focusing on the columns for the average ratings of the *Engineers*, *HR*, *Senior Managers* and the *p-values*. To compare the difference between the ratings of the various respondent groups, the p-values were calculated for each competency. This was done by testing independent samples using the Kruskal-Wallis statistical test with a 95% confidence interval. The p-values of this test are shown in the right-hand column of Table 32 (see Chapter 5), with the significant values (smaller than 0.05) highlighted in red.

From Table 32 it can be seen that for six of the 13 methods there was a significant difference between the responses of the various respondent groups, which means that the three groups did not agree on almost half the methods in terms of their importance,

and the ranking of the development methods. There is thus a significant statistical difference between the opinions of the graduate engineers, human resources professionals and senior managers on which methods are the most relevant in developing project management competencies in graduate engineers in the construction industry. This would prove that Muchiri et al.'s (2011) study, which found that there are definite differences in the perspectives between managerial (or senior) and non-managerial (or junior) employees, does apply with regard to methods of development in this study (unlike for Research Question 3, where their findings did not apply to the project management competencies in the construction).

Table 35: Development Methods: Difference of Opinions

Development Methods	Rating Average			
	Engineers	HR	Senior Managers	*p*-value
On-site Experience – Physically doing different construction tasks	**4.1**	**4.9**	4.8	**0.001**
Job rotation between various disciplines during first year in the company	**4.0**	**4.9**	4.1	**0.012**
Running a "service" on the first project, e.g. running the batch-plant, scheduling plant	**3.6**	**4.3**	4.2	**0.018**
Training courses provided by the Company	**4.1**	3.8	**3.5**	**0.014**
Working in Estimating and Planning department in first year ensuring understanding of various activities	**3.1**	**4.3**	3.3	**0.016**
Training courses provided by external service providers	**3.7**	3.6	**3.0**	**0.011**

The first method in Table 35 relates to gaining physical experience on a construction site, and it is clear that the graduate engineers rate this lower than either the human resources personnel or the senior managers do. This corresponds with the findings for Research Question 3 and Table 34, which found that the engineers also rated the physical work on a construction site much lower than the human resources professionals and the senior managers did. This finding contrast with what prior studies found, namely that most development of project managers depends on the experiences that they go through in their working life (Edum-Fotwe & McCaffer, 2000) and not simply on the formal training received. The other items where the graduate engineers were on the lower extremity also relate to gaining experience through doing actual work on a construction site. This can be seen in the third and fifth rows in the table. By contrast, the methods where the graduate engineers were on the higher extreme all related to receiving formal training from external or internal suppliers.

This is an extremely important finding in that the senior managers and human resources professionals that usually structure the development and training in a company would have to carefully consider the methods that they anticipate using for developing graduates, as the younger engineers might not see on-site training as training and may be disappointed when they do not receive structured training from a dedicated service provider. Possible reasons for this might be the fact that the senior managers have much more experience and that they can actually see the use of gaining experience through physically working on a construction site, or that when they were working on a site, formal training courses were not available and they were never exposed to it.

Table 33 indicates that all the respondents felt that the industry has become more demanding from the time when the current senior managers were site engineers and this might be a contributing factor to the differences between the senior managers and the graduate engineers.

It is therefore clear that there are distinct differences between the methods that graduate engineers, human resources professionals and senior managers see as being the most appropriate in the development of project management competencies in graduate engineers.

6.7. General Findings from the Study

An interesting finding from the sample description data is the fact that the majority of the graduate engineers have completed a BEng or BSc degree, as can be seen from Table 10, compared to the majority of the senior managers, who completed a national diploma or BTech degree. This is interesting because part of the diploma course is a one-year practical working experience to complete the diploma. The diploma also focuses more on engineering management than the BEng or BSc degrees. It would thus seem that the diploma might be better suited for the construction industry, but the current sample of graduate engineers does not reflect this. This might be due to the changing of the industry in terms of the requirements set by clients.

CHAPTER 7: Conclusion

7.1. Introduction

This chapter revisits the research problem outlined in Chapter 1 by looking at the research results set out in Chapters 5 and 6. Recommendations are made to managers in construction companies and graduate engineers who find themselves in the construction industry after graduating from a tertiary education institution. Finally, recommendations for possible future research are identified and discussed briefly.

7.2. Discussion of Findings

On the basis of the problem posited in Chapter 1, the research set out to ascertain which project management competencies should be developed in graduate engineers in the construction industry during their first five years after graduating and to identify which methods would be best suited for this development. With regard to both these problems, the study also aimed to establish whether there are any differences between the perceptions or opinions of graduate engineers, those of human resources professionals and those of senior managers in the construction industry.

7.2.1. Project management competencies

From the literature that was reviewed, various general project management competencies were identified, but none were related specifically in the literature to graduate engineers in the first few years after graduating. In this regard, the study contributed to the broader theory by identifying seven specific competencies that need to be developed in graduate engineers after they graduate and join the construction industry. It also identified six competencies that can be focused on once the first seven have been mastered and that will also complement the first seven. Finally, it noted five competencies that are aimed more specifically at the senior engineer level or site agent level and that will be applicable once an engineer is ready make the transition to becoming a project manager. These competencies are listed in Table 31, and the three groups can also be presented visually, as in the blue blocks in Figure 6.

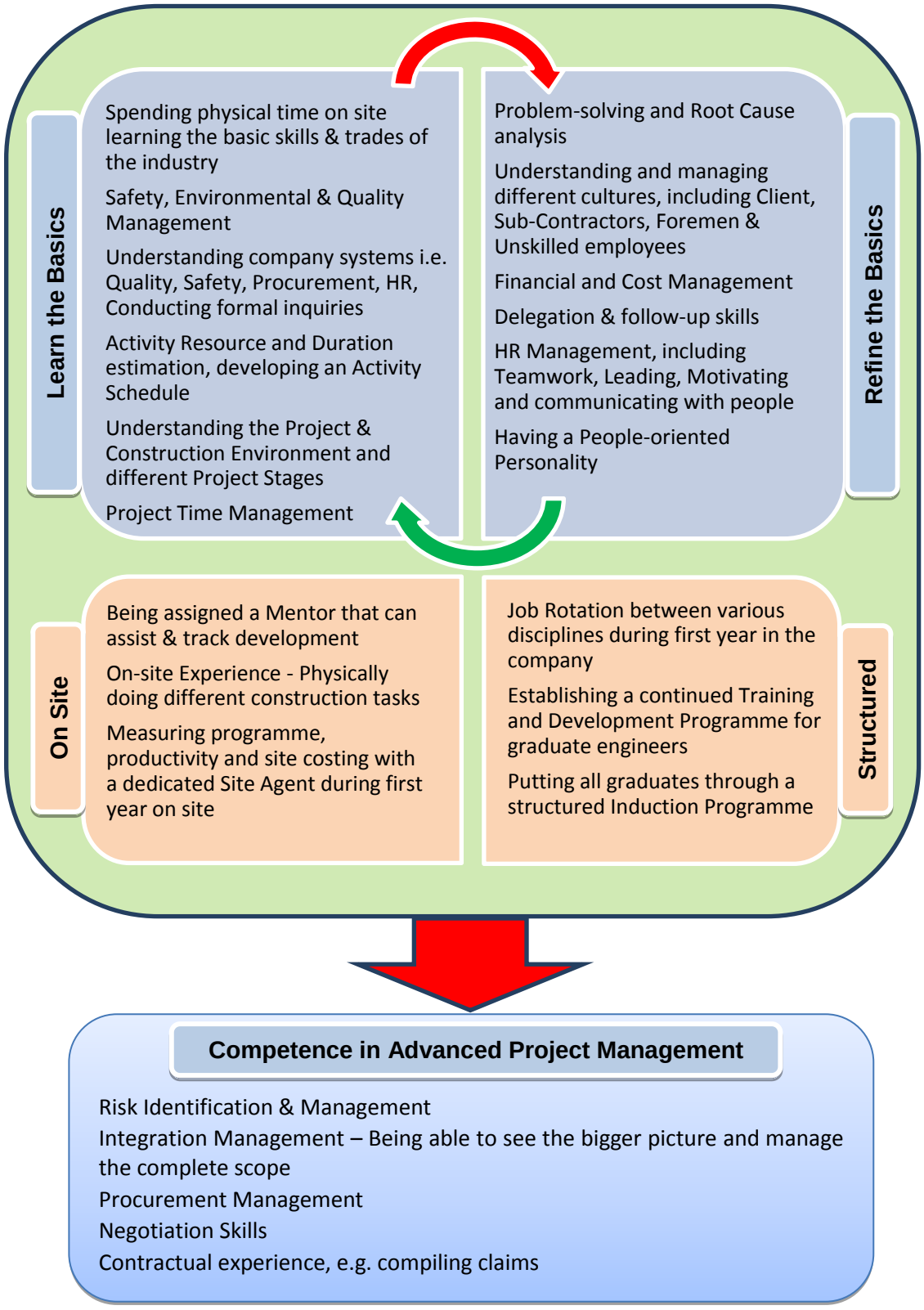

Figure 6: Project Management Competencies and Development Methods in the Construction Industry

The first group of competencies at the top left of Figure 6 are all related to activities directly associated with working on a construction site. This confirms the claims in the literature that it is important for a graduate engineer first to learn the basics of the construction industry before venturing to undertake more advanced project management.

A very reassuring result was obtained in respect of Research Question 3, which looked at the perceptions or opinions of graduate engineers, human resources professionals and senior managers in the construction industry on the competencies that need to be developed in graduate engineers. It was confirmed that there were no significant differences between the perceptions of and ranking in the list of competencies by the various respondent groups. This implies that the content of development programmes that a construction firm's human resources professionals or senior managers develop should be well received by graduate engineers.

7.2.2. Development methods

After identifying the project management competencies that need to be developed in graduate engineers, it was important to identify the most appropriate methods to get this done in the construction industry environment. Six methods were identified as being the most applicable to development of project management competencies in graduate engineers in the construction industry. These are listed in Table 32 and are depicted in Figure 6 in the light red blocks. Of the six methods identified, three can be classified as training on the construction site, and three form part of a more structured development programme. This division corresponds well with the groups of competencies that were identified and can be allocated as set out in Figure 6.

The bottom six methods from Table 32 can be classified as *Might be applicable.* It should be noted that, although these methods are not as applicable for the competencies that need to be developed on the construction site as the others, these methods are more applicable to the competencies in the bottom block of Figure 6 – these relate to the more advanced competencies aimed at actual project managers, rather than at graduates working their way up to project management level.

In relation to Research Question 5, it was found that the different respondent groups, namely graduate engineers, human resources professionals and senior managers in the construction industry, held significantly different opinions or perceptions on which methods are best suited for the development of graduate engineers. The senior managers and human resources professionals regarded learning on site as more important than the graduate engineers, who preferred being developed by internal or external training.

7.3. Recommendations

Based on the research, a number of recommendations can be made and can be shared with both the companies in the construction industry and graduate engineers working in the industry. These are set out below.

7.3.1. Recommendations for construction companies

The following recommendations can be made to companies in the construction industry and their senior and human resources management teams:

Companies need to look at the benefits of establishing structured mentorship and development programmes where graduate engineers can be exposed to possible career paths and can also gain an understanding as to why specific paths are followed, for example, training on site. Contracts directors must realise the large role that they need to play in this process, because they possess the most knowledge and experience of the industry and are best suited to explain this field to graduate engineers. The company should also ensure that the graduate engineers understand that their development is a responsibility shared between the company and the engineers themselves.

The company should also spend time on making sure that all employees are aware of how the industry has changed over the last two decades and of the current challenges faced by graduate engineers coming into the industry from a tertiary education institution. This is important for all the parties involved, as senior staff members may have to adapt the ways in which they approached problems and development in the

past, and the young engineers must aware of the challenges that they are about to face before they are exposed to these challenges.

A company should be cautious about development programmes that are developed by human resources professionals working in isolation, as these programmes might be too theoretical, due to the lack of an engineering background on the side of the human resources professionals. This said, the company also needs to realise who in their human resources department actually communicates with the graduate engineers more frequently, human resources managers or officers, as these communication points might be valuable sources of information and also of communication back to the graduate engineers. They need to ensure that the officers are not merely clerks, but that they are fully aware of the development plans or programmes of the company as a whole.

Lastly, the study found that there may be a need for further investigation of who is appointed as a site engineer or graduate engineer. The study found that the majority of senior managers had obtained a diploma, as opposed to the current graduate engineers who have mostly obtained a Bachelor's degree. This might be significant as the course content the young engineers were exposed to in terms of the quantity of design education, compared to the quantity of management education in courses such as a BEng in Civil Engineering or a diploma in Construction Management might differ significantly.

All of these findings and recommendations should improve the quality of the project management teams that a company ultimately requires to compete in the industry.

7.3.2. Recommendations for graduate engineers

A number of recommendations to graduate engineers in the construction industry are set out below.

The first and the probably the most important recommendation to graduate engineers is that they need to be acutely aware of the fact that their development is a matter of joint responsibility between themselves and the company they work for. They need to be aware that as they might change companies more frequently than their current senior

managers did, so they have to take responsibility for their own career development, because different companies hold different views on development and implement different development programmes. It is vital that they continuously learn and develop themselves over the course of their professional career.

Graduate engineers must also accept the fact that there is no substitute for experience. No training programme on its own can give engineers the skills that they require to advance in their careers. The experience that they will gain by working on a construction site is just as, if not more, important than any training course that they could ever attend.

Graduate engineers must recognise the wealth of experience that is available to them from the project managers and contracts directors that they report to. They should tap this vast reservoir of experience to accelerate their careers by engaging with these senior staff members and learning from previous mistakes, so that they will not have to repeat mistakes.

Lastly, graduates must be prepared to be very open-minded about the various career options open to them. There is not only one directional path for career growth in the industry – the more young engineers interact with the different disciplines and understand what each discipline actually does in the overall industry, the more their chances of finding and pursuing a career that both challenges and satisfies them increase.

By paying attention to these findings and these recommendations, graduates can increase their chances of accelerating their careers and of being fulfilled in them.

7.4. Recommendations for Future Research

The topic of this research has not been researched in depth before and this topic should thus receive more attention in future. This study was conducted in one construction company based in South Africa, so the findings and opinions are likely to be biased. Based on this limitation, a number of recommendations for future research are made, as set out below.

The study should be repeated with a larger sample from various construction companies in South Africa and possibly with companies from different countries to validate the findings of this study in the current context.

The study was specifically directed at the development of project management competencies, but feedback from the various respondent groups showed that various other career options are open to graduate engineers. Hence, a more global study can be conducted on graduate engineer development in general, instead of looking specifically at project management only.

For this, the model in Figure 7 is proposed. Reading the model from the top downwards, an undergraduate degree or discipline is identified and the various careers that can be followed based on that degree are identified. Then the various competencies that the individual careers require are listed. Finally, the model looks at the various competencies between careers and focuses on similar or complementary competencies that can form the foundation for various careers in the development of a graduate engineer. Such an approach will make it possible to expose graduates to various career options before they start to specialise in a definite career.

The study could also be repeated for an engineering career in general by involving other industries in the engineering field, including construction, consulting, design and educational institutions to complete a more in-depth study on the development of graduate engineers.

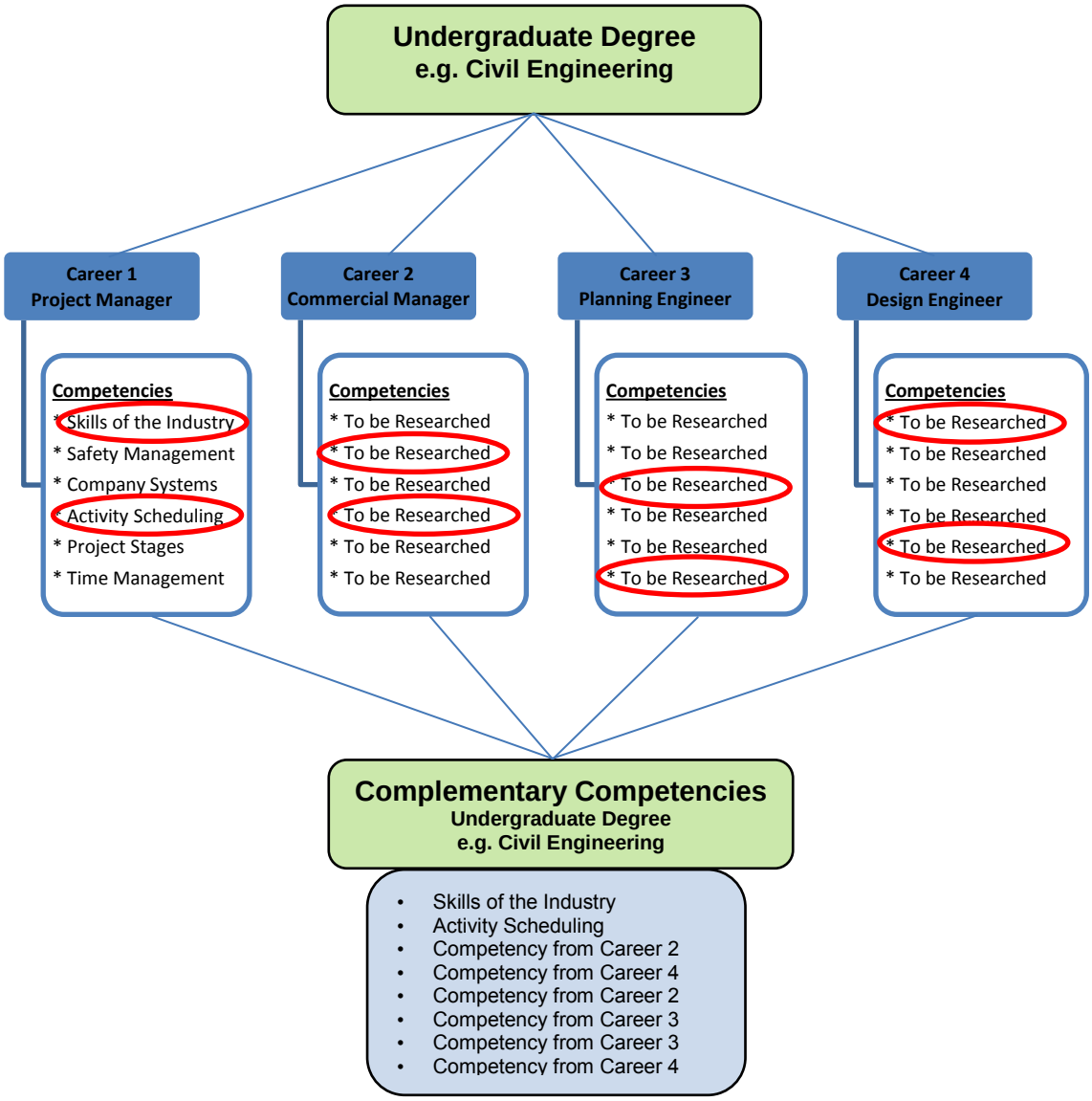

Figure 7: Overall Competency Development for Graduate Engineers

7.5. Concluding Remarks

Infrastructure development is currently a vital area of development in South Africa and the importance of competent construction project managers in such projects was shown in the opening chapters of the research report. Hence, this research was done and makes a contribution at an important point in South African history.

The study has shown that there are currently no best practices for the development of graduate engineers into construction project managers. Therefore, this study's findings on which project management competencies need to be developed in graduate

engineers and which methods should be used to develop these competencies address the lack of best practices in the construction industry. The findings could greatly assist in accelerating the development of graduate engineers in South Africa in general and in the construction industry in particular, and in addressing the problem that graduate engineers are often given heavy responsibility early on in their careers without the proper management development that they require.

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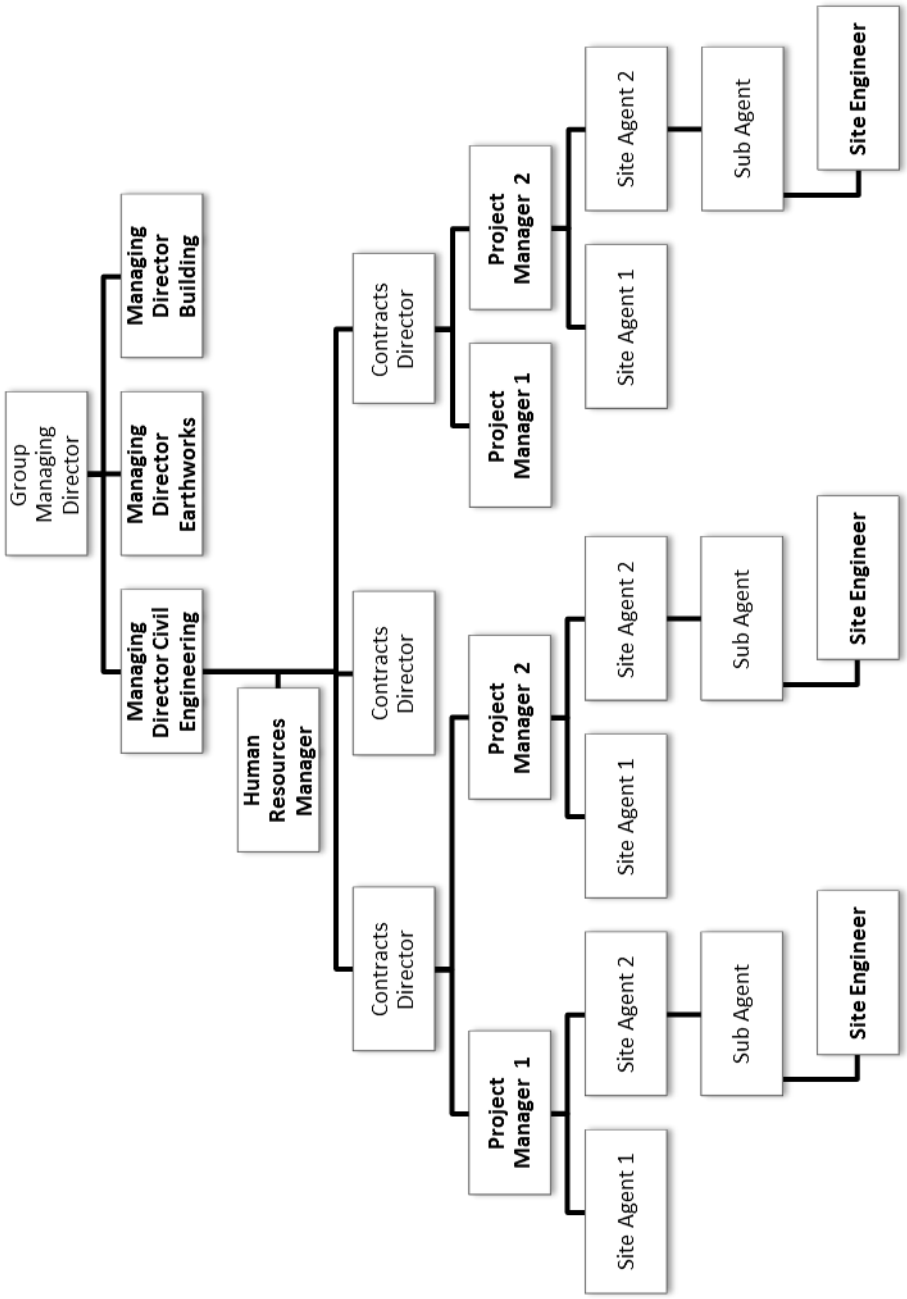
Appendices

Appendix 1: Typical Organogram of a South African Construction Company



Appendix 2: Interview Guideline

Developing Project Management Competencies in Graduate Engineers in the Construction Industry

- Greet the person being interviewed and thank him/her for his/her time.
- Explain the purpose of the research and interview and explain that you would value his/her own opinions
    - Graduate engineers' lack of management and leadership training
    - Graduate engineers' position on a project
    - Possible difference of opinions regarding project management development of graduate engineers
- Ensure that the person understands that the interview is voluntary
- Ask the person to sign the consent from

Interview

1. What competencies do you feel that a project manager should possess?
    1.1. Over what period should this be learned / obtained?
    1.2. Should there be levels of competence in the careers leading up to a project manager?
2. Which of these competencies do the graduate engineers need during their first five years in a construction company and should therefore be developed first in their careers as site engineers?
    2.1. Over what period should this be learned / obtained?
3. How should the site engineer be exposed / learn these competencies?
    3.1. Experience on site
    3.2. Mentorship
    3.3. External courses and learning
    3.4. Internal courses and learning
    3.5. Trial and error
    3.6. Should typical site engineers be involved in planning any possible development plan?
4. Would it be to the company's benefit to accelerate the training and development of the site engineers?

- Thank the person again for his/her time and reassure him/her that all the information that was given will be kept confidential.

Appendix 3: Consent Form for Interview

Developing Project Management Competencies in Graduate Engineers in the Construction Industry

I am currently studying to complete my Master of Business Administration degree at the **Gordon Institute of Business Science, University of Pretoria** and am busy doing research on the *Developing Project Management competencies in Graduate Engineers in the Construction Industry.* I am trying to find out what exactly the competencies of project managers are that are of the most importance to graduate engineers in the construction industry and should be developed first in their careers and if there are different opinions or perceptions of which competencies are required between the different levels of engineering management and the human resources professionals in the company.

Your participation is voluntary and you can withdraw at any time without penalty.

All data will be kept confidential. If you have any concerns, please do not hesitate to contact me or my supervisor.

Researcher:

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Research Supervisor

Margie Sutherland

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+27 11 771 4362

Stefan Bothma _____ _____

Signature Date

_____ _____ _____

Participant Name Signature Date

Appendix 4: Matrix for Analysis of Interviews

Competencies	Managing Directors							Graduate Engineers in 1st year							Graduate Engineers in 2nd year				Senior Managers					Human Resources Professionals				Total	
	No1	No2	No3	No4	No5	Total		No1	No2	No3	No4	No5	Total		No1	No2	Total		No1	No2	No3	Total		No1	No2	Total			
Understanding Project / Construction Environment and Project Stages	1	1	1	1		4	80%			1	1	1	3	60%		1	1	50%	1	1	1	3	100%	1	1	2	100%	**13**	**76%**
Activity Resource Estimation	1	1	1	1	1	5	100%	1	1		1		3	60%	1	1	2	100%	1			1	33%			0	0%	**11**	**65%**
Activity Duration Estimation	1			1	1	3	60%	1	1	1	1		4	80%	1	1	2	100%	1			1	33%			0	0%	**10**	**59%**
Activity Scheduling				1	1	2	40%		1	1	1	1	4	80%	1	1	2	100%	1			1	33%			0	0%	**9**	**53%**
Schedule Development	1			1		2	40%	1	1	1			3	60%		1	1	50%	1		1	2	67%	1		1	50%	**9**	**53%**
Communication to both Subordinates & Client		1	1		1	3	60%			1	1	1	3	60%			0	0%			1	1	33%			0	0%	**7**	**41%**
Problem-solving / Route cause Analysis	1	1	1		1	4	80%				1		1	20%	1		1	50%				0	0%	1		1	50%	**7**	**41%**
Financial Management						0	0%			1	1	1	3	60%	1		1	50%	1			1	33%			0	0%	**5**	**29%**
Managing different persons - Client, Subcontractors, Foremen, Unskilled				1	1	2	40%						0	0%		1	1	50%		1		1	33%	1		1	50%	**5**	**29%**
Personal Time Management					1	1	20%				1	1	2	40%	1		1	50%			1	1	33%			0	0%	**5**	**29%**
Safety Management					1	1	20%	1	1				2	40%			0	0%	1			1	33%		1	1	50%	**5**	**29%**
Leading People					1	1	20%			1	1	1	3	60%			0	0%				0	0%			0	0%	**3**	**18%**
Quality Management						0	0%	1					1	20%	1		1	50%	1		1	2	67%			0	0%	**4**	**24%**
Learning Basic Skills in Industry (Physical & Technical)	1			1		2	40%						0	0%		1	1	50%		1		1	33%			0	0%	**4**	**24%**
Understanding Company Systems (QA, Safety, Procurement, HR)						0	0%						0	0%	1	1	2	100%		1		1	33%		1	1	50%	**4**	**24%**
Understanding Standard Specifications						0	0%			1	1	1	3	60%		1	1	50%				0	0%			0	0%	**4**	**24%**
Project Time Management						0	0%	1			1		2	40%			0	0%	1			1	33%			0	0%	**3**	**18%**
People Management				1		1	20%						0	0%	1		1	50%				0	0%		1	1	50%	**3**	**18%**
Personality – People-oriented		1	1	1		3	60%						0	0%			0	0%				0	0%			0	0%	**3**	**18%**
Progress Measuring					1	1	20%			1		1	2	40%			0	0%				0	0%			0	0%	**3**	**18%**
Teamwork					1	1	20%		1				1	20%			0	0%				0	0%	1		1	50%	**3**	**18%**
Being a Change Agent						0	0%						0	0%			0	0%		1	1	2	67%			0	0%	**2**	**12%**
Delegation Skills				1	1	2	40%						0	0%			0	0%				0	0%			0	0%	**2**	**12%**
Risk Identification & Management						0	0%	1					1	20%			0	0%			1	1	33%			0	0%	**2**	**12%**
Being able to see the bigger picture				1		1	20%						0	0%			0	0%		1		1	33%			0	0%	**2**	**12%**
Understanding different Cultures in the workplace		1	1			2	40%						0	0%			0	0%				0	0%			0	0%	**2**	**12%**
Cost Management						0	0%						0	0%			0	0%				0	0%		1	1	50%	**1**	**6%**
HR Management						0	0%						0	0%			0	0%			1	1	33%			0	0%	**1**	**6%**
Negotiation						0	0%						0	0%	1		1	50%				0	0%			0	0%	**1**	**6%**
Procurement Management						0	0%	1					1	20%			0	0%				0	0%			0	0%	**1**	**6%**
Scope Management						0	0%						0	0%			0	0%			1	1	33%			0	0%	**1**	**6%**
Claims & Contractual Experience						0	0%			1			1	20%			0	0%				0	0%			0	0%	**1**	**6%**
Conducting Disciplinary Enquiries						0	0%						0	0%			0	0%				0	0%		1	1	50%	**1**	**6%**
Integration Management						0	0%						0	0%			0	0%			1	1	33%			0	0%	**1**	**6%**
Motivate Subordinates						0	0%						0	0%	1		1	50%				0	0%			0	0%	**1**	**6%**
Understanding Own Responsibility						0	0%						0	0%			0	0%		1		1	33%			0	0%	**1**	**6%**
Environmental Management						0	0%						0	0%			0	0%				0	0%			0	0%	**0**	**0%**
Calculating Team Sizes						0	0%						0	0%	1		1	50%				0	0%			0	0%	**1**	**6%**

Methods of Exposure	Managing Director							Graduate Engineer in 1st year							Graduate Engineer in 2nd year				Senior Managers					Human Resources Professionals				Total	
	No1	No2	No3	No4	No5	Total		No1	No2	No3	No4	No5	Total		No1	No2	Total		No1	No2	No3	Total		No1	No2	Total			
On-Site Experience - Physically doing different construction tasks	1	1	1	1		4	80%	1	1	1	1	1	5	100%	1	1	2	100%	1	1	1	3	100%	1	1	2	1	**16**	**94%**
Internal / External Training Courses	1	1	1	1	1	5	100%	1		1			2	40%	1		1	50%		1	1	2	67%		1	1	0.5	**11**	**65%**
Mentoring		1	1	1	1	4	80%	1		1	1	1	4	80%	1		1	50%		1	1	2	67%			0	0	**11**	**65%**
Structured Induction / Training & Development Programme / Guide	1				1	2	40%			1	1	1	3	60%					1	1	1	3	100%		1	1	0.5	**9**	**53%**
Job rotation between disciplines		1	1			2	40%					1	1	20%					1			1	33%	1		1	0.5	**5**	**29%**
Starting working with Estimator & Planner		1	1			2	40%																	1		1	0.5	**3**	**18%**
Bi Annual get together of all young engineers in the company to discuss experience gained / exposed to																				1	1	2	67%					**2**	**12%**
Spend 1st year measuring programme and productivity and run site services, Batch plant / Rebar / cast-in Items																1	1	50%	1			1	33%					**2**	**12%**
Working through Case Studies																								1		1	0.5	**1**	**6%**

Appendix 5: Survey Sent to Graduate Engineers

Project Management - Graduate Engineers Development Needs -

Thank you very much for taking the time to complete this survey.

The data from this survey will be made available to all the business units in [redacted] to benefit the development of graduate engineers

Please note that for the purpose of this questionnaire, the term Project Manager also refers to Contracts Manager or Senior Contracts Manager

This questionnaire would take approximately 10 minutes to complete

Page 1

Project Management - Graduate Engineers Development Needs -

Background Information

The purpose of the questionnaire is to get the view from Graduate and Site Engineers in the [redacted] Group with regards to the Project Management Development needs of Graduate Engineers in their first three years after graduating

***1. What year did you Qualify from University or University of Technology (previously Technicon)?**

- ◯ 2005
- ◯ 2006
- ◯ 2007
- ◯ 2008
- ◯ 2009
- ◯ 2010
- ◯ 2011

Other (please specify)

***2. What degree or diploma did you obtain?**

- ◯ N.Dip Civil Engineering
- ◯ N.Dip Building
- ◯ N.Dip Construction Management
- ◯ N.Dip Mechanical Engineering
- ◯ B.Tech Civil Engineering
- ◯ B.Tech Building
- ◯ B.Tech Construction Management
- ◯ B.Tech Mechanical Engineering
- ◯ B.Eng or B.Sc Civil Engineering
- ◯ B.Eng or B.Sc Construction Management
- ◯ B.Eng or B.Sc Mechanical Engineering
- ◯ B.Eng or B.Sc Mining Engineering
- ◯ M.Eng or M.Sc Civil Engineering
- ◯ M.Eng or M.Sc Mechanical Engineering
- ◯ M.Eng or M.Sc Mining Engineering

Other (please specify)

Project Management - Graduate Engineers Development Needs -

***3. How long have you been working in the construction industry?**

- ◯ Less than One year
- ◯ One to Two years
- ◯ Two to Three years
- ◯ Three to Four years
- ◯ Four to Five years
- ◯ Longer than Five years

***4. On how many construction projects have you worked on post qualification?**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10
- ◯ More than 10

***5. What is your current job title?**

- ◯ Junior Site Engineer
- ◯ Site Engineer
- ◯ Sub Agent
- ◯ Project Engineer
- ◯ Technician
- ◯ Construction Engineer

Other (please specify)

***6. What, according to you, is the importance of further career development for graduate engineers in the construction industry after obtaining a qualification and starting to work?**

Not important	At some stage	Required	Absolute necessity
◯	◯	◯	◯

Project Management - Graduate Engineers Development Needs -

7. In your opinion, who is responsible for the career development of graduate engineers?
(from left to right, left being 100% the responsibility of the engineer and the right being 100% the responsibility of the company)

100% Employee	75% - 25%	50% - 50%	25% - 75%	100% Company
◯	◯	◯	◯	◯

8. In your opinion, what percentage of undergraduate engineering education is devoted to management skills as opposed to engineering skills?

The scale is the percentage of management education included in the undergraduate curriculum, e.g. if you think that 5% of the content of the curriculum is spent on management and therefor 95% spent on engineering skills, click the 0% to 20% button

0% to 20%	21% to 40%	41% to 60%	61% to 80	81% to 100%
◯	◯	◯	◯	◯

Project Management - Graduate Engineers Development Needs -

Typical Project Management Competencies

The purpose of the next questions is to identify project management competencies that graduate engineers need to develop in the first three years after graduating.

Please rate every competency on the 5 point scale.

***9. Below is a list of typical Competencies that is generally associated with Project Managers (Contracts Managers).**

Please make full use of the 5-point scale to rate each in terms of its relative importance during the first three years after graduation

	Can be acquired at a later stage		Would be advantageous during year 1 to 3		Absolute requirement during year 1 to 3
Activity Resource and Duration estimation, developing an Activity Schedule	◯	◯	◯	◯	◯
Safety, Environmental & Quality Management	◯	◯	◯	◯	◯
Spending physical time on site learning the basic skills & trades of the industry	◯	◯	◯	◯	◯
Negotiation Skills	◯	◯	◯	◯	◯
Understanding and managing different cultures, including Client, Sub-Contractors, Foremen & Unskilled	◯	◯	◯	◯	◯
Delegation & follow-up skills	◯	◯	◯	◯	◯
Problem solving and Root Cause analysis	◯	◯	◯	◯	◯
Understanding company systems i.e. Quality, Safety, Procurement, HR, Conducting formal inquiries	◯	◯	◯	◯	◯
Integration Management – Being able to see the bigger picture and manage the complete scope	◯	◯	◯	◯	◯
Procurement Management	◯	◯	◯	◯	◯
Project Time Management	◯	◯	◯	◯	◯
HR Management, including Teamwork,	◯	◯	◯	◯	◯

Project Management - Graduate Engineers Development Needs -

Leading, Motivating and communicating to people					
Understanding the Project & Construction Environment and different Project Stages	◯	◯	◯	◯	◯
Having a People orientated Personality	◯	◯	◯	◯	◯
Financial and Cost Management	◯	◯	◯	◯	◯
Contractual experience, e.g. compiling claims	◯	◯	◯	◯	◯
Risk Identification & Management	◯	◯	◯	◯	◯
Personal Time Management	◯	◯	◯	◯	◯

Any other Competency not mentioned above

Project Management - Graduate Engineers Development Needs -

Methods for gaining experience

The purpose of the question on this page is to identify the best methods of ensuring that graduate engineers become competent in the Project Management competencies.

***10. There are various ways / methods that can be used to develop these competencies.**

Below are typical methods, please rate each method based on its relative effectiveness in ensuring that these competencies are developed in graduate engineers.

Please make full use of the 5-point scale to rate each in terms of its relative effectiveness during the first three years after graduation

	Not required		Might be applicable		Best suited to development
Bi-Annual conference for engineers from different Business units in [redacted] to share experiences	◯	◯	◯	◯	◯
Running a "service" on the first project, e.g. running the batch-plant, scheduling plant	◯	◯	◯	◯	◯
Putting all graduates through a structured Induction Programme	◯	◯	◯	◯	◯
On site Experience - Physically doing different construction tasks	◯	◯	◯	◯	◯
Working in Estimating and Planning department in first year ensuring understanding of various activities	◯	◯	◯	◯	◯
Being assigned a Mentor that can assist & track development	◯	◯	◯	◯	◯
Training courses provided by external service providers	◯	◯	◯	◯	◯
Working through case studies of different construction projects	◯	◯	◯	◯	◯
Training of current managers to be competent in the training of graduate engineers	◯	◯	◯	◯	◯
Measuring programme, productivity and site costing with a dedicated	◯	◯	◯	◯	◯

Project Management - Graduate Engineers Development Needs -

Site Agent during first year on site					
Establishing a continued Training and Development Programme for graduate engineers	◯	◯	◯	◯	◯
Job Rotation between various disciplines during first year in the company	◯	◯	◯	◯	◯
Training courses provided by [redacted]	◯	◯	◯	◯	◯

Other (please specify)

Project Management - Graduate Engineers Development Needs -

Possible Career paths in the Construction Industry

The purpose of the questions on this page is to find out whether graduate engineers have been exposed to different career path options in the construction industry.

11. Who in your opinion, is responsible for exposing graduate engineers to all the possible career paths?
Tick all that you think is applicable

- [ ] Project Manager
- [ ] Contracts Director
- [ ] Other colleagues
- [ ] Human Resource personnel

Other (please specify)

12. Do you think that all possible career paths for graduate engineers are clearly defined?

- ◯ Yes
- ◯ Could be done better
- ◯ Not at all

13. Are career paths effectively communicated to the graduate engineers?

- ◯ Never
- ◯ Only when someone threatens to resign
- ◯ Only if someone actually asked about some options
- ◯ With some of the engineers
- ◯ It definitely gets discussed and explained

***14. Based on your experience in the industry, please indicate some other possible career paths for a graduate engineer besides becoming a Project Manager**

Option 1
Option 2
Option 3
Option 4

Project Management - Graduate Engineers Development Needs -

***15. In your opinion, how has the construction industry changed the most during the past 10 to 15 years (when your current Project Managers and Directors were Site Engineers) in terms of:**

	Is less demanding	Is still the same	Has become more demanding	Changed fundamentally
Technology	◯	◯	◯	◯
Safety	◯	◯	◯	◯
Environmental factors	◯	◯	◯	◯
General pace of a construction project	◯	◯	◯	◯
Professionalism of industry	◯	◯	◯	◯

Other (please specify)

***16. In your opinion, what is the biggest challenge that a graduate engineer faces in the construction industry during the first three years after graduating?**

Project Management - Graduate Engineers Development Needs -

Thank you very much for your participation in this survey.

Your time is appreciated

Appendix 6: Project Management Competencies – IBM SPSS Data Output

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Understanding the Project & Construction Environment and different Project Stages is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.453	Retain the null hypothesis.
2	The distribution of Activity Resource and Duration estimation, developing an Activity Schedule is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.310	Retain the null hypothesis.
3	The distribution of Understanding company systems i.e. Quality, Safety, Procurement, HR, Conducting formal inquiries is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.929	Retain the null hypothesis.
4	The distribution of Problem solving and Root Cause analysis is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.031	Reject the null hypothesis.
5	The distribution of Understanding and managing different cultures, including Client, Sub-Contractors, Foremen & Unskilled is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.277	Retain the null hypothesis.
6	The distribution of Safety, Environmental & Quality Management is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
7	The distribution of Financial and Cost Management is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.157	Retain the null hypothesis.
8	The distribution of Personal Time Management is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.997	Retain the null hypothesis.
9	The distribution of Project Time Management is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.179	Retain the null hypothesis.
10	The distribution of Spending physical time on site learning the basic skills & trades of the industry is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.006	Reject the null hypothesis.

11	The distribution of HR Management, including Teamwork, Leading, Motivating and communicating to people is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.213	Retain the null hypothesis.
12	The distribution of Having a People-oriented Personality is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.409	Retain the null hypothesis.
13	The distribution of Risk Identification & Management is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.069	Retain the null hypothesis.
14	The distribution of Delegation & follow-up skills is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.071	Retain the null hypothesis.
15	The distribution of Integration Management – Being able to see the bigger picture and managing the complete scope is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.108	Retain the null hypothesis.
16	The distribution of Negotiation Skills is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.220	Retain the null hypothesis.
17	The distribution of Procurement Management is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.374	Retain the null hypothesis.
18	The distribution of Contractual experience, e.g. compiling claims is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				

Appendix 7: StatTools: Competency – Spending Physical Time on Site

ANOVA Summary	
Total Sample Size	87
Grand Mean	4.609
Pooled Std Dev	0.768
Pooled Variance	0.590
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Time on Site	HR Time on Site	Senior Time on Site
Sample Size	29	16	42
Sample Mean	4.207	4.750	4.833
Sample Std Dev	1.082	0.683	0.490
Sample Variance	1.170	0.467	0.240
Pooling Weight	0.333	0.179	0.488

One Way ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	7.121	2	3.560	6.031	0.004
Within Variation	49.592	84	0.590		
Total Variation	56.713	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval of *Tests*	Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.543	**-1.019**	**-0.067**	-1.128	0.041	-1.114	0.028	-1.139	0.053
Engineer-Senior	-0.626	**-0.995**	**-0.258**	**-1.080**	**-0.173**	**-1.069**	**-0.184**	**-1.089**	**-0.164**
HR-Senior	-0.083	-0.532	0.366	-0.635	0.468	-0.622	0.455	-0.646	0.479

Appendix 8: StatTools: Competency – Safety, Quality and Environmental Management

ANOVA Summary	
Total Sample Size	87
Grand Mean	4.598
Pooled Std Dev	0.721
Pooled Variance	0.520
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Safety	HR Safety	Senior Safety
Sample Size	29	16	42
Sample Mean	4.276	4.938	4.690
Sample Std Dev	0.922	0.250	0.680
Sample Variance	0.850	0.063	0.463
Pooling Weight	0.333	0.179	0.488

One Way ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	5.213	2	2.606	5.009	0.009
Within Variation	43.707	84	0.520		
Total Variation	48.920	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.662	**-1.108**	**-0.215**	**-1.210**	**-0.113**	**-1.198**	**-0.126**	**-1.221**	**-0.102**
Engineer-Senior	-0.415	**-0.761**	**-0.068**	-0.840	0.011	-0.830	0.001	-0.849	0.019
HR-Senior	0.247	-0.174	0.668	-0.271	0.765	-0.259	0.753	-0.281	0.775

Appendix 9: StatTools: Competency – Problem-Solving and Root Cause Analysis

ANOVA Summary	
Total Sample Size	87
Grand Mean	4.046
Pooled Std Dev	1.070
Pooled Variance	1.144
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Data Set #1	HR Data Set #1	Senior Data Set #1
Sample Size	29	16	42
Sample Mean	4.069	4.625	3.810
Sample Std Dev	1.193	0.619	1.110
Sample Variance	1.424	0.383	1.231
Pooling Weight	0.333	0.179	0.488

One Way ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	7.728	2	3.864	3.378	0.039
Within Variation	96.088	84	1.144		
Total Variation	103.816	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.556	-1.218	0.106	-1.370	0.258	-1.351	0.239	-1.386	0.274
Engineer-Senior	0.259	-0.254	0.773	-0.371	0.890	-0.357	0.876	-0.384	0.903
HR-Senior	0.815	**0.191**	**1.440**	**0.048**	**1.583**	**0.066**	**1.565**	**0.032**	**1.599**

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Appendix 10: StatTools: Competency – Contractual Experience

ANOVA Summary	
Total Sample Size	87
Grand Mean	2.93
Pooled Std Dev	1.23
Pooled Variance	1.52
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Contractual	HR Contractual	Senior Contractual
Sample Size	29	16	42
Sample Mean	3.14	3.88	2.43
Sample Std Dev	1.03	1.45	1.27
Sample Variance	1.05	2.12	1.62
Pooling Weight	0.33	0.18	0.49

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	26.102	2	13.051	8.599	0.0004
Within Variation	127.484	84	1.518		
Total Variation	153.586	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.737	-1.500	0.026	-1.674	0.200	-1.653	0.179	-1.693	0.219
Engineer-Senior	0.709	**0.118**	**1.301**	-0.017	1.436	0.000	1.419	-0.032	1.451
HR-Senior	1.446	**0.727**	**2.166**	**0.562**	**2.331**	**0.583**	**2.310**	**0.544**	**2.348**

Appendix 11: Competency Development – IBM SPSS Data output

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of On-site Experience – Physically doing different construction tasks is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
2	The distribution of Training courses provided by the company is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.014	Reject the null hypothesis.
3	The distribution of Training courses provided by external service providers is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.011	Reject the null hypothesis.
4	The distribution of Being assigned a Mentor that can assist & track development is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.767	Retain the null hypothesis.
5	The distribution of Putting all graduates through a structured Induction Programme is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.442	Retain the null hypothesis.
6	The distribution of Establishing a continued Training and Development Programme for graduate engineers is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.676	Retain the null hypothesis.
7	The distribution of Job Rotation between various disciplines during first year in the company is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.012	Reject the null hypothesis.
8	The distribution of Working in Estimating and Planning department in first year ensuring understanding of various activities is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.016	Reject the null hypothesis.
9	The distribution of Bi-Annual conference for engineers from different Business units in the group to share experiences is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.698	Retain the null hypothesis.
10	The distribution of Measuring programme, productivity and site costing with a dedicated Site Agent during first year on site is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.130	Retain the null hypothesis.

11	The distribution of Running a "service" on the first project, e.g. running the batch-plant, scheduling plant is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.018	Reject the null hypothesis.
12	The distribution of Working through case studies of different construction projects is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.105	Retain the null hypothesis.
13	The distribution of Training of current managers to be competent in the training of graduate engineers is the same across categories of V1.	Independent-Samples Kruskal-Wallis Test	.670	Retain the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.				

Appendix 12: StatTools: Development – On-Site Experience

ANOVA Summary	
Total Sample Size	87
Grand Mean	4.586
Pooled Std Dev	0.900
Pooled Variance	0.810
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer On Site Experience	HR On Site Experience	Senior On Site Experience
Sample Size	29	16	42
Sample Mean	4.138	4.938	4.762
Sample Std Dev	1.217	0.250	0.790
Sample Variance	1.480	0.063	0.625
Pooling Weight	0.333	0.179	0.488

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	9.099	2	4.549	5.619	0.005
Within Variation	68.005	84	0.810		
Total Variation	77.103	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.800	**-1.357**	**-0.242**	**-1.484**	**-0.115**	**-1.468**	**-0.131**	**-1.498**	**-0.101**
Engineer-Senior	-0.624	**-1.056**	**-0.192**	**-1.155**	**-0.093**	**-1.142**	**-0.106**	**-1.165**	**-0.083**
HR-Senior	0.176	-0.350	0.701	-0.470	0.821	-0.455	0.806	-0.483	0.834

Appendix 13: StatTools: Development – Training by the Company

ANOVA Summary	
Total Sample Size	87
Grand Mean	3.759
Pooled Std Dev	1.026
Pooled Variance	1.052
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Training Company	HR Training Company	Senior Training Company	Training Company
Sample Size	29	16	42	
Sample Mean	4.138	3.813	3.476	
Sample Std Dev	1.093	1.167	0.917	
Sample Variance	1.195	1.363	0.841	
Pooling Weight	0.333	0.179	0.488	

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	7.569	2	3.785	3.598	0.032
Within Variation	88.362	84	1.052		
Total Variation	95.931	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	0.325	-0.310	0.961	-0.455	1.106	-0.437	1.088	-0.471	1.121
Engineer-Senior	0.662	**0.169**	**1.154**	**0.057**	**1.267**	**0.071**	**1.253**	**0.045**	**1.279**
HR-Senior	0.336	-0.263	0.936	-0.400	1.072	-0.383	1.055	-0.415	1.087

Appendix 14: StatTools: Development – External Training

ANOVA Summary	
Total Sample Size	87
Grand Mean	3.379
Pooled Std Dev	1.030
Pooled Variance	1.061
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer External Training	HR External Training	Senior External Training
Sample Size	29	16	42
Sample Mean	3.759	3.563	3.048
Sample Std Dev	1.123	1.153	0.909
Sample Variance	1.261	1.329	0.827
Pooling Weight	0.333	0.179	0.488

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	9.330	2	4.665	4.395	0.015
Within Variation	89.153	84	1.061		
Total Variation	98.483	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	0.196	-0.442	0.834	-0.588	0.980	-0.570	0.962	-0.603	0.996
Engineer-Senior	0.711	**0.216**	**1.206**	**0.103**	**1.319**	**0.117**	**1.305**	**0.091**	**1.331**
HR-Senior	0.515	-0.087	1.117	-0.224	1.254	-0.207	1.237	-0.239	1.269

Appendix 15: StatTools: Development – Job Rotation

ANOVA Summary	
Total Sample Size	87
Grand Mean	4.218
Pooled Std Dev	0.990
Pooled Variance	0.980
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Job Rotation	HR Job Rotation	Senior Job Rotation
Sample Size	29	16	42
Sample Mean	4.034	4.875	4.095
Sample Std Dev	0.981	0.342	1.144
Sample Variance	0.963	0.117	1.308
Pooling Weight	0.333	0.179	0.488

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	8.516	2	4.258	4.344	0.016
Within Variation	82.335	84	0.980		
Total Variation	90.851	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.841	**-1.454**	**-0.227**	**-1.594**	**-0.087**	**-1.576**	**-0.105**	**-1.609**	**-0.072**
Engineer-Senior	-0.061	-0.536	0.415	-0.645	0.523	-0.631	0.510	-0.656	0.535
HR-Senior	0.780	**0.201**	**1.358**	**0.069**	**1.490**	**0.086**	**1.474**	**0.055**	**1.505**

Appendix 16: StatTools: Development – Working in Estimating Department

ANOVA Summary	
Total Sample Size	87
Grand Mean	3.40
Pooled Std Dev	1.33
Pooled Variance	1.76
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Estimating	HR Estimating	Senior Estimating
Sample Size	29	16	42
Sample Mean	3.069	4.250	3.310
Sample Std Dev	1.334	1.065	1.405
Sample Variance	1.781	1.133	1.975
Pooling Weight	0.333	0.179	0.488

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	15.081	2	7.541	4.285	0.017
Within Variation	147.838	84	1.760		
Total Variation	162.920	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-1.181	**-2.003**	**-0.359**	**-2.190**	**-0.172**	**-2.167**	**-0.195**	**-2.211**	**-0.151**
Engineer-Senior	-0.241	-0.878	0.396	-1.023	0.542	-1.005	0.524	-1.039	0.558
HR-Senior	0.940	**0.165**	**1.716**	-0.012	1.893	**0.010**	**1.871**	-0.031	1.912

Appendix 17: StatTools: Development – Running a Service on First Project

ANOVA Summary	
Total Sample Size	87
Grand Mean	3.977
Pooled Std Dev	1.073
Pooled Variance	1.151
Number of Samples	3
Confidence Level	95.00%

ANOVA Sample Stats	Engineer Service	HR Service	Senior Service
Sample Size	29	16	42
Sample Mean	3.517	4.250	4.190
Sample Std Dev	1.122	1.000	1.065
Sample Variance	1.259	1.000	1.134
Pooling Weight	0.333	0.179	0.488

OneWay ANOVA Table	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio	p-Value
Between Variation	9.236	2	4.618	4.011	0.022
Within Variation	96.718	84	1.151		
Total Variation	105.954	86			

	Difference	No Correction		Bonferroni		Tukey		Scheffe	
Confidence Interval Tests	of Means	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Engineer-HR	-0.733	**-1.397**	**-0.068**	-1.549	0.084	-1.530	0.065	-1.566	0.100
Engineer-Senior	-0.673	**-1.188**	**-0.158**	**-1.306**	**-0.040**	**-1.292**	**-0.055**	**-1.319**	**-0.028**
HR-Senior	0.060	-0.567	0.686	-0.711	0.830	-0.693	0.812	-0.726	0.845