Cape Peninsula University of Technology

QUALITY FACTORS CONTRIBUTING TO THE GENERATION OF CONSTRUCTION WASTE

by

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Dissertation submitted in fulfilment of the requirements for the degree

Master of Technology: Quality

in the Faculty of Engineering

at the Cape Peninsula University of Technology

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Bellville

November 2010

DECLARATION

I, Caron Viljoen, declare that the content of this dissertation represents my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed   2011-04-13

Date

ABSTRACT

The proposed research will consist of an investigation into the prevalence of construction waste in construction companies in the Western Cape. Construction waste has been proved to have a negative effect on the economic strength of construction companies and on the environment.

Currently, the South African construction industry is faced with low productivity compared to the manufacturing industry, which poses a serious challenge to the construction industry in its effort to deliver quality projects. Poor work quality and low productivity are the common problems of the industry. Storage, handling and flaws in management systems were also identified as major causes of construction waste.

The construction industry has a critical role to play in ensuring economic growth and development in the formal and informal sectors of the South African economy. However, the industry faces some serious challenges in its endeavour to deliver infrastructure projects effectively. Contractors face many problems when undertaking construction projects owing to poor performance and their work is characterised by poor quality. In construction, higher productivity means seeing the final result sooner, which in turn creates customer satisfaction and ensures sustainability.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and appreciation to

My Creator for His grace and blessings.

My supervisor, Prof. Watkins, for his guidance and support.

My employer for their financial assistance.

My editors for sharing their extensive knowledge and for their support.

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GLOSSARY OF TERMS

Terms/Acronyms/Abbreviations	Definitions/Explanation
Attitude:	Attitude is defined as a "psychological tendency to evaluate a particular object or situation in a favourable or unfavourable way, which causes someone to behave in a certain way towards it".
Contractor:	Refers to an employer who performs construction work and includes principal contractors.
Decision making:	Sequence of steps, actions or procedures that result in decisions, at any level, at any stage of a proposal.
Direct Waste:	Total loss of materials e.g. waste caused by other trades, theft, vandalism, and delivery waste.
Indirect Waste:	Materials not lost physically e.g. Sub-situations, production waste and operation waste.
Labour only:	Main contractor purchases materials and sub-contractor provides labour force only. Hence, main contractor directly pays for the wastage.
Paradigms:	A paradigm is basically a 'world-view'. The concept of the paradigm can be used to represent "people's value judgments, norms, standards, frames of references, perspectives, ideologies, myths, theories, and approved procedures that regulate their thinking and actions".
Phenomenon:	An observation fact, concept or event.
Primary data:	Data collected for the first time, for use in research.

Principal Materials: Standard construction materials used on construction sites e.g. cement (bagged), sand, stone, common bricks, cement (site mixed), mortar in brickwork (site mixed) and mortar (site mixed).

Productivity: Productivity in economics refers to measures of output from production processes, per unit of input.

QMS: Quality Management System related to the ISO 9001 standards.

Recycling: A process where materials are collected, processed and remanufactured into a new product or used as a raw material substitute. To recycle is to return materials to a previous stage in a process or convert waste into reusable materials. 'Recycling' is defined in Section 5 of the Waste Management Acts 1996 to 2005, as being "the subjection of waste to any process or treatment to make it re-usable in whole or in part."

Re-use: Reducing the amount of waste begin discarded by using a product/material on more than one occasion, either for the same purpose or for a different purpose, without the need to reprocess.

Root cause analysis: A technique used to identify the conditions that initiate the occurrence of an undesired activity or state. A system identifies the control or decision points, and uses a series of 'why' questions to determine the reasons for variation in the process path.

Secondary data:	Data already being collected for another purpose are utilised for current research. These data may or may not be collected for the research purpose.
Sustainability:	Sustainability is how to make human economic systems last longer and have less impact on ecological systems, and particularly relates to concern over major global problems.
Waste Audit:	A check of waste to determine amount generated, type, source and means to avoid or reduce waste production.
Waste Management Plan:	A plan devised to prevent and minimise waste and to encourage and support the recycling and recovery of waste. The plan includes policies, objectives and priorities in relation to prevention, minimisation and recovery of waste.
Waste Management:	Waste management is the collection, transport, processing, recycling or disposal of waste materials. Waste management is also carried out to recover resources. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each.

1 CHAPTER 1: SCOPE OF THE RESEARCH

1.1 BACKGROUND TO THE RESEARCH PROBLEM

The construction industry currently contributes approximately 3% to the economy of South Africa, compared to 7% in the 1970's, and it remains an important economic sector (Thawala & Monese, 2004:**Online**). The construction industry has a vital role to play in ensuring economic growth in the formal and informal sectors of the South African economy. The industry employs 540,581 employees and contributes 35% to the total gross domestic product. The gross capital structure consists of civil engineering, residential buildings and non-residential buildings. The total value of the construction sector in 2007 was R169 billion (Statistics South Africa, 2007:**Online**). The South African Government is the single biggest construction client, making up between 40% and 50% of the entire domestic construction expenditure in the country.

Construction waste reduction has become an important issue to improve the performance of the industry in terms of economics, quality and sustainability. One way of achieving this target is by reducing the waste at all stages of the construction process. A study by Garas (2001:2-7), explains that contractors have the perception that waste 'whenever found', is not considered valueless as long as the contractor can sell it to waste dealers at any cost, not one comparable with the original cost, at the end of the project. Material loss is seen as an inevitable by-product of construction projects.

An unacceptable level of material waste creates growing tension for local authorities in many countries. Although the waste problem is well known, it does not seem to be given the recognition it deserves because of the trend to underestimate waste levels. According to McGrath and Anderson (2000:148), wastage within the United Kingdom (UK) construction industry is as high as 17%. Construction wastage is estimated around 70 million tonnes per annum. Research has shown that the Brazilian construction industry has a waste rate of 20–30% if compared to the weight of materials on site. The Netherlands site waste averages 9% (by weight) of the purchased construction materials. In addition, construction waste has become a burden to clients, as they eventually have to bear the costs of waste, and is also a major problem to the contractor, as it leads to loss of profits and potential bankruptcy (Skoyles & Skoyles, 1987:11, Ekanayake & Ofori, 2000:1-6). As a result, minimisation of construction waste has become a sensitive topic among professionals in the construction industry (Poon, Yu, Wong & Cheung 2004:675-89, Teo & Loosemore 2001:741-9, Ekanayake & Ofori, 2000:1-6).

1.2 STATEMENT OF THE RESEARCH PROBLEM

Against the above background, the research problem statement reads as follows: The generation of construction waste leads to a decrease in profitability and an increase in costs, culminating in low productivity of construction companies, and also impacts on the environment.

1.3 THE RESEARCH QUESTION STATEMENT, SUB-QUESTIONS AND OBJECTIVES

1.3.1 Research question

The research question statement to be investigated within the ambit of this report, reads as follows: "What quality factors contributing to construction waste must be addressed to increase sustainability, decrease costs, and minimise environmental impact?"

1.3.2 Investigative (sub-) questions

In support of the research question, the following investigative questions will be researched:

- What are the top three waste categories within the construction industry?
- What are the possible sources and causes of waste generation for the top three categories of waste selected for this study?
- What is the attitude and perception of the construction workforce regarding construction waste?

- What is the attitude and perception of subcontractors (labour only) regarding construction waste?

1.3.3 Primary research objectives

Owing to the fact that material waste in the construction industry is seldom measured and monitored, its management is seen by contractors as a detailed and/or expensive process. It is also generally agreed that construction projects generate large amounts of material waste. According to Skoyles (1984:84-92), the approach has been that it is more efficient to allow for waste to occur than to involve extra resources to control it.

The following research objectives have been set for this research study:

- To identify the three top categories responsible for construction waste.
- To identify the critical sources and causes of construction waste.
- To evaluate attitudes and perceptions of the construction workforce regarding construction waste.
- To evaluate attitudes and perceptions of the sub-contractors (labour only) regarding construction waste.

1.4 THE RESEARCH PROCESS

The research process provides insight into the process of the way that the study will be conducted, from formulating the research proposal to final submission of the thesis or dissertation. Stages in the research process common to all scientific based investigations are listed below.

Remenyi, Williams, Money and Swartz (2002:64-65), explain the research process as consisting of eight specific phases, namely:

- Reviewing the literature.
- Formalising a research question.
- Establishing the methodology.
- Collecting evidence.
- Analysing the evidence.

- Developing conclusions.
- Understanding the limitations of the research.
- Producing management guidelines or recommendations.

According to Collis and Hussey (2003:16), there are six fundamental stages in the research process, namely:

- The identification of the research topic.
- Definition of the research problem.
- Determining how the research will be conducted.
- Collection of the research data.
- Analysis and interpretation of the research data.
- Writing up the dissertation or thesis.

The following research process will be followed in this dissertation:

- Identify a research topic regarding a quality problem experienced in own environment/industry.
- Perform an initial literature review regarding the origin, sources and causes of construction waste; the attitudes of subcontractors and construction workforce towards construction waste; the classification and ranking of construction waste.
- Determine the feasibility of undertaking studies within particular construction projects.
- Formalise the research question.
- Define the research methodology.
- Formalise and submit the research proposal.
- Identify projects involved in research and communicate these to management.
- Develop a structured questionnaire survey for the workforce to determine their attitude and perception regarding construction waste.
- Develop a questionnaire on the causes of construction waste.
- Develop a questionnaire for subcontractors (labour only) to determine their attitude towards construction waste.
- Interview workforce regarding their attitude and perception.
- Develop a survey to rank the three top categories of construction waste.

- Collect evidence.
- Analyse data.
- Develop conclusions.
- Proofread the dissertation and submit for formal evaluation.
- Schedule feedback to project management regarding findings and make provisional recommendations.

1.5 THE RESEARCH DESIGN AND METHODOLOGY

According to Leedy and Ormrod (2010:87), planning the research design is particularly important for the researcher, not only to choose a practical research problem, but also to think about the kinds of data that an investigation of the problem will require, as well as logical ways of collecting and interpreting such data.

According to Yin (1994:19), a research design can be defined as "the logical sequence that connects the empirical data to a study's initial research question and ultimately, to its conclusions. Colloquially, a research design is an action plan for getting from here to there, where 'here' maybe defined as the initial set of questions to be answered, and 'there' is some set of conclusions (answers) to these questions".

Sammy (2008:6), suggests that there are three types of research functions, namely basic research, applied research and evaluation research. Collis and Hussey (2003:66-67), suggest that descriptive research refers to research which describes phenomena as they exist, while analytical research is a continuation of descriptive research, and aims to understand phenomena by discovering and measuring causal relations among them. Collis and Hussey (2003:66-67), describe applied research as the type of research in which the results or findings can be used to solve a specific, existing problem. Based on the definitions of De Vos (2002: 339) and Collis and Hussey (2003:66-67), the proposed study to be conducted in this dissertation will be a combination of 'descriptive' and 'applied' research.

Yin (1994:1), indicates that although the case study research falls within the phenomenological (qualitative) paradigm, case study research can equally be applied within the positivistic (quantitative) paradigm. A case study is an empirical enquiry that investigates a contemporary phenomenon in its real-life context. Case study research explains questions 'how' and 'why'. An explanatory case study approach will be followed in this research endeavour.

According to Collis and Hussey (2003:68-70), various types of case studies can be identified:

- **Descriptive case study:** Where the objective is restricted to describing current practice.
- **Illustrative case study:** Where the research attempts to illustrate new and possible innovative practices adopted by particular companies.
- **Experimental case study:** Where the research examines the difficulties in implementing new procedures and techniques in an organisation and evaluating the benefits.
- **Explanatory case study:** Where existing theory is used to understand and explain what is happening.

This research will attempt to be descriptive in nature, endeavouring to describe the current practices in construction companies in the Western Cape.

According to Yin (1994:20-27), the five components of a research design, important for case studies, are:

- **Study questions:** The 'how' and 'why' questions will be appropriate to clarify the nature of the research.
- **Study propositions:** Will clarify the reasons for the study.
- **Unit of analysis**: Different sized construction projects were identified as the unit of analysis in this research project.
- **Link data to proposition:** 'Pattern matching' is an approach suggested by Yin whereby pieces of information from the same case may be related to some theoretical proposals.
- **Criteria for interpreting findings:** Contrast findings can be interpreted in terms of differences.

1.6 RESEARCH ASSUMPTIONS

The researcher considers that:

- There is a lack of concern on the construction sites regarding waste of materials.
- Respondents to the study will be able to provide correct, complete and timely information.
- From one construction company to the next, waste allowances may vary significantly. This allowance is based on the size and nature of the project.

1.7 RESEARCH CONSTRAINTS

The construction companies being investigated have large staff complements situated at various locations in the Western Cape. For this reason the assessments will involve only staff from nominated construction companies and will not include any design function. This research is restricted to construction companies in the Western Cape.

Owing to the competitive nature of the construction industry and a lack of data from previous projects, estimators are unclear on what actual amounts to use for waste assessment in their tenders. Various authors have also indicated that profits and overheads of the projects are the estimators' priority and not the allowance for wastage. More attention is given to bidding than to waste elimination.

1.8 SIGNIFICANCE OF THE PROPOSED RESEARCH

Castelo Branco (2007:21), supports the views of Opara (1993), who states that, compared with other sectors of the economy, construction has a reputation of low productivity, antiquated technology and waste production. These factors together contribute significantly to the increase in construction costs. This study will identify the top three waste categories and their causes, and endeavour to minimise the construction waste, thus increasing competitiveness and assisting sustainability. The research also has the potential to be expanded to other construction companies, significantly improving waste reduction on sites and creating the correct level of awareness regarding construction waste.

1.9 CHAPTER AND CONTENT ANALYSIS

The chapter and content analysis with the headings of each chapter are briefly discussed in terms of each of their proposed contents. The following contents have been defined:

- **Chapter 1: The scope of the research:** In this chapter, a holistic perspective will be provided of the scope of the research.
- **Chapter 2: A holistic perspective of the research environment:** In this chapter, a holistic perspective will be provided of the creation of waste, its various forms and impact on projects.
- **Chapter 3: A Literature review:** In this chapter, a literature review will be conducted on construction waste.
- **Chapter 4: Research design and methodology:** In this chapter, the research design and methodology will be elaborated upon.
- **Chapter 5**: **Interpretation of data and analysis of results:** In this chapter, data collected in Chapter 4 will be analysed and interpreted.
- **Chapter 6: Conclusions and recommendations:** In this chapter, the research will be concluded and final analogies drawn, together with appropriate recommendations.

2 CHAPTER 2: BACKGROUND TO THE RESEARCH ENVIRONMENT: A HOLISTIC PERSPECTIVE

2.1 INTRODUCTION

This chapter will provide an assessment of the application of the following concepts. This will provide a holistic and practical underpinning to the research environment:

- Background to the construction industry.
- Long- and short-term planning in the construction industry.
- Codes and regulations.
- State of the construction industry.
- Quality improvement definitions.
- Waste hierarchy.

2.2 BACKGROUND

Nunnally (2007:1), notes that the construction industry is a very competitive business with a high rate of bankruptcy. People involved in the construction industry will be familiar with materials lying around on sites and this is seen as a natural consequence of building (Skoyles & Skoyles, 1987:11-12). People working on sites recognise that losses occur and that some of the materials delivered to construction sites are not used for the purposes for which they were ordered. This loss is termed ‘waste’.

In the construction industry, waste is a loss of profit. Building materials are far too expensive to waste, but in spite of this, money is being wasted because of breakages and losses during construction. This waste also results in higher building costs to the general public (Skoyles & Skoyles, 1987:11-12).

Waste, according to Skoyles and Skoyles (1987:12), can occur in many ways. Materials may be lost in the ground or be damaged by lying around and have to be discarded, or they may be rejected as unsuitable for the purpose for which they were purchased, thereby becoming surplus to the site. Additional materials may be needed to renew damaged work or to replace articles missing through lack of materials control.

2.2.1 Construction industry divisions

Nunnally (2007:3), explains that the major divisions of the construction industry consist of building construction and heavy construction. The building construction may be subdivided into public and private, as well as residential and non-residential. Heavy construction includes highways, airports, railways, bridges, canals, harbours, dams and other major public works. Other speciality divisions of the construction industry include industrial construction, process plant construction, marine construction and utility construction, etc.

2.2.2 The construction process

According to Nunnally (2007:3), the major steps in the construction contracting process include bid solicitation, bid preparation, bid submission, contract award, contract administration and construction management.

2.3 LONG- AND SHORT-TERM PLANNING IN CONSTRUCTION

The minimisation of construction waste has two critical components. The first is efficient planning and the second is control (Castelo Branco, 2007:11). These two tasks are accomplished in different phases of the project. Macro or long-term planning focuses on the project objectives and the restrictions that each project has. Short-term planning defines what tasks will be done on the next day of work.

2.4 BUILDING CODES AND REGULATIONS

Nunnally (2007:8), explains that projects in the construction industry in South Africa must comply with a number of governmental regulations. These include building codes, health and safety regulations, environmental regulations and contractor licensing laws.

2.4.1 Building codes

Building codes are primarily concerned with public safety and minimum design and construction standards for structural and fire safety (Nunnally, 2007:8). These codes only apply to the construction of buildings. The National Building Regulation Act 30 of 1982 and the Building Standards Amendment Act 36 of 1984 provide and promote consistency relating to the erection of buildings within the jurisdiction of local authorities. These building codes are only advisory and may be unnecessarily restrictive (Nunnally, 2007:9). Such restrictions and delays in updating local codes result in increased building costs. At local level, another problem with the building codes is the quality of code administration. The lack of technically qualified building officials leads to inspections using the checklist approach and discourages contractors from utilising new materials and procedures.

Building permits generally must be obtained before construction may begin. According to Nunnally (2007:9), construction delays may be caused after issuing these permits, as local building officials will inspect the project at designated points during construction. The scheduling of these inspections may pose problems for the contractor and often results in construction delays.

Other regulations such as environmental and safety regulations may also have an impact on the construction industry. Environmental regulations (ISO 14001:2004) protect the public and the environment by controlling factors such as water usage, waste disposal and preservation of beaches and wetlands. Safety regulations protect both the public and construction workers. Almost all construction sites are governed by the Occupational Health and Safety (OSHAS) Act No. 85 of 1993. SABS 400:1990 which covers provisions for building site operations, building design and construction, and are deemed to satisfy the provisions of the National Building Regulations. The SANS 1200 series is a set of standardised specifications for civil engineering construction and SANS 12001 for Construction Works.

2.5 STATE OF THE CONSTRUCTION INDUSTRY

2.5.1 Productivity

The term 'productivity' means the output of construction goods and services per unit of labour input (Nunnally, 2007:531). This definition does not take into consideration construction technology and investments to measure productivity. The fast growth of technology in the world economy makes it possible that new technology such as robotics and industrialised building processes will have a major impact on the construction industry in the future.

2.5.2 Construction management

According to Nunnally (2007:11), skilful construction management results in project completion on time and within budget. Poor construction management results in one or more of the following:

- Project delays that increase labour and equipment cost of borrowed funds.
- High material costs caused by poor purchasing, inefficient handling, and/or loss.
- Increased insurance costs resulting from material and equipment loss or damage or a poor safety record.
- Low profit margin or a loss in construction volumes.

The scope of construction management includes topics such as construction contracts, construction methods and materials, production and cost estimating, progress and cost control, quality control and safety.

According to Council for Scientific and Industrial Research (CSIR) (2004:8), the construction industry in South Africa is capable of delivering the most innovative and complex projects at times; it is widely acknowledged that the industry as a whole is underachieving. If the industry wishes to deliver improvements in, amongst others, quality and efficiency, it will need to radically improve the process through which it delivers its projects. Improvements to the delivery process will require building professionals to review their current practice methodologies and to examine the scope of improvement, through innovation, of their own products and processes. Improved construction industry performance will require innovative and energetic professionals within each company.

According to CSIR (2004:8), many quality improvement methodologies are in use. The purpose of this research is to review the leading quality improvement methodologies utilised in the market to help the industry answer one of the most important questions that executives face: how does an organisation choose the methodology that is right for them? Quality improvement activities can be very helpful in improving how things work. Trying to find where the ‘defect’ in the system is, and figuring out new ways to do things, can be challenging and fun. It is a great opportunity to ‘think outside the box’.

2.6 QUALITY IMPROVEMENT DEFINITIONS

According to the Business Directory (2008:**Online**), quality improvement is a systematic approach of analysis of performance to reduce or eliminate waste, and to ensure improvement. Quality improvement is aimed at measuring where the organisation is and considering ways to make things better. It specifically attempts to avoid shifting blame, but seeks to create systems that prevent errors from happening. The success of quality improvement is based on the understanding by all employees of their customers’ requirements (internal and external). Quality improvement expresses the need for effectiveness and efficiency in meeting customers’ requirements.

2.6.1 Quality improvement methodologies

The quality improvement methodologies reviewed in this research are: ISO 9001, TQM, Six Sigma and Lean production or Lean thinking.

2.6.2 ISO 9001 as a quality improvement methodology

According to Delgado-Hernandez and Aspinwall (2005:965), the use of quality improvement tools has proven to be an important aspect of continuous improvement. Following a comprehensive literature review, various quality improvement tools are available. ISO 9001 as a Quality Management System was investigated. It was found that certified companies made more use of and placed higher levels of importance on these tools than companies, which were not certified. ISO 9001 was developed as a standard for business quality systems. To be certified, businesses need to document their Quality Management System and ensure adherence to it with frequent reviews and audits.

According to Lakshy Management Consultants (2010:**Online**), ISO 9001 certification is considered a strategic growth tool for the construction industry. The ISO 9001 Quality Management System is the best tool available to increase productivity, streamline operations, increase customer satisfaction and improve profit margins through superior quality of product, process and service. ISO 9001 offers a variety of benefits to the construction industry. These benefits range from better resource planning to effective monitoring, and control of the project from improved employee efficiency to reduced customer complaints, and from increased productivity to enhanced market image. The ISO 9001 standard places greater emphasis on customer needs and expectations and improving business performance.

A well-established ISO 9001 Quality Management System delivers the following benefits to the construction industry:

- Consistent and effective control of key processes and project management.
- Promotion and standardisation of good working practices.
- Provision of a vehicle for training new employees.
- Effective management of risk and improved crisis management.
- More effective data analysis, generation of key performance matrix and continual improvement objectives.
- Greater emphasis on communication, leadership, change management and adequacy of training.
- A planning and review process which ensures that the system in place remains suitable, effective and capable of identifying new opportunities.
- Effective remote site management, accountability and contractual control.

- Promoting control of suppliers and subcontractors and the development of effective supply chain management.
- World-wide recognition and improved market image.

Besides the fact that ISO 9001 is used as a great marketing selling point, cost education is probably the biggest significant aspect. Regardless of the methodology implemented, managers need to have a better understanding of the impact that poor quality and good quality may have on their investments and on their products/services (Delgado-Hernandez & Aspinwall, 2005:965).

ISO 9001 does not specify quality improvement methodologies. Therefore the implementation of an effective non-conformance system is essential for the success of the system. The development of a formal documented complaint process outlined in the Quality Management System supports continuous improvement ideals (Delgado-Hernandez & Aspinwall, 2005:965). Table 2.1 compares ISO's Eight Quality Management Principles with Deming's Fourteen Points, and TQM.

Table 2.1: ISO 9000's Quality Management Principles vs. Deming's Fourteen Points and TQM. (**Source:** Goetsch & Davis, 2002:314)

ISO 9001	**Deming's Fourteen Points**	**TQM**
1. Customer focus		√
2. Leadership	#1,2,7	√
3. Involvement of people		√
4. Process approach		√
5. System approach to management		√
6. Continual improvement	#5	√
7. Factual approach to decision making		√
8. Mutually beneficial supplier relationships	#4	√

2.6.3 Total Quality Management as a quality improvement methodology

The integrated approach commonly known as Total Quality Management (TQM) has been adopted by most companies, which have been successful in their quality improvement efforts. The TQM philosophy of management is customer-focused.

TQM is a set of management and control processes designed to focus on the entire organisation and all its employees. The TQM process must involve all employees, empowering them to contribute to continuous quality improvement. People will take the initiative to improve their own departments. Each person is responsible and accountable for his/her own work and has to ensure that the desired results are achieved.

According to Talha (2004:15), the aim of TQM is to provide quality products or services that do the best possible job to satisfy the customer. TQM emphasised the use of multi-functional teams to solve problems. The teams were trained to use basic statistical tools to collect and analyse data. Comparisons between ISO 9001 and Total Quality Management, will explain the relationship between the two methodologies. Table 2.2 illustrates how close ISO 9001's evolution has brought it to TQM.

Table 2.2: ISO 9001 as a stepping stone to Total Quality Management. (**Source:** Goetsch & Davis, 2002:313)

Characteristics of Total Quality Management	**ISO 9001:2008**	**TQM**
Customer focus (internal and external)	√	√
Obsession with quality		√
Scientific approach to problem solving	√	√
Long-term commitment	partial	√
Teamwork		√
Continual process and product improvement	√	√
Education and training intensive	√	√
Freedom though control		√
Unity of purpose	√	√
Employee involvement and empowerment	partial	√

According to Brecker Associates (2001:**Online**), the TQM techniques help to identify improvement opportunities. The collected data is used to measure results, before, during and after completion of a project. Problem-solving techniques and quality improvement tools are used to ensure high volumes, high quality and lower material costs. These improvement opportunities ensure that effective overall products and/or service performance are achieved. In the cycle of continuous improvement, measurement plays an important role. The Deming cycle of continuous improvement requires measurement to drive this improvement cycle. TQM is based on the teachings of Deming, Juran, Ishikawa et al., with criteria defined by Deming's Fourteen Points, Juran's Ten Steps of Quality Improvement, and Malcolm Baldrige National Quality Award. These teachings are more demanding and literally require the transformation of the entire organisation (Goetsch and Davis (2002:312).

2.6.4 Six Sigma as a quality improvement methodology

According to Andersson, Eriksson and Torstensson (2006:282-296), Six Sigma, a methodology pioneered by Motorola and made famous by General Electric, focuses on variance reduction through a problem-solving approach that will improve output quality. Six Sigma is acknowledged as a quality technique and a business improvement strategy implemented to reduce variation/defects within a process and thus improve productivity. The main objective of the programme is to reduce defects and costs related to poor quality and render a product or service of exceptional quality when compared with those produced by an organisation's competitors.

The methodology of Six Sigma aims at integrating all operations throughout the processes to make them produce their desired results (Andersson, Eriksson & Torstensson, 2006:282-296). Six Sigma (DMAIC) is defined as a method for improvement and is a popular approach. It has basic quality tools that provide inflexibility and repeatability in quality improvement efforts. The basic quality tools can be used to handle 90% of quality problems. Only 10% requires advanced training and analytical techniques and 1% requires outside specialists not found in a company. The focus on profits is one of the strengths of this approach.

2.6.5 Lean construction and lean production

According to Foster (2007:87), 'lean' as a philosophy is an important element in improving quality. Lean construction, according to Ballard and Howell (2004:38), can be understood as a new paradigm for project management. The paradigm has been described as the change from mass to lean manufacturing.

Lean construction is a source of inspiration the impact of which has been criticised because of dissatisfaction with the practical achievements of project management.

Ballard and Howell (2004:39) find that this source takes the form of an anomaly, namely that only 50% of the tasks on a weekly work plan are completed by the end of the planned week. This demonstrates that project management relies on detailed, centralised planning. Lean construction challenges traditional thinking about construction and project management. The key characteristic of lean construction is that it conceives a construction project as a temporary production system dedicated to the three goals of delivering the product while minimising value and waste (Ballard & Howell, 2004:39).

According to Dahlgaard and Dahlgaard-Park (2006:263-281), lean production or lean thinking have their origin in the philosophy of achieving improvements in most economical ways with special focus on reducing waste. By defining waste as "the excess resources used in relation to perfection", one can say that the aim or objective of lean production or lean thinking is to eliminate waste. Waste has first to be defined as "everything that increases cost without adding value to the customer".

2.7 THE WASTE HIERARCHY

According to Keys, Baldwin and Austin (1999:1-7), in the United Kingdom (UK) more than 70 million tonnes of waste is produced in the construction industry each year. Therefore, the government suggested a hierarchy approach to be followed to reduce waste, which focuses on the re-use and recycling of waste products. The strategy summarises the need for a major change in the way that industry thinks about waste, including product design. Keys, Baldwin and Austin (1999:1-7) explain that the waste hierarchy establishes waste reduction as one of the top priorities for addressing the increasing volumes of waste. Design changes have been identified as the most significant causes of waste during construction. The causes of waste during the design process will, however, not be discussed in detail in this research.

The waste management strategy followed in Botswana highlights key principles of waste prevention, namely payments by the polluter and cooperation amongst all parties involved in the waste cycle. These key principles are the foundation on which all other waste management tools are built (Keys, Baldwin & Austin, 1999:1-7).

2.7.1 The definitions of waste

According to Koskela (1992:34), waste is defined as "any inefficiency that results in the use of equipment, materials, labour, or capital in larger quantities than those considered as necessary in the production of a building".

According to Skoyles (1976:232-243), waste is usually caused by a combination of events, and not by an isolated factor. Waste includes both the incidence of material losses and the execution of unnecessary work, which generates additional costs but does not add value to the product. Therefore, waste can be defined as any losses produced by activities that generate direct or indirect costs but do not add value to the product from the point of view of the client.

2.7.2 Construction waste identification

Building construction involves many activities that have a high potential to generate waste. The waste streams differ largely between different construction phases and waste overlaps from one construction phase to the next. The waste normally arises during the structure and fitting phase. Bossink and Browers (1996:55-60), report a variation in waste percentages between different materials. Materials used in the UK building industry were found to be 295 million tons on average. Each building construction project involves many activities that can be grouped and each of these activities has a high potential to generate waste. Consequential waste is an additional cost that appears to be unrelated to the waste of materials. An example of this is delay caused by a shortage of materials, by correcting damaged work or by the additional costs of re-ordering to replace materials already ordered. This delay may also cause extended hiring of plant and labour, as well as uneconomical use of plant and labour, all of which result in increased costs to the contract.

2.7.3 Concept of waste in the construction industry

According to Formoso, Isatto and Hirota (1999:328), waste is understood to be any inefficiency in equipment, materials, labour and capital. They explain the classification of waste based on the following categories:

- **Overproduction:** This relates to the production of a greater quantity than required. An example of this kind of waste is the overproduction of mortar that cannot be used on time.
- **Substitution:** This waste is caused by the substitution of a material by a more expensive one.
- **Waiting time:** Relates to the idle time caused by the lack of synchronisation and materials flow.
- **Transportation:** This relates to the internal movement of materials on site. Excessive handling can cause this kind of waste. It is related to poor layout, and a lack of planning of materials flow.
- **Processing:** Relates to the nature of the processing activities, which can only be avoided by changing the construction technology.
- **Inventories:** Excessive or unnecessary inventories lead to material waste (deterioration, losses, robbery and vandalism).
- **Movement:** This relates to the unnecessary or inefficient movement made by workers during the job. This might cause inadequate equipment, ineffective work methods or poor arrangement of the working place.
- **Production of defective products:** Occurs when the final or intermediate product does not fit the quality specified. This may lead to re-work.
- **Others:** Waste of any nature different from the previous ones, such as theft, damage, inclement weather, accidents, etc.

3 CHAPTER 3: LITERATURE REVIEW

3.1 INTRODUCTION

This chapter will provide definitions and an assessment of the application of the following concepts, which will give an insight into the theoretical and practical underpinning of the research study:

- Background to the construction industry.
- Commonly used terms.
- Definition of construction waste.
- Origin of construction waste.
- High waste rates of five principal materials.
- Causes of construction waste.
- Classification of waste.
- Measuring and ranking of construction waste.

The literature review defines the following:

- The concept of the differences between international and South African legislation.
- The waste management hierarchy.
- The various types of waste.
- Waste identification during construction.
- Phases in the life of a building through the life cycle of materials in the construction industry.
- Economic benefits and the benefits of contract specifications.
- Less important but interesting markets.
- The South African construction and demolition waste experience.

The literature review will address the following areas:

- Quality relationships through partnering.
- Attitudes and perceptions of the construction workforce towards waste reduction.
- The role sub-contractors (labour only) play in construction waste.
- Construction waste avoidance and management.

3.2 BACKGROUND TO THE CONSTRUCTION INDUSTRY

A review of the South African construction industry, according to CSIR (2004:3), states that the industry is capable of delivering the most innovative and complex projects at times. It is also acknowledged that the industry is underachieving in, amongst others, quality and efficiency, and that the industry needs to radically improve the practice through which it delivers its projects. Improvements to the delivery process will require building professionals to review their current practices and through innovation, their own products and processes. Improved construction industry performance will require vigorous and energetic professional leadership.

The construction industry is considered a wasteful sector. The industry consumes an estimated 12-16% of fresh water and 40% of energy, and added to this an estimated 15% of purchased materials end up as waste. According to the research of Mocozoma (2002:1), the South African construction industry has been in recession for more than two decades. The deterioration in capital investment and activity in infrastructure delivery in the late 70’s and a lack of efficiency in construction processes, have all contributed to this. Inefficiencies in the construction practice occur in three areas: acquisition and use of equipment and machinery, labour practices, and procurement and use of materials.

Construction waste management has become essential to improve the performance of the industry in terms of economic quality and sustainability. One way of achieving this target is by reducing waste at all stages of the construction process. Managing building material waste can result in higher construction productivity, save time and assist sustainability. Hardly any data from previous projects are available on how to avoid the causes of waste generation during construction projects.

This research aims to identify how, where and when waste in construction projects is generated, as well as the dominant causes as identified according to South African current practices. Skoyles and Skoyles (1987:11), support Ekanayaka and Ofori (2000:1-6), in stating that construction waste has become a burden to clients, as they have to bear the costs of waste. This is a major problem for contractors as well, because it leads to loss of profits and may even contribute to bankruptcy. According to De Silva and Vithana (2008:188-198), many countries are experiencing an increase in construction waste, which has created growing tension for authorities, especially as the search for new landfill sites has become an increasing priority.

3.3 COMMONLY USED TERMS ASSOCIATED WITH THE BUILDING INDUSTRY

In order to better understand the current research, some definitions are necessary:

- **Productivity:** According to Wideman (2002:2), productivity refers to the "rate of output of a worker or group of workers per unit of time, usually compared to an established standard or expected rate of output".
- **Debris:** Debris is "solid waste from construction, remodelling, repair or demolition of buildings, roads or other structures".
- **Lean Construction:** According to The Boldt Company (2010:3), lean construction is "a design and construction administration process based on Japanese 'lean manufacturing principles' which are designed to promote efficiency and eliminate waste".

3.4 DEFINITION OF CONSTRUCTION WASTE

Construction waste can be divided into three principal categories, namely material, labour and machinery waste. Most of the construction waste comes from non-renewable resources (Ekanayaka & Ofori 2000:1-6).

According to the Building Research Establishment (1981), cited by Skoyles and Skoyles (1987:11), construction waste is defined as "the difference between the amount of purchased materials and that used in a project". The Hong Kong Polytechnic's (1993), definition of construction waste, as cited in MacDonald and Smithers (1998:71-8), suggests that construction waste is "the by-product generated and removed from construction, renovation and demolition work places or sites of buildings and civil engineering structures".

3.5 ORIGIN OF CONSTRUCTION WASTE

Figure 3.1 and Figure 3.2 graphically depict the origin of waste coming from all stages of the construction process, and which is typically identified throughout the production phase. Furthermore, it can originate as a result of processes that occur before production, such as materials manufacturing, design, materials supply, and planning.

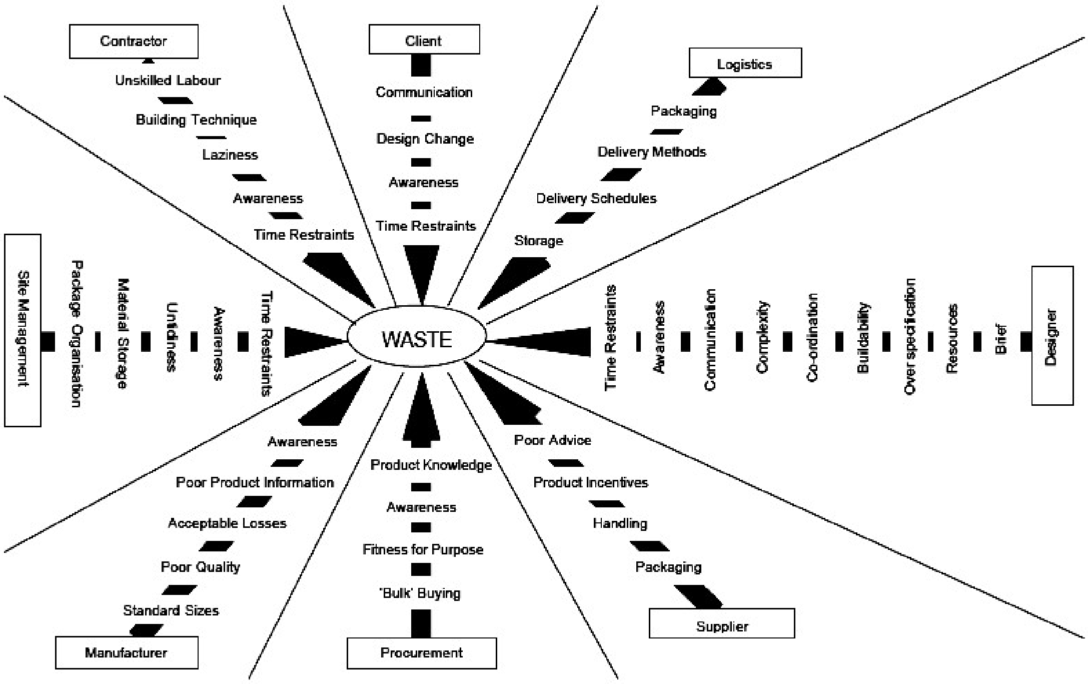

Figure 3.1: The origin of waste. (**Source:** Keys, Baldwin & Austin, 1999:4)

Various stages of the construction process directly or indirectly create physical waste. This becomes more complex when further parties involved add waste during the sub-contracting and construction phases. Figure 3.2 graphically depicts the origin of waste.

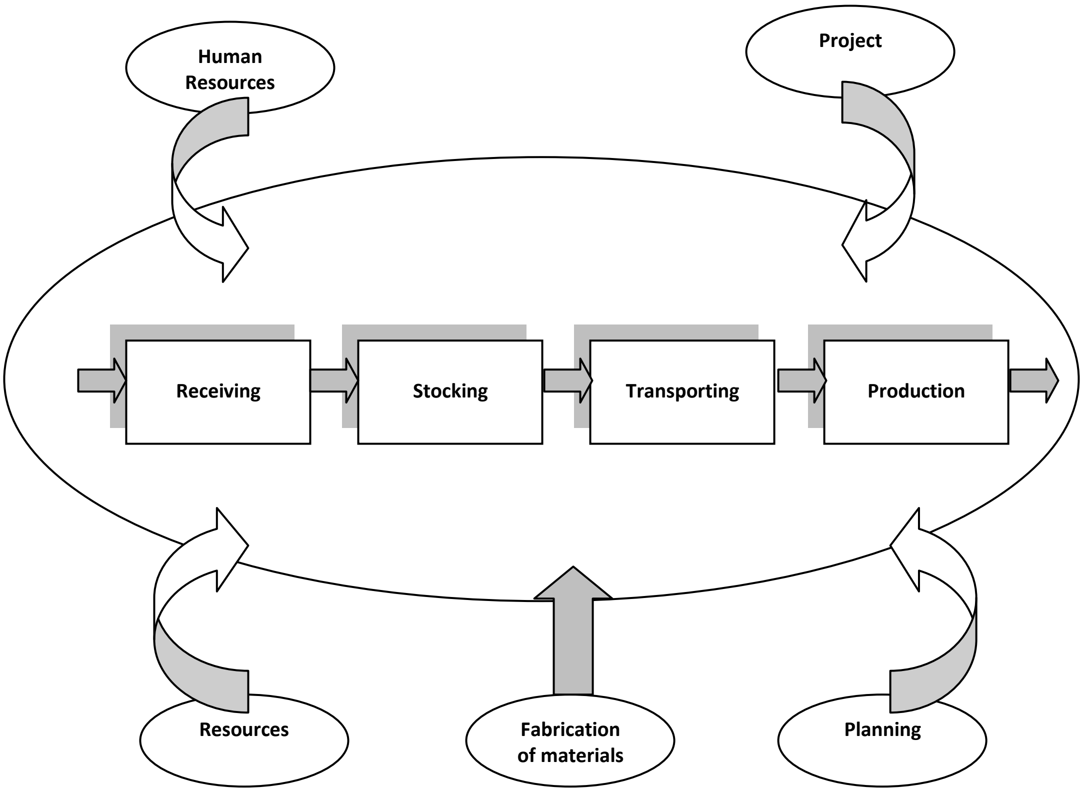

Figure 3.2: Waste according to its origin. (**Source:** Formoso, Cesare, Lantelme & Soilbelman, 1996: 154)

The above stages of construction include not only high value direct material wastage such as ductwork and cabling, but also indirect 'secondary' wastage such as packaging. Secondary waste can contribute up to 10-15% of waste volumes when services are installed.

3.6 HIGH WASTE RATES OF FIVE PRINCIPAL MATERIALS

Preliminary studies have shown that waste rates pertaining to concrete, mortar, bricks, cement and sand were found to be high. The reasons for the high waste are elaborated upon in Table 3.1. According to Urio and Brent (2006:21), there is a call for a change in attitude towards material waste control and the disposal of the unavoidable waste in the industry.

Table 3.1: The reasons for high waste rates of 5 principal materials. (**Source:** Urio & Brent, 2006:21)

Principal materials	Conclusions on high waste rate
Waste of concrete Waste of mortar	Three main factors were identified: ▪ Spillage, during transportation and placing ▪ Over-production ▪ Loss resulting from mixing material on bare ground
Waste of bricks	A number of factors were identified as being responsible for the high waste rate of bricks: ▪ Cutting ▪ Poor handling at the stacks ▪ Irresponsible loading and off-loading ▪ Inappropriate lifting equipment
Waste of cement	Two main factors were identified as being the cause of the wastage of cement: ▪ Spillage ▪ Theft and pilferage
Waste of sand and stone	Poor storage was the major cause of the high waste rates in sand and stone.

Owing to complex and difficult construction projects currently undertaken in South Africa, the constraints on time, resources and performance must be managed effectively.

3.6.1 Categories of construction waste problem

Economic development has resulted in an increased volume of construction and demolition activities. The increased amount of construction and demolition waste has resulted in serious problems both locally and globally, according to Ekanayake and Ofori (2000:2). Figure 3.3 illustrates the relationship between the waste problem categories.

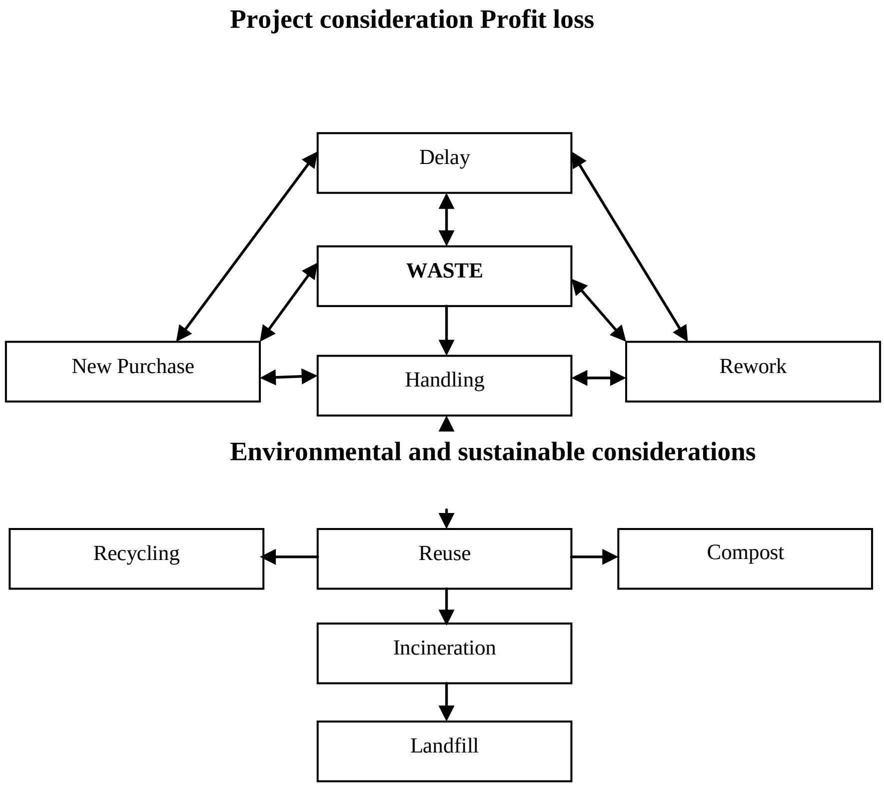

Figure 3.3: Waste problem. (**Source:** Ekanayaka & Ofori, 2000:2)

According to Ekanayaka and Ofori (2000:2), the waste problem can be divided into two categories: problems at the project level and problems at national level. At the project level, construction waste directly affects the contractor's profit. According to the Advanced Construction and Demolition Waste Management of Florida Builders (CSN) (2008:**Online**), waste classification and quantities may vary in type, size, method, materials and location of projects. The quantities and types of waste generated on site will be influenced by the exploration and development of waste management choices.

3.7 CAUSES OF CONSTRUCTION WASTE

Gavilan and Bernold (1994:536-55), classify the causes of waste into six categories, namely:

- Design.
- Procurement.
- Material handling.
- Operation.

- Residual-related.
- Other.

Waste weakens the efficiency, effectiveness, value and profitability of construction activities, calling for the need to identify the causes of waste and to control them within reasonable limits. In Table 3.2, the sources and causes of construction waste have been categorised into six groups, based on the stage of the project in which the waste originated.

Table 3.2: Sources and causes of construction waste. (**Source:** Urio & Brent, 2006:20)

Group	Source and cause factors	Examples
Design	▪ Poor coordination of all parties during the design stage ▪ Lack of attention to the standard size of specific products ▪ Error in contract documentation ▪ Design changes	▪ Demolition of work due to a change in the design at an advanced stage of the project.
Procurement	▪ Material delivery procedures ▪ Other errors ▪ Material storage and internal transport ▪ Supplier errors	▪ Procurement of incorrect sizes and poor storage on site.
Material handling	▪ During transport to the site ▪ During transport on the site ▪ Inappropriate storage	▪ Chipping of face-brick due to bad handling on site.
Operation	▪ Errors by tradesman ▪ Equipment problems ▪ Inclement weather ▪ Damage by subsequent trade ▪ Use of incorrect material ▪ Accidents ▪ Poor site management and supervision ▪ Lack of coordination of responsibilities between contractor and subcontractors ▪ Lack of influence of contractor ▪ Lack of knowledge about construction during design activities	▪ Errors by tradesman such as wrong measurements, alignment and material use. ▪ Damage by another tradesperson whose work comes after major work has been completed.
Residual Related	▪ Waste from uneconomical shape ▪ Off-cuts ▪ Over-mixing of materials ▪ Waste from the application process	▪ Waste such as bricks, mortar and concrete
Other	▪ Criminal waste due to theft ▪ Lack of onsite material control and waste management plans	▪ Inefficient material schedules and waste reconciliation plans

According to Garas, Anis and Gammal (2001:5), the dominant causes of waste generation in the Egyptian construction industry, have been summarised as:

- Late information.
- Incomplete design.
- Inadequate information.
- Poor control.
- Unnecessary movement of people.
- Untrained labour.
- Work not done.
- Poor technology of equipment.
- Changes to design.
- Damages during transport.

3.8 CLASSIFICATION OF WASTE

Waste in construction can culminate as a result of different causes and situations. Construction waste falls into different categories, which are elaborated on below:

3.8.1 Waste according to the type of resources consumed

According to Castelo Branco (2007:13), construction waste can be categorised into physical and financial waste. This classification includes the following:

- **Physical waste of materials:** Additional amount of materials relative to those specified in the project.
- **Physical waste of man-hours:** Man hours increased by delay in the arrival of materials and overproduction.
- **Physical waste of equipment:** Equipment hours increased in function of the problem quoted for the man power.
- **Financial waste as a result of physical waste:** Determine the costs associated with physical waste.
- **Financial waste in result of material purchase:** Relative additional cost for the use of a material with superior value to the specified one.

The above classification is graphically depicted in Figure 3.4.

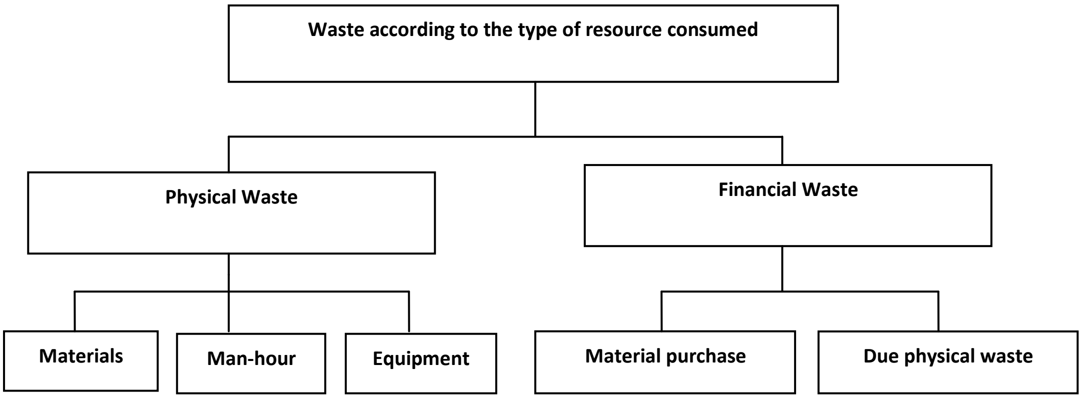

Figure 3.4: Waste according to the type of resources consumed. (**Source:** Castelo Branco, 2007:13)

3.8.2 Waste according to its nature

Skoyles and Skoyles (1987:18-24), categorise waste into four principal types, namely 'natural', 'direct', 'indirect' and 'consequential' waste. Waste is, to a certain extent, inevitable on building sites and this is generally recognised by everybody in the construction industry. Skoyles and Skoyles (1987:19), refer to this acceptable level of waste as 'natural waste'.

'Indirect' waste is distinguished from 'direct' waste in that the materials are not usually lost physically, but the payment for part or whole of the value is lost. This is the waste, which can be prevented, and involves the actual loss. Table 3.3 summarises the various forms in which direct and indirect waste can occur.

Table 3.3: Indirect and direct waste. (**Source:** Urio & Brent, 2006:19)

Principal Types	Forms of the principal types
Indirect waste	• Substitution, where materials are used for purposes other than those specified. • Production waste, where materials are used in excess of those indicated or not clearly defined in contract documents, e.g. additional concrete in trenches, which are extracted wider than designed because no appropriately sized digger bucket was available. • Operational waste, where materials are used for temporary site work for which no quantity or other allowances have been made in the contract documentation, e.g. tower crane bases, site paths, temporary protection. • Negligent waste, where materials are used in addition to the amount required by the

	contract, owing to the construction contractor's own negligence.
Direct waste	• Deliveries waste comprises all losses in transit to the site, unloading and placing into the initial storage. • Site storage and internal site transit waste comprise losses due to bad stacking and initial storage, including movement and unloading around the site, to stack at the workplace or placing into position. • Conversion waste comprises losses due to cutting uneconomical shapes, e.g. timber, sheeted goods. • Fixing waste comprises materials dropped, spoiled or discarded during the fixing operation. • Cutting waste includes losses caused by cutting materials to size or irregular shapes. • Application waste includes materials such as mortar for brickwork and paint spilled or dropped during application, similarly, materials left in containers or cans which are not sealed and mixed materials like mortar and plaster left to harden at the end of the day. • Waste due to the uneconomical use of the plant. This covers plant running when not in use, or not employed to its optimal use. • Management waste includes losses arising from an incorrect decision and not related to anything other than poor organization or lack of supervision. • Waste caused by other trades. This includes losses arising from events such as "borrowing" by trades for purposes other than work, and not returning the plant or material or damage by succeeding trades. • Criminal waste covers pilfering, theft from the site and vandalism. • Waste due to incorrect type or quality of materials. This includes waste stemming from materials wrongly specified and waste due to errors, particularly in the bills of quantities and specification. • Waste that is usually caused by apprentices, unskilled tradesmen, and tradesmen on new operations.

According to Urio and Brent (2006:18-22), waste materials may produce costs in areas that appear to be related. For example, when a delay is caused by the shortage of materials or by rectifying damaged work, there will be the additional cost of re-ordering replacement materials. The delay may also cause extended hiring time of plant and labour, and thus increase costs to the contract. Such additional costs are collectively termed 'consequential waste'. Cost of wasted materials is greater than their value. This additional cost is usually hidden.

3.8.3 Waste according to its control

The possibility of controlling or reducing the index of detected waste, according to Castelo Branco (2007:15), can be classified into two categories, namely 'avoidable' or 'unavoidable' waste. Unavoidable waste represents an acceptable level of waste that escapes the control of the contractor and is economically viable. Castelo Branco (2007:16), citing Santos, Formoso, Isatto and Oliveira (1996), also states that avoidable waste is the consequence of a process of low quality, in which resources are used inadequately.

3.9 MEASURING AND RANKING OF CONSTRUCTION WASTE

According to Urio and Brent (2006: 21), Table 3.4 summarises the ranking value of the causes of construction waste by project managers, contractors, site representatives and waste management supervisors.

Table 3.4: Ranking of the causes of construction waste. (**Source:** Urio & Brent, 2006:21)

Causes of construction waste	Overall Ranking
Lack of onsite waste management plan	1
Waste from application process, e.g. during plastering	2
Over-mixing of material due to the lack of knowledge of the requirements	3
Errors by tradesperson and labourer	4
Cutting of uneconomical shapes/length	5
Damages by subsequent trades	6
Changes to design	7
Use of incorrect material	8
Damage during transportation on site	9
Inclement weather	10
Other error	11
Contract document incomplete at time of construction commencement	12
Error in contract document	13
Over-ordering	14
Inappropriate storage on site	15
Damage during transportation to site	16
Accident	17
Supplier error	18
Criminal waste due to damage or theft	19
Equipment malfunction	20

3.10 THE DIFFERENCES BETWEEN INTERNATIONAL AND SOUTH AFRICAN WASTE LEGISLATION

An ongoing debate on the definition of waste has been revealed by a literature review. Figure 3.5 represents the internationally accepted waste hierarchy, as accepted in the European Community in the Framework Directive of 1975. The aim is to prevent waste by re-using, recovering and recycling waste to reduce volumes. According to the South African Journal of Science (2008:242), one of the main obstacles to the implementation of this definition depends on its translation into policy, strategy and legislation.

Cleaner Production	Prevention
	Minimisation
Recycling	Re-use
	Recovery/Reclamation
	Composting
Treatment	Physical
	Chemical
	Biological
Disposal	Landfill

Figure 3.5: Defining waste in South Africa: Moving beyond the age of waste. (**Source:** South African Journal of Science, 2008:242)

Defining something as waste creates a thin line between what are 'resources' and what is 'waste'. In certain cases it is clear that materials are waste, and re-use cannot be considered, for example medical waste. Resource recovery at landfill sites and waste dumps is a clear indication of waste disposal.

According to Oelofse and Godfrey (2008:242-246), there are currently two legal definitions of waste in the South African legislation. The first legislation is the Environmental Conservation Act, (ECA), Act 73 of 1989. According to the ECA, this definition of waste is published in the form of legal notices. In this Act, waste is defined in terms of its unwanted or surplus nature. The National Water Act, Act 36 of 1998 follows a similar protection-based approach by defining waste in terms of the potential it has to create pollution. The preventative principle, as applied in the Minimum Requirements for Handling, Classification and Disposal of Hazardous Waste, 2nd edition, assumes that waste is highly hazardous and toxic until proven otherwise.

This restrictive, protection-based definition of waste currently adopted by South African legislation is viewed by the construction industry as an obstacle to the implementation of a successful waste hierarchy (Oelofse & Godfrey 2008:242). Figure 3.6 identifies the current move towards waste management and waste re-use in South Africa, and is driven mainly by the current legal definition of waste and the relevant legal requirements.

The question is whether the material suitable for re-use is waste or a by-product. In South Africa, the re-use and recovery of waste is subject to waste management regulations and controls that should regulate the life cycle of waste.

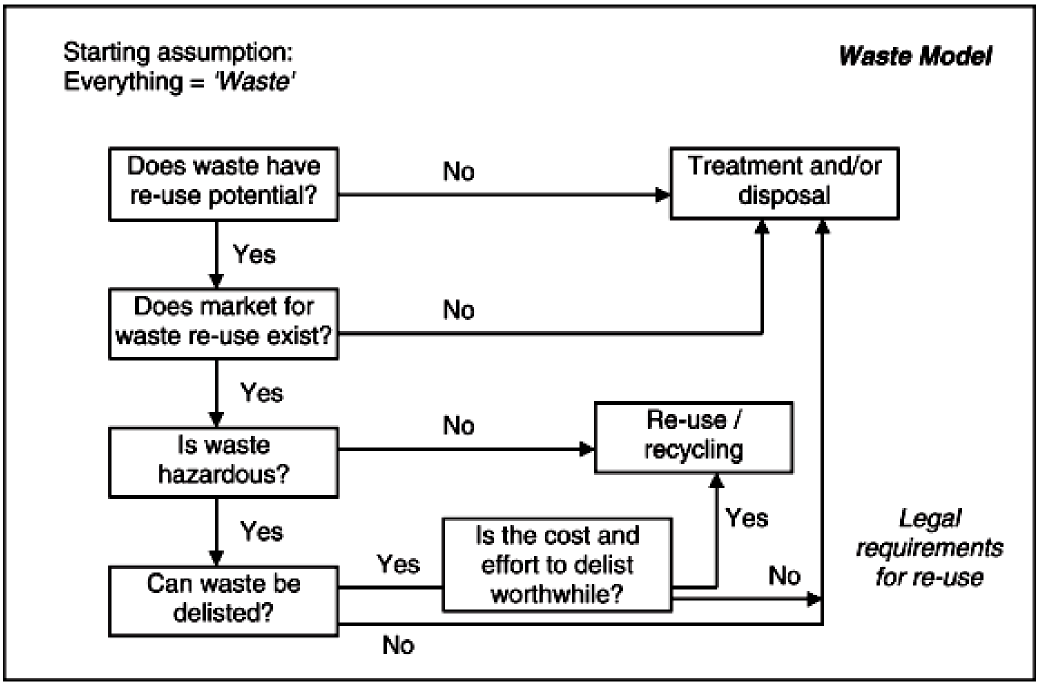

Figure 3.6: Managing waste through a 'Waste Model'. (**Source:** Oelofse & Godfrey, 2008:244)

Owing to a lack of economic incentives, there is a risk that certain materials will be disposed of, irrespective of the possibility that they could be re-used. The conclusion from a literature review is that the waste hierarchy has not been accomplished by a single definition of waste, and that every country adopting the hierarchical approach has adopted its own definition of waste (Oelofse & Godfrey, 2008:244).

3.11 WASTE MANAGEMENT HIERARCHY

The waste management process consists of material reduction in the design and planning stages. Reducing scrap and waste at building sites, as well as re-using and recycling of materials which contractors cannot re-use themselves, are all important processes in reducing waste.

According to the Advanced Construction and Demolition Waste Management of Florida Builders (CSN) (2008:**Online**), the most important step in the waste management process is reducing the waste management burden by reducing the amount of waste generated. The waste management hierarchy is illustrated in Figure 3.7.

The most important step in waste control is by reducing waste, followed by reusing, recycling, composting, burning and as a last result, land filling.

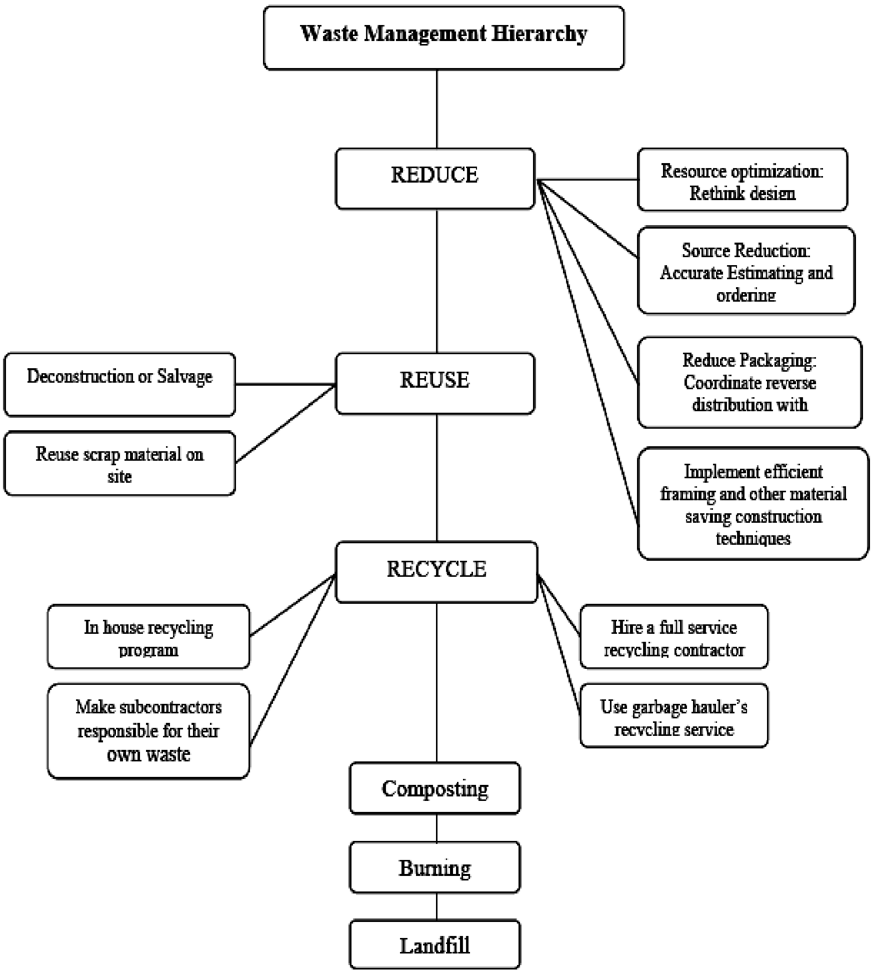

Figure 3.7: Waste Management Hierarchy. (**Source:** CSN, 2008:**Online**)

3.11.1 Reduce

According to CSN (2008:**Online**), reducing involves actions to eliminate or reduce the amount of materials used on site, before they enter the solid waste stream. An example would be reducing the amount of packaging that comes on site, or using efficient framing techniques. Another key component in reducing is changing design principles and practices.

The architect has the ability to design structures on a modular basis, which lends itself to the use of standard-size materials. In addition to modular design, accurate estimating is extremely important. Any excess materials brought to a construction site will ultimately either be used, wasted or stolen. Materials are rarely transported to other job sites for use. The key to reduction is planning. By thoroughly planning throughout the entire construction process, reduction of waste is easily facilitated.

3.11.2 Re-use

The second level of the waste management hierarchy is re-use. It is the next step in materials efficiency and waste prevention (CSN, 2008:**Online**). Effective re-use preserves the present structure of a material or article and does not require additional time or energy for utility. Examples of re-use include the immediate re-use of materials on site extracted from a demolition/deconstruction project, or re-using left-over materials for a future or ongoing project at another site. The re-use concept also incorporates the concept of re-buy. Re-buy refers not only purchasing salvaged materials, but involves purchasing products that are designed for source reduction and/or constructed from recycled materials. This practice encourages market and technology development for materials and products that conserve resources and prevent waste, such as used building material centres.

3.11.3 Recycling

According to CSN (2008:**Online**), this step involves separating waste into recyclable and non-recyclable materials. In this step, recyclable waste is re-used in some way; often to manufacture new materials with recycled content. By replacing virgin materials with recycled feedstock, natural resources and energy are preserved. Additionally, recycling contributes to the economy, both in providing jobs and in providing business opportunities. Developing countries suffer the worst effects of waste and pollution. Concerted efforts need to be made to reduce waste and prevent illegal dumping of waste materials. Waste according to the National Environmental Management is described in the Waste Act, 2008, part 2, Section 16(1) (NEMA) which deals with the general duty in respect of waste management and the classification of waste. According to Engledow (2007:1), the establishment of waste management facilities is governed by a number of laws. The National Environmental Management Act, 107 of 1998, Section 28 (NEMA) states that “any person, who causes, has caused or may cause significant pollution or degradation of the environment, must take reasonable measures to prevent such pollution or degradation from occurring". The Environmental Conservation Act 73 of 1989, Section 20(6) focuses on waste facility permit application and land-use planning legislation, especially the Offensive Trade By-law, as the establishment of a waste management facility. Compliance with all the laws governing waste management currently tends to be a time-consuming and costly exercise and can prove to be a constraint in the establishment of smaller waste processing facilities, such as clean material recovery facilities.

Legislation presents many challenges to the timeous and effective management of waste (Engledow, 2007:1). This legislation includes the Environmental Impact Assessment (EIA) regulations, waste site permits and land use rezoning applications. The major aim of the EIA is a focus on the identification and assessment of predicted impacts, with management actions to mitigate impacts or enhance positive impacts (i.e. benefits). The general sources of legislation are: International Environmental Law, Constitution of RSA, National Statutes, Provincial Bylaws and Standards.

According to Engledow (2007:1), there are only three landfill sites remaining in Cape Town, namely Coastal Park, Bellville South and Vissershok. These sites are filling up rapidly because of the rapid increase in waste generation over the last ten years. The current waste volume per annum is in Cape Town area is around 2.7 million tons, and this excludes the waste being received at private waste sites. Reasons for the increase in waste generation include: urbanisation and population increase; increase in production and consumption patterns including increase in affluence; equitable service delivery; and accurate record keeping. The increase in waste generation cannot be attributed to a single factor but rather to a combination of factors. Figure 3.8 depicts the landfill sites in the Western Cape.

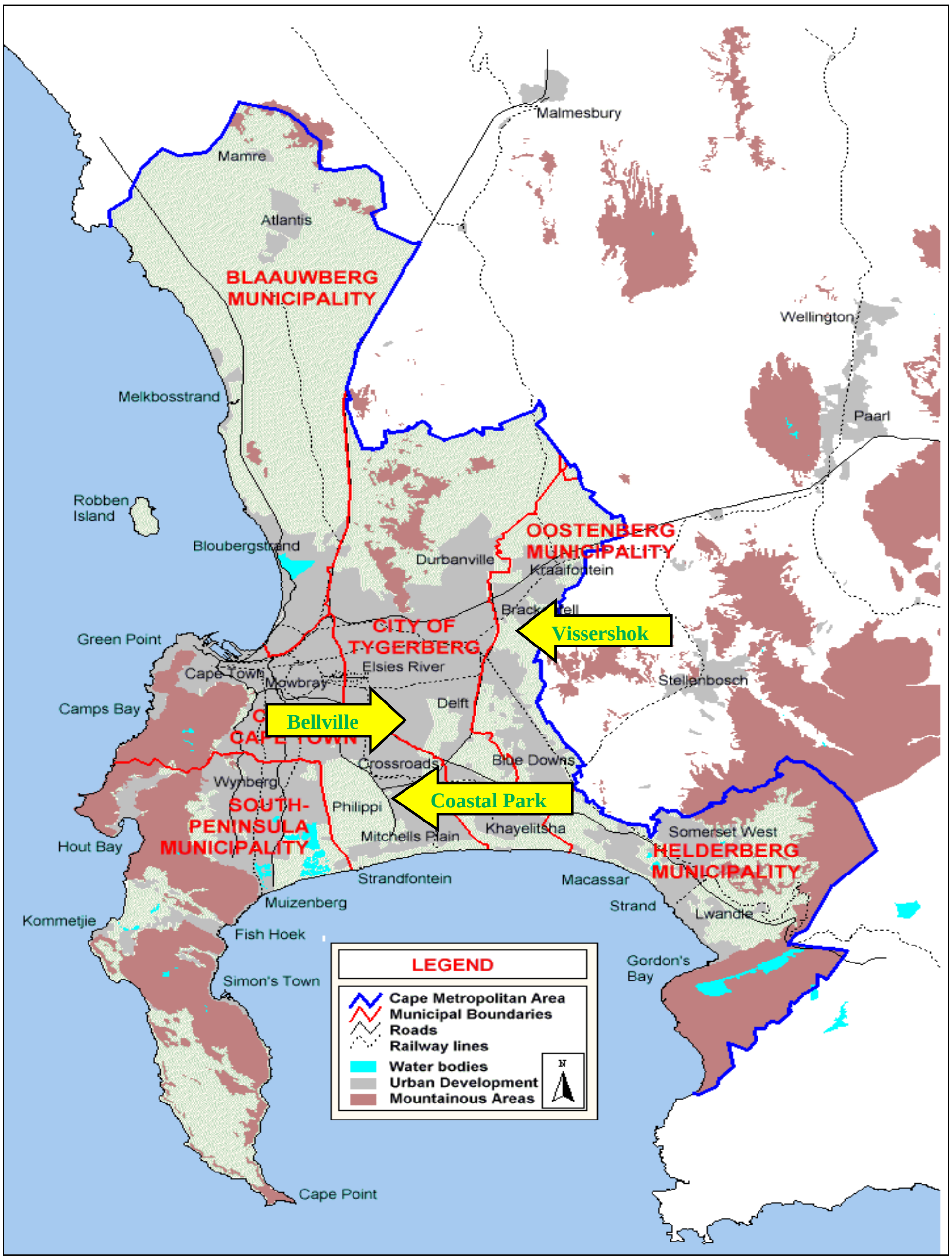

Figure 3.8: Landfill sites Western Cape (**Source:** CSN, 2008:**Online**)

In addition, the Municipal Finance Management Act and the Municipal Systems Act, which govern the financial aspects of municipalities provide waste services respectively, also pose challenges and constraints to waste management in the construction industry.

3.12 WASTE TYPES IN CONSTRUCTION PROJECTS

In the construction industry, waste types have been identified to isolate the most frequent onsite waste categories affecting the final costs of projects. The results showed that 'materials waste' was due to: over ordering/excess; overproduction; incorrect handling; incorrect storage; manufacturing defects, and theft or vandalism.

The waste in time is caused by: idle waiting periods; stoppages; clarifications; variation in information; re-work; ineffective work (errors); interaction between various specialties; delays in plan activities, and abnormal wear of equipment (Garas, Anis & Gammal 2001:1-8).

3.13 WASTE IDENTIFICATION

The building construction involves many activities that can be grouped as land clearing, road and sewers, substructure work (excavation and foundation work), superstructure work (framing), service installations (plumbing, wiring, drywalling), finishing work (paint, roofing), landscaping and external works.

Each of these activities has a high potential to generate waste, and Figure 3.9 indicates the various construction site activities and the high potential of waste that may be generated by each of these activities.

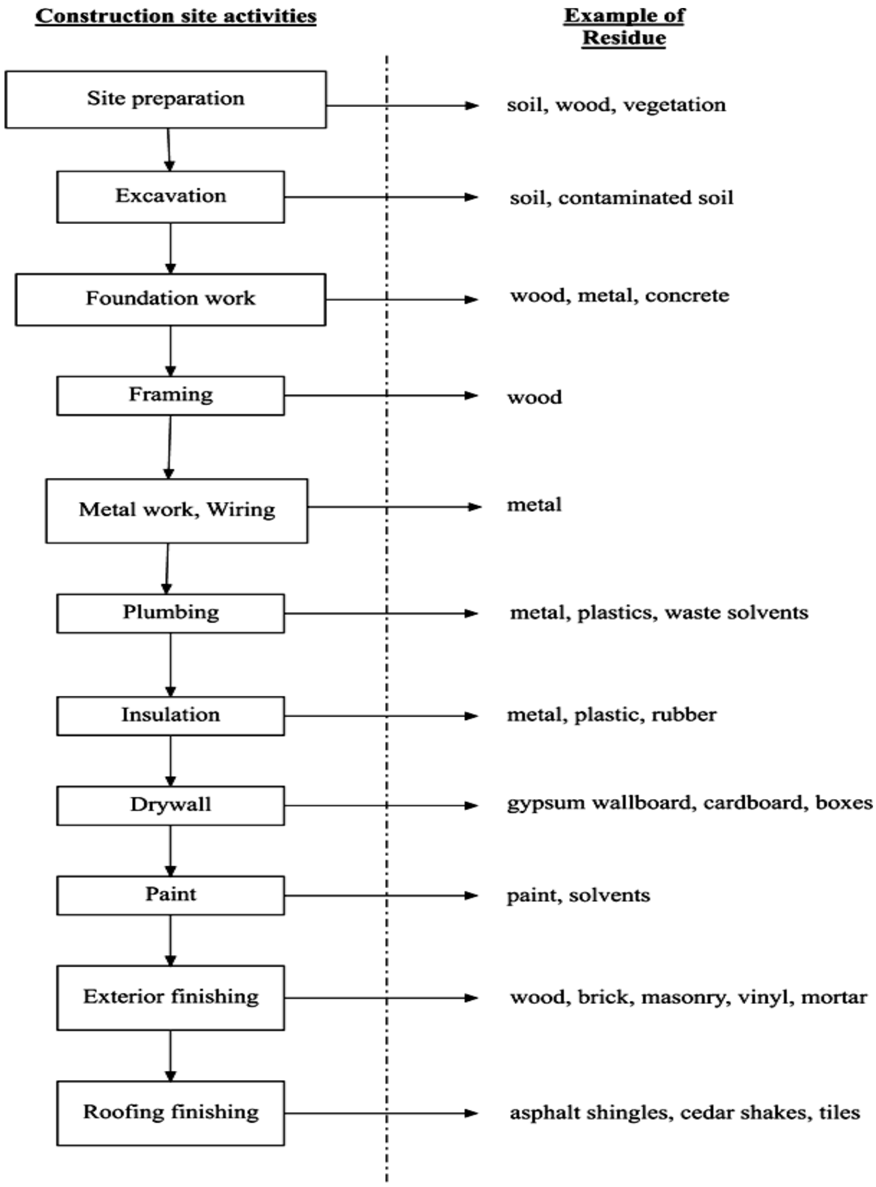

Figure 3.9: Activities that have potential to generate waste. (**Source:** Yahya & Boussabaine, 2006: 13)

Jones and Greenwood (2003:**Online**), conducted a case study on ways to minimise construction waste in the UK. This revealed that the waste streams vary from one construction phase to the next. Waste was typically generated during the structure and fitting phases. Consequential waste is an additional cost that appears to be unrelated to the waste of materials. An example of this is when a delay is caused by shortage of materials or by correcting damaged work, or additional costs of re-ordering replacement materials already ordered. This delay may also cause extended hiring of plants and labour, and such delays result in increased costs to the contract. According to the Advanced Construction and Demolition Waste Management for Florida Builders (CSN) (2008:**Online**), the intention is to divert construction demolition, renovation and land clearing debris from landfill disposal, and redirecting recyclable materials back to the manufacturing process. Waste streams vary according to construction type, namely residential, commercial or demolition. The figures show the percentage breakdown according to construction type. Figure 3.10 shows the percentage breakdown of the waste stream created from each of these construction types and an actual waste stream analysis conducted by Franklin and Associates (U.S. EPA, 1998).

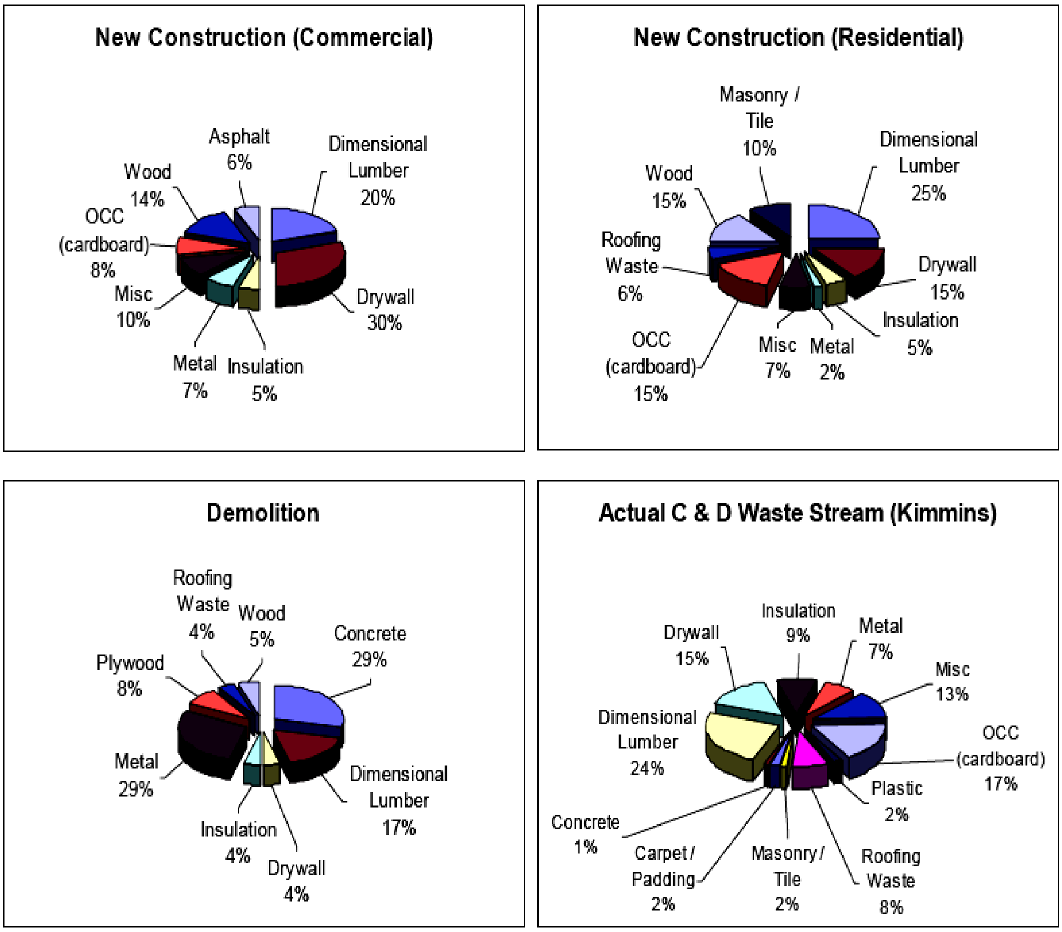

Figure 3.10: Waste Percentages by Construction Type. (**Source:** CSN, 2008:**Online**)

3.14 LIFE CYCLE OF MATERIALS IN CONSTRUCTION

According to Mocozoma (2002:1), construction has traditionally been a linear chain consisting of input (raw material), processing (construction), and output (waste). This suggests an unlimited supply of resources that provide inputs to the process and a bottomless pit that absorbs the output. This is unfortunately not the case, and our planet is experiencing the consequences of this approach. Global warming and pollution are examples of this. Figure 3.11 depicts the inefficiencies related to building materials that extend throughout the phases of a building's life.

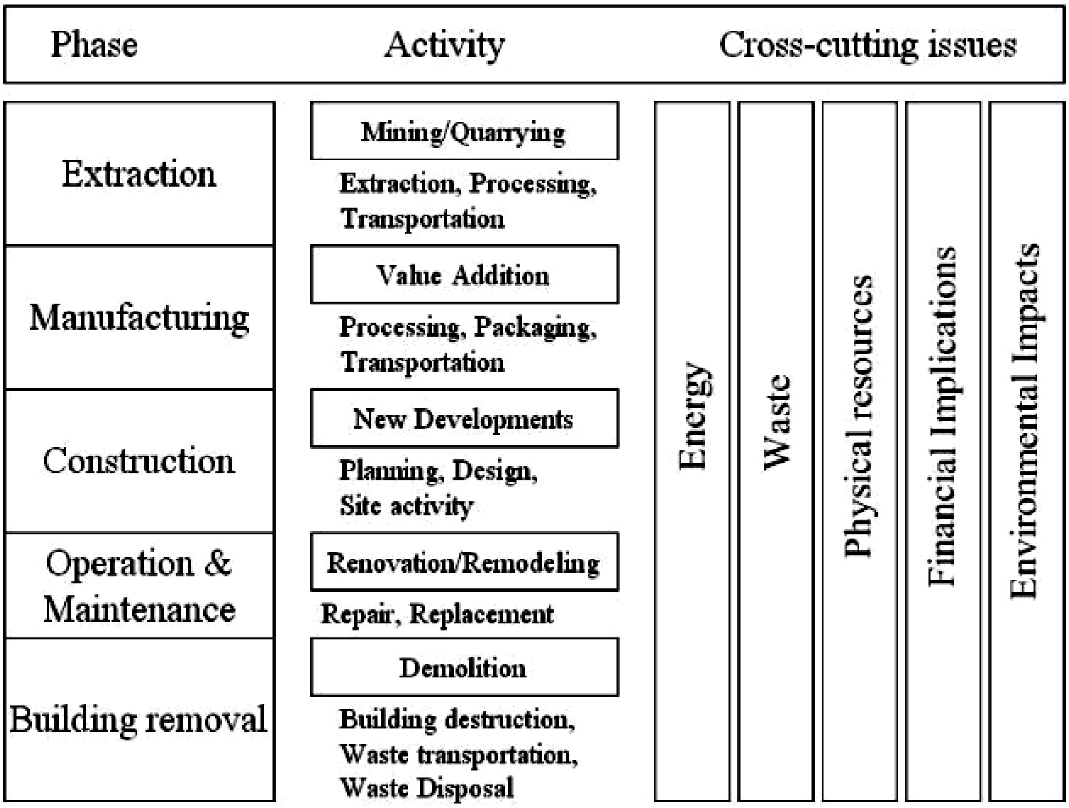

Figure 3.11: Life Cycle of materials in building construction. (**Source:** Macozoma, 2002:2)

A call for closure of the loop of material flow was made by Young & Sachs (1994:121). The focus was on two main elements: the reduction of raw material extraction and the minimisation of waste through reduction and recovery for secondary use. Looking at the life cycle of materials in building construction reveals the inefficiencies that contribute to the construction industry's poor performance.

3.14.1 Virgin material removal

According to Macozoma (2001:2), the removal of material in natural reserves has resulted in abuse of the environment. This includes:

- Extracting more and using less due to resource availability and artificially cheap land.
- High energy consumption rates.
- Emissions to the environment.
- Disturbance of ecosystems and no rehabilitation.
- Waste generation and irresponsible disposal.

3.14.2 Manufacturing of materials and products

Macozoma (2002:3), points out that the manufacturing process used in the beneficiation of virgin materials for use in construction is responsible for the following:

- High energy consumption rates.
- Emissions into the environment.
- Generation of general and toxic waste by-products.
- Use of packaging materials that end up as waste.

3.14.3 Construction

Macozoma (2002:3), finds that the construction process often results in avoidable waste because of poor design, labour practice and construction methods such as:

- Poor material procurement and handling practice.
- Human error.
- Lack of waste management planning.

3.14.4 Operation and Maintenance

Macozoma (2002:3), states that upon occupation a building requires a certain amount of maintenance. Some of the inefficiencies associated with this include:

- Energy performance of buildings.

- Renovation without planning for material recovery and secondary material use.
- Adaptability of buildings to different user needs over time.

3.14.5 Demolition

Many buildings are demolished, not because they have reached the end of their design lives, but rather because their owners no longer have a use for them (Macozoma, 2002:3). The shortcomings relating to this include:

- Lack of building flexibility.
- Lack of design for deconstruction.
- Demolition without planning for material recovery.
- The loss of embodied energy that is contained in materials.

3.14.6 Cross-cutting issues

According to Macozoma (2002:3), there is a common thread of factors that are found throughout the phases of the construction process (with reference to materials). These cross-cutting issues are:

- Energy.
- Waste.
- Physical resources.
- Financial implications.
- Environmental impacts.

Design changes have been identified as the most significant cause of waste during construction. The cause of waste during the design process will, however, not be discussed in detail in this research project. Because various architects are involved in the design phase and access to information is limited, this is regarded as a restriction in the research project (Macozoma, 2002:4).

3.15 ECONOMIC BENEFIT

According to CSN (2008:**Online**), the expense related to waste disposal has been accepted in the construction industry as a way of doing business. Consequently, setting up an effective method to minimise materials sent to the landfill would reduce the bottom-line cost of the project over time. Builders, architects and engineers face increasing client demand for measures to reduce this cost. Reducing waste will not only save money, but also enhance a company's reputation. Construction companies can save money in two ways, firstly by reducing the amount of waste produced and secondly by reusing and recycling waste materials. Reducing the amount of waste produced reduces both disposal costs and the amount of raw materials purchased (often added to the material order as waste by the estimators). Reducing the volume of waste ending up in dumpsters reduces the number of times payment must be made for the dumpster to be towed off site. The potential cost savings combined with waste reduction and recycling opportunities vary depending upon the nature of each project and the project location.

3.16 CONTRACT SPECIFICATIONS

In order to encourage waste reduction and recycling practices, engineers and architects can develop relevant contract language to include in their specifications. Recycling and waste reduction specifications communicate to prospective bidders what the project involves as well as the traditional waste management practices (CSN 2008:**Online**). Several advantages are associated with waste reduction and recycling specifications. For bidders, these specifications can eliminate concerns that they may be at a competitive disadvantage if they choose to recycle or practise other waste-reduction techniques in the job.

The specifications can be developed so that the contractor makes a waste management plan and cost estimate for recycling after being selected as the preferred builder on the project. For this reason, the owner could choose whether to go ahead with the plan if it is more costly, and the cost burden would not fall on the contractor. Another advantage of waste reduction and recycling specifications is that they clearly identify what types of measures are to be established at the site. This helps eliminate any confusion about which materials are target recyclables and which waste reduction techniques are to be employed according to CSN (2008:**Online**).

3.17 LESS IMPORTANT MARKETS

In order to achieve a successful construction and demolition waste management plan, Macozoma (2004:7), suggests the following three elements:

- Construction and demolition (C&D) waste material supply.
- Secondary material industries.
- End markets for products.

Macozoma (2004:7), considers the factors that influence these three elements. In order to guarantee a consistent supply of good quality C&D waste materials, the following factors need to be addressed:

- Availability of stock for C&D waste material supply.
- Techniques for waste material recovery.
- Construction and demolition waste material quality control.
- Storage facilities for recovered waste materials.
- Location of secondary industries with respect to waste material sources.
- Cost of waste material supply.

3.17.1 Government support

Mocozoma (2004:7), explains that the government is one of the most important stakeholders that can support the development of a self-sustaining secondary construction material market. This support could take one of the following forms:

- Technical support and staff for research.
- Financial support.
- Infrastructure support for using government facilities.
- Legislation support to promote waste recovery and re-use.
- Partnership with the private sector and communities.

3.17.2 Other stakeholders

Table 3.5 indicates other important stakeholders in the life cycle of a C&D waste management plan and their areas of influence:

Table 3.5: Construction and Demolition Waste stakeholders and their areas of influence. (**Source:** Macozoma, 2004:8)

Stakeholders	**Contribution**
Designers	Design for waste reduction and recovery for reuse and recycling.
Building owners	Advocacy for ‘green’ building practices
Demolishers	Alternative technologies and source control
Contractors	Waste management planning
Consultants	Client support in green construction
Waste collectors	Waste recovery and separate collection
Landfill sites	Stockpiling of useful C&D waste
Salvagers	Waste recovery
Secondary material shops	Supply of good quality secondary materials
Recyclers	Supply of good quality recycled materials and products
Local authorities	Approval and support of secondary industries
Funding agencies	Sponsorship of research and pilot projects
NGO’s	Advice and support
Research	Innovation and decision support
Standards generating bodies	Testing and recognition of innovations
Communities	Involvement and demand for secondary materials and products

According to Macozoma (2004:8), there are various aspects to the involvement of other stakeholders and their areas of influence, generally found in other literature:

- Goals and objectives.
- Trust.
- Problem solution.
- Commitment.
- Continuous evaluation.
- Group working and teams.
- Equity.
- Shared risk.
- Win-win philosophy.
- Collaboration/cooperation.

3.18 THE SOUTH AFRICAN CONSTRUCTION AND DEMOLITION WASTE EXPERIENCE

3.18.1 Definition

Construction and demolition (C&D) waste means non-hazardous waste resulting from the construction, remodelling, repair and demolition of structures. These structures include residential and non-residential buildings, and public works such as roads, bridges, piers and dams. C&D waste includes, but is not limited to, concrete, bricks, masonry, ceramics, metals, plastic, paper, cardboard, gypsum drywall, timber, insulation, asphalt, glass, carpeting, roofing, site clearance, excavation material and site sweepings. Materials such as paint, asbestos, tyres, appliances and containers with residue are not included in the definition of C&D waste (Macozoma 2004:8).

3.18.2 Limitations

According to Macozoma (2004:8), the estimates of construction and demolition waste quantities are limited by poor record keeping, no site analysis, non-uniform waste classification, an absence of structured plans for waste management and recovery on construction and demolition sites, ad-hoc re-use on and off site, and illegal dumps. The construction industry is not yet convinced that C&D waste management has a good potential to provide alternative resources for construction and help to improve the industry's resistance. Construction practice is not moving quickly enough towards innovative techniques. For this reason, recycling is perceived as an expensive exercise.

3.18.3 Disposal, recovery, re-use and recycling

Disposal by land is still the main method of waste disposal in South Africa. Legislative regulations, partnerships and support have been successful in solving this problem. Innovative construction and demolition techniques with proper waste management planning can release large quantities of C&D waste for use in other applications (i.e. re-use and recycle). Re-use applications include site levelling, landscaping and backfill (Macozoma 2004:8). Waste re-use is ranked higher in the waste management hierarchy than recycling. Recycling industries exist in South Africa, but differ tremendously by type of material. A recent study by the ECA in the United States (US) has revealed that recycling is a multi-million dollar industry that is capable of standing alone as a sector. Closing this loop requires a revisit of the material life cycle in construction. As a result, Figure **3.11** culminates in comprehensive depiction as reflected in Figure 3.12.

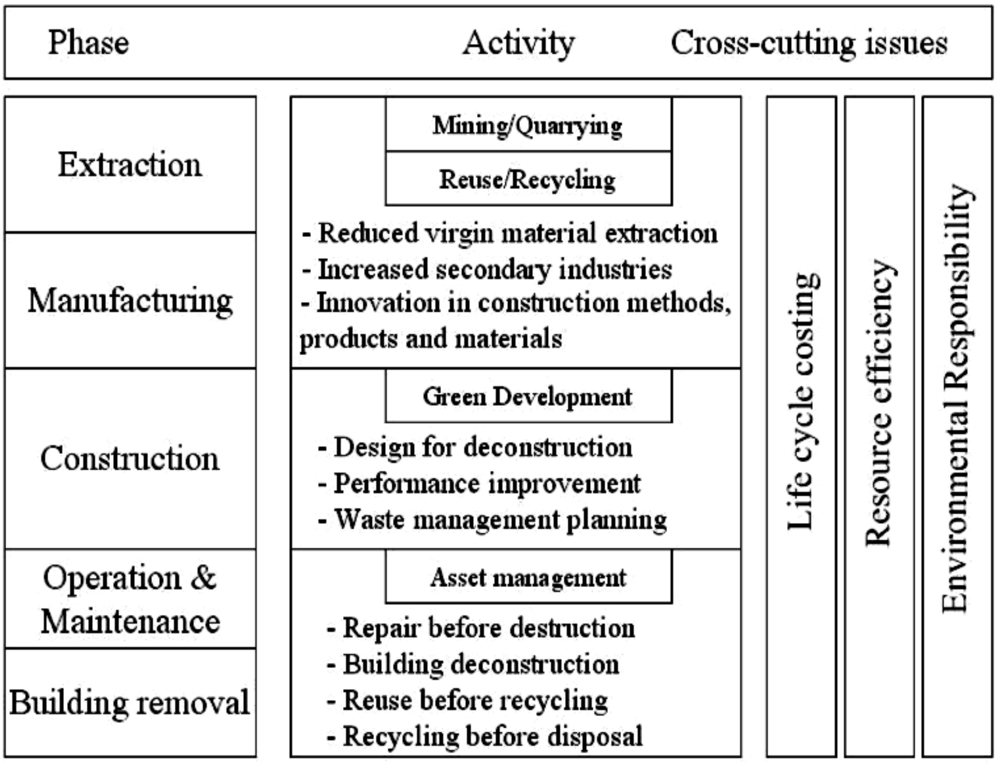

Figure 3.12: Revised life cycle of materials in building construction (towards sustainable construction). (**Source:** Macozoma, 2004:10)

The aim of a proper waste management strategy will result in efficient resource allocation, and a reduction of construction and demolition waste, in addition to reaching an environmental goal. The key is resource efficiency and the closure of the materials flow loop.

3.19 QUALITY RELATIONSHIPS THROUGH PARTNERING

Sub-contractors and suppliers play an increasingly important role in construction. According to Matthews, Pellew, Phua and Rowlinson (2000:493-510), it is not uncommon that 90% of a project's total value is to be undertaken by sub-contractors. This results in the main contractor being involved in managing the sub-contractors rather than employing direct labour. An overview of recent studies in the UK indicates that the construction industry is concentrating on partnering, quality and lean production. It aims to improve the procurement process by establishing levels of trust and cooperation between main contractors and sub-contractors through a partnering approach. Particular focus is on how the partnering approach enables quality management through the adjustment of the main contractor/sub-contractor relationship. Unlike manufacturing, the construction process is not continuous and repetitive, and the steps involved are not always identical. According to Jamieson, Thorpe and Tyler (1996:279-89), the increased use of sub-contractors contributes to the difficulty of both the construction of buildings and the organisational relationship. The increase in complexity, the over-supply of specialist firms, and declining construction output has cultivated an atmosphere, which has had a negative effect on the main contractor/sub-contractor relationship.

The main contractor realises that the greatest potential for cost savings lies with unfair contract conditions, subcontractor auctioning and their difficult practices (Matthews *et al*., 1996:117:31). Agapiou, Flanagan, Norman and Notman (1998:351-61), conclude that builders' vendors are an important link in the construction supply chain and could help by improving the supply chain and reducing cost and waste.

In order for these changes to be achieved, the construction industry has developed long-term relationships through partnering with the supply chain. Research by Matthews *et al*. (1996:200), has identified that the benefits of partnering can be achieved in the following areas:

- Contractual situation.
- Communication and information flow.

- Level of understanding.
- Efficiency of resources.
- Financial position.
- Quality.

3.19.1 Quality and lean production

The following discussion centres on TQM and lean production, but must be viewed in the context of the main contractor/sub-contractor relationship in the construction industry, as it is different in context from that for which these two philosophies were originally developed.

3.19.2 Quality

The concept of 'quality' has gained increasing importance since the 1980's although it has been employed since the Second World War. With the establishment of the International Standards Organisation's ISO 9000 series, quality has become a valuable and necessary quest for many companies. Matthews *et al*. (1996:200), (citing Hamel and Pralahad 1994), argue that quality is no longer a competitive differentiator, but the price of market entry.

3.19.3 Definition of quality

Matthews *et al*. (1996:200), explain that it has become crucial to develop a partnering charter. Hardie and Walsh (1994:53-63), identify eleven different definitions of quality; including that put forward by Crosby, which states that quality is "conformance to specifications". This definition has been widely implemented throughout the construction industry, stating, as Cosby stipulates, that if a product does not meet the specified standard defined according to customer demand and requirements, then it is defective. Other definitions by Hardie and Walsh (1994:53-63), include 'anything that can be improved'.

3.19.4 Lean production

Matthews *et al*. (1996:497), indicate that lean production has its origin in the philosophy of achieving improvements and more economical ways with the focus on reducing waste. Major improvements in performance have been observed in the automotive industry in the last few decades; this was not only due to a change of technology but was the result of the application of the 'lean production' philosophy. More attention is now paid in the construction industry to the lessons that can be learnt from manufacturing for the improvement of its production processes. However, the construction industry is still limited in its application of the philosophy. TQM and Quality Assurance have been adopted, first in material and component manufacturing, and later in design and construction, but this is more a commercial than a business philosophy.

Koskela (1993:11-13), comments that the dispersal of the lean production philosophy has been slow in construction because of the following barriers to the implementation of these ideas:

- Difficulty to internalise, generalise and teach the new concepts and approach in construction.
- Relative lack of international competition in construction.
- Lagging response by academic institutions.

Koskela (1993:11-13), suggests that the first task for academics is to explain the new philosophy in the context of construction. According to Koskela (1993:11-13), the overwhelming thinking in construction is to reduce waste resulting from non-value adding activities. Table 3.6 indicates the extent of such waste in construction worldwide.

Table 3.6: Waste in construction. (**Source:** Koskela, 1993:11)

Waste	% Total project cost	Country
Quality costs (non-conformances)	12 %	USA
External quality cost (during facility use)	4 %	Sweden
Lack of constructability	6-10 %	USA
Poor materials management	10-12 %	USA
Excess consumption of materials on site	10 % on average	Sweden
Working time used for non-value adding activities on site	Approx. 2/3 of total time	USA
Lack of Safety	6 %	USA

The construction industry is seen as different from the manufacturing industry, and design improvements can reduce waste and decrease cost in construction. According to Howell, Miles, Fehlig and Ballard (1996:38-45), partnering has been seen as a 'programmatic band-aid' on the construction management system. There is a need to develop the concept of partnering and start revising the current mindset and practice of partnering. This finding shows a trend toward greater emphasis on production management through supply-chain alliances. Waste is being reduced at downstream level by actions taken upstream, and the gains are shared. The construction industry is changing in terms of demands made by the clients. It becomes more important to respond to the increasing application of quality and flexibility in the construction process. Both are key issues in the concept of partnering in the realm of lean production (Howell *et al.*, 1996:38-45). Lean thinking focuses attention on how value is generated rather than how one activity is managed. Lean production views the project as if it were one large operation

3.19.5 ISO 14000

According to CSN (2008:**Online**), everyone recognises the need for environmental protection. Industrialisation has contributed to the deterioration of our air, water, and soil quality. As a result, environmental regulations have been developed for emissions to the air, water and land; but these are external laws that change, making it difficult for a company to remain current. A complementary method for achieving environmental protection is to use internal standards. These enable a company to integrate quality management systems in their business operations without relying solely on external laws. This is the basis for the ISO

14000 environmental management standards. ISO 14000 is a set of international standards for improving the environmental performance of organisations. It includes the new standard for environmental management systems (EMS) called ISO 14001. Five areas are identified as a part of this standard:

- **Environmental management systems:** There are three components to an environmental management system: a written programme, education, and training and knowledge of relevant local, national and international environmental regulations. The written programme requires the company to be committed to producing the highest quality product with the lowest possible environmental impact. It aims at procedures to be followed in achieving these goals. The EMS must also incorporate the relevant local and federal environmental regulations that apply to its specific facility.
- **Environmental performance evaluations:** These measures the impact a business is having on the environment. This is determined by a register of impacts such as air emissions and water discharges. A company can use these indicators to identify improvement.
- **Environmental auditing:** A routine evaluation of a company's environmental controls, conducted by an independent third party defines the inputs (raw materials, energy) and outputs (waste streams, emissions) for the system.
- **Life cycle assessment:** All products have a life cycle. They are born (manufactured), they live (operate) and die (are disposed of). Life-cycle efforts are geared towards substituting less harmful products and minimisation of the waste stream.
- **Environmental labelling:** Environmentally friendly products have an advantage over their 'non-friendly' competitors. Under ISO 14000, the aim is to define standards for environmental labelling, encouraging manufacturers to reduce the environmental impact of their products.

3.20 ATTITUDES AND PERCEPTIONS OF THE CONSTRUCTION WORKFORCE

The construction industry is labour-intensive, with the attitudes and perceptions of workers influencing its growth. It is argued that the causes of construction waste are directly or indirectly affected by the attributes and perceptions of the personnel involved in the construction industry. Kulatunga, Amaratunga, Haigh and Rameezdeen (2006:57-72), identify workers involvement during the pre-contract stage as a major influence on the prevention of waste.

Worker involvement during the post-contract stage influences the minimisation of waste by ordering materials according to correct quantities and quality, the use of proper storage facilities, and proper handling of materials. Research has also shown that the attitudes of construction labourers towards waste minimisation activities are negative. The attitude of the workforce is important to management as it determines people's behaviour and provides an insight into their motivating values and beliefs. An attitude can be defined as a "psychological tendency to evaluate a particular object or situation in a favourable or unfavourable way, which causes someone to behave in a certain way towards it" (Ajzen, 1993:41-57, cited in Teo & Loosemore, 2003:345-76). Table 3.7 reflects that an attitude includes affect (feeling), cognition (thought), and behaviour (Spooncer, 1992:**Online**).

Table 3.7: Components of attitude. (**Source**: Spooncer, 1992:**Online**)

Component	Characteristic
Affect	Emotional reactions
Cognition	Internalised mental representations, beliefs, thoughts
Behaviour	The tendency to respond or overtly act in a particular way

Attitude is difficult to grasp because of the interaction between beliefs and attitude, as well as the interaction between people's underlying values and opinions. See Figure 3.13 in this respect. To measure attitude, people must be assessed during work, either because the project is intended to change people's attitude or because people need to increase some measure of their appreciation.

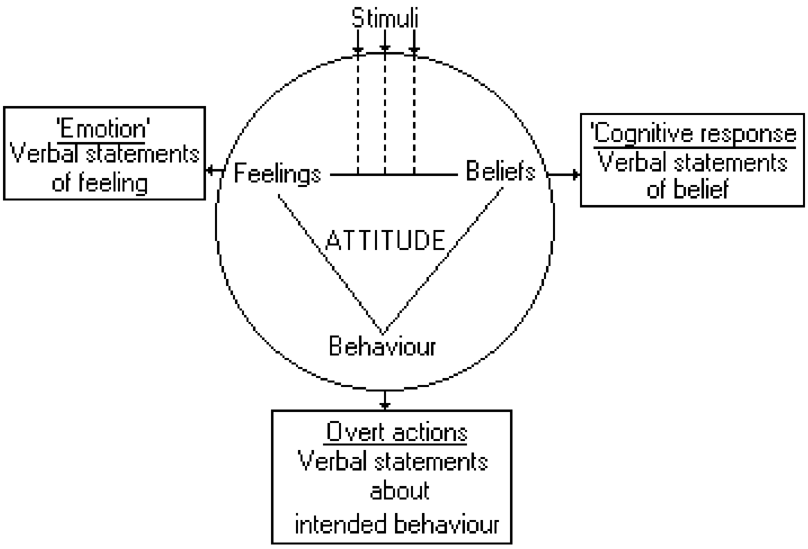

Figure 3.13: Components of attitude. (**Source:** Spooncer, 1999:**Online**)

Hussey and Skoyles (1974:91-4), believe that "a change in this attitude rather than a change in techniques is likely to have most effect overall". Teo and Loosemore (2001:741-9), find that attitudes towards waste reduction have become one of the reasons behind the difficulties encountered in the management of waste in the construction industry. Loosemore, Lingard and Theo (2002:256-76), and Skoyles and Skoyles (1987:86-90), highlight the importance of human factors in the minimisation of waste, and argue that waste can be prevented by changing people's attitudes. According to Skoyles and Skoyles (1987:86-90) (cited in Teo and Loosemore 2001:741-9), the involvement of people is being ignored in the waste management equation. The attitudes on waste also differ from one organisation to the next, based on their culture and waste management policies. Another contributing factor to high levels of construction waste is the high level of non-conforming work experienced from sub-contractors.

3.21 THE ROLE SUB-CONTRACTORS (LABOUR ONLY) PLAY IN CONSTRUCTION WASTE

The high involvement of sub-contractors for short periods during projects is significant. Jayawardane (1994:41-5), has found that the waste of materials by sub-contractor labour is higher than that of direct labour. Previous literature has examined the sub-contractors' awareness and understanding of waste and their perceptions of the causes, as well as their attitudes towards allocation of financial responsibility to waste minimisation. Reluctance among sub-contractors to accept some of the costs of waste reduction was found in the present research. Johnston and Mincks (1995:31-40), indicate that waste reduction should be considered as a potential profit with the financial benefits at all levels on site. Poon, Yu and Ng (2001:157-72), conclude that financial incentives alone have little effect on waste, and can only be implemented through contractual terms or legislation.

According to Saunders and Wynn (2004:148-155), sub-contractors accept that more should be done to reduce waste and that it has become more of an issue. Their attitude was that the main contractor has the responsibility for waste management. Saunders and Wynn (2004:148-155) have found the main causes of waste were due to poor off-loading and storage of materials, although poor design was also accepted as a major cause. Poor workmanship was least likely to be the cause of wastage. Sub-contractors have also agreed that education in reducing site waste was important. Despite the general positive attitude to the need for waste management, cost prevailed as the primary motivating factor. There is a willingness from labour only sub-contractors to carry some of these costs, but that there should be reasonable sharing of benefits coming from the treatment of waste management.

According to Saunders and Wynn (2004:148-155), literature has shown that sub-contractors contribute to delays in site operations, are responsible for untidy site conditions, and lower overall productivity. These problems not only control the profit of the sub-contractors, but also disturb the progress of the main project. The client will eventually pay for the waste, and the main contractor suffers losses as a result. It is considered by Shen, Tam and Tam (2002:125-132) that different sub-contracting arrangements cause different extents of material wastage. Skoyles and Skoyles (1987:101), suggest that sub-contracting arrangements can bring problems into the construction activities, such as delay in site operations, untidy site conditions, and lower overall efficiency. These issues not only diminish profits for the sub-contractor, but also disturb the progress of the main project. Table 3.8 summarises different types of sub-contracting arrangements and their relationship to wastage levels. No matter which arrangement is chosen, the cost of removing material waste is paid by the main contractors.

Table 3.8: Types of Sub-contracting arrangements and their relationship with waste generation. (**Source:** Shen, Tam & Tam 2002:17)

Sub-contracting arrangements	Responsibility in material wastage
Direct labour	Main contractors provide their in-house staff to purchase materials directly. Hence, the main contractor directly control and pay for the wastage.
Labour only	Main contractors purchase materials and sub-contractors provide labour force only. Hence, the main contractor directly pays for the wastage.
Labour and material	Sub-contractors purchase materials and hire labour. But the main contractor indirectly pays for wastage through higher sub-contractor prices.

Research has demonstrated that waste generation has a direct link with sub-contracting arrangements. Labour only sub-contracting produces the highest wastage levels compared with direct labour.

3.22 CONSTRUCTION SITE WASTE AVOIDANCE AND MANAGEMENT

According to the CSIR (2004:**Online**), the cost of material purchase and for disposal of C&D waste can be prevented and managed. Avoidable waste can be reduced by prioritising waste management on site. This will result in efficiency and reduced cost.

3.22.1 Waste avoidance

Avoiding waste refers to the activities that focus on ensuring that waste is not created in the first place (CSIR, 2004:**Online**). This can be separated into three main components:

- **Waste prevention:** The first component is found in design, operations and procurement processes. It concentrates on practices that determine whether or not whether waste is created on site.
- **Demand management:** The second component includes delivery, material storage, material use and human error. It concentrates on practices that rely on the human element and whether they are responsible for waste creation.
- **Waste reduction:** The third component concentrates on practices that can determine the amount of waste that will end up in landfill sites.

3.22.2 Waste specifications and waste contract documents

Waste specifications are prepared by designers and are included in tender documents. Increasing pressure from clients for measures to reduce wastage has ensured this action (CSIR, 2004:**Online**). This is a limitation of the review and will not be discussed in detail. This also includes the waste contract language where designers can use the power of contract documents to prioritise waste management on site.

3.22.3 Waste management plans

According to the CSIR (2004:**Online**), a waste management plan makes provision for prevention, separation, salvage, re-use, recycling and disposal of construction and demolition (C&D) waste. The goal is to reduce to a minimum the amount of C&D waste destined for landfill. A typical construction waste management plan will contain the following:

- Waste management goals.
- A waste audit.
- Waste disposal options.
- Waste handling requirements.

- Transportation requirements.
- Economic considerations.

The success of the waste management plan depends on how it is initially introduced to prevent employees becoming discouraged and lose their motivation and enthusiasm for the initiative. The following key elements are essential for the success of the waste management plan implementation:

- Train all employees on the waste management plan.
- Ensure appropriate and adequate container placement.
- Identify the reporting procedure.
- Identify the procedure for correcting any disposal errors.
- Recognition strategies for employees and their sites that meet company goals.
- Strategies to promote continued visibility and awareness.

The CSIR (2004:**Online**), explains that waste can only be reduced once all employees and sub-contractors are aware of the extent of the problem, and waste management is fully understood in the company. All employees must be trained in the waste management plan. This training may include green helmet stickers, displayed on the employees' hardhats with the words 'waste management induction'. The preparation of a waste management plan at the early stages of a project is crucial to ensure suitable actions for the management of construction waste. The sequence that operations follow is important to sort and segregate materials. Transportation linked with the movement of material should also be considered. Deconstruction and reclamation activities must be identified for critical material content, and recycling of materials is essential.

3.23 CONCLUSION

In this chapter, a literature review was conducted on various aspects of construction waste. The application of these and related aspects pertaining to significance and quality within the industry were investigated. In the next chapter, the construction industry's efficiency survey design and methodology will be addressed.

4 CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

The aim of the chapter and the surveys it contains is to determine the quality factors that contribute to the generation of construction waste in the construction industry; the ultimate objective being to solve the research problem as defined in Chapter 1, Paragraph 1.2, and which reads as follows: "The generation of construction waste leads to a decrease in profitability and an increase in costs, culminating in low productivity by construction companies, furthermore impacting on the environment".

4.2 BACKGROUND

According to Yin (1994:19), a 'research design' can be defined as "the logical sequence that connects the empirical data to a study's initial research question and ultimately, to its conclusions". According to Collis and Hussey (2003:55), the term 'methodology' refers to the overall approaches and perspectives to the research process as a whole and is concerned with the following main issues:

- **Why** certain data was collected.
- **What** data was collected?
- **Where** data was collected.
- **How** data was collected.
- **How** data was analysed.

According to Collis and Hussey (2003:68-70), various types of case studies can be identified:

- **Descriptive case study:** Where the objective is restricted to describing current practice.
- **Illustrative case study:** Where the research attempts to illustrate new and possible innovative practices adopted by particular companies.

- **Experimental case study:** Where the research examines the difficulties in implementing new procedures and techniques in an organisation and evaluating the benefits.
- **Explanatory case study:** Where existing theory is used to understand and explain what is happening.

A descriptive case study approach will be followed in this research endeavour. This research will be descriptive in nature, describing the current practices in construction companies in the Western Cape.

Collis and Hussey (2003:122), point out that a unit of analysis could refer to the following:

- An individual.
- An event.
- An object.
- A body of individuals.
- A relationship.
- An aggregate.

The unit of analysis in this case study is the group of individuals in the construction industry in the Western Cape.

4.3 THE SURVEY ENVIRONMENT

According to Nunnally (2007:3), the South African construction industry consists of the building construction and heavy construction. The building construction is subdivided into:

- Public and private,
- Residential and non-residential building construction.

Heavy construction includes highways, airports, railroads, bridges, canals, harbours, dams and other major public works. Other speciality divisions of the construction industry include industrial construction, process plant construction, marine construction and utility construction. For the purpose of this research, the focus will be on public, private, residential and non-residential building construction.

4.4 THE TARGET POPULATION/CHOICE OF SAMPLING METHOD

Collis and Hussey (2003:56), define a population as "any precisely defined set of people or collection of items which is under consideration". Collis and Hussey (2003:155-160), define a 'sample' as made up of the members of a 'population' (the target population), the latter referring to a body of people, or to any other collection of items, under consideration for the research purpose. For this survey, the population is building construction companies chosen from the Master Builders South Africa (MBSA). Three criteria were used to select companies for the study. Firstly, companies from building construction were chosen. Secondly, the companies included contractors from the public, private, residential and non-residential sectors. Thirdly, only companies who were operating in the Western Cape were chosen.

For this survey, employees were randomly selected from the construction industry at various organisational levels to represent the sampling frame. The sampling included employees from different construction companies in the Western Cape that randomly participated in the following identified research strata:

- Estimators.
- Contract directors.
- Site agents.
- Site engineers.
- Senior foremen.
- Sub-contractors.
- Other.

Surveys were conducted involving all of these role players.

4.5 DATA ANALYSIS

According to Emory and Cooper (1995:278), three primary types of data collection (survey) methods can be distinguished, namely:

- Personal interviewing.
- Telephone interviewing.
- Self-administered questionnaires/surveys.

The data collection method used falls within the ambit of the concept 'survey'. Remenyi *et al*. (2002:290), define 'survey' as "the collection of a large quantity of evidence usually numeric, or evidence that will be converted to numbers, normally by means of questionnaires". According to Gay and Diebl (1992:238), a 'survey' is an attempt to collect data from members of a population in order to determine the current status of that population with respect to one or more variables. In this study, questionnaires were used as a tool for collecting data for qualitative analysis. Leedy & Ormrod (2005:185), state that a questionnaire allows the participants to respond to questions with assurance that their responses will be anonymous, and this will allow the respondents to be more truthful than if they were in a personal interview. A questionnaire is an instrument with open and closed questions or statements to which a respondent must react.

The reason for using a questionnaire is that the opinions of respondents can be acquired in a structured manner. According to Castelo Branco (2007:23), a questionnaire is the most common method used to identify the practice of companies. Designing a questionnaire appears to be a relatively simple process, but the aim of the research must continuously be borne in mind. At this stage, four questionnaires were designed to collect data. The first questionnaire was designed to identify the top three construction waste categories and rank the categories according to the effect they have on construction sites. The second questionnaire was based on the waste identification of questionnaire one. The questionnaire ranked the types of waste (such as delays, waste of materials, and deterioration of materials and inefficient movement of workers) for the top three categories, identified in the first questionnaire to determine their possible sources and causes (such as poor design and specifications, poor jobsite layout, unnecessary requirements, lack of control etc.).

The third questionnaire was structured around an interview with members of the workforce of the construction companies, regarding their attitude towards waste management. According to Collis and Hussey (2003:155-160), interviews are associated with both positivist and phenomenological methodologies. They are a method of collecting data in which selected participants are asked questions in order to find out what they do, think or feel. The use of personal interviews as an additional element to the data collection process is, in the opinion of the researcher, important since this allows for the identification of issues within the target environment, which may not be readily identifiable using a pure survey questionnaire. Interviews are associated with both positivist and phenomenological methodologies as employed within the ambit of this dissertation. The fourth questionnaire was designed to determine the perception and attitude of labour-only sub-contractors towards waste management.

4.6 MEASUREMENT SCALES

The survey was to be based on the Lickert scale, in which respondents were asked to respond to questions or statements (Parasuraman 1991:410). The Lickert scale (Lickert, 1932:1-55), was chosen because the scale can be used in both respondent-centred (how responses differ between people) and stimulus-centred studies, and was judged to be most appropriate to glean data in support of the research problem in question (Emory & Cooper 1995:180-181).

According to Emory and Cooper (1995:180-181), the advantages of using the Lickert scale are:

- Easy and quick to construct.
- Each item meets an empirical test for discriminating ability.
- The Lickert scale is probably more reliable than the Thurston scale, and it provides a greater volume of data than the Thurston differential scale.
- The Lickert scale is also treated as an interval scale.

According to Remenyi *et al*. (2002:60-66), interval scales facilitate meaningful statistics when calculating means, standard deviations and Pearson correlation coefficients.

4.7 SURVEY DESIGN

Collis and Hussey (2003:60-66), express the opinion that "if research is to be conducted in an efficient manner and make the best of opportunities and resources available, it must be organised. Furthermore, if it is to provide a coherent and logical route to a reliable outcome, it must be conducted systematically using appropriate methods to collect and analyse the data". A survey should be designed in accordance with the following stages:

- **Stage one:** Identify the topic and set some objectives.
- **Stage two:** Pilot a questionnaire to find out what people know and what they see as the important issues.
- **Stage three:** List the areas of information needed and refine the objectives.
- **Stage four:** Review the responses to the pilot.
- **Stage five:** Finalise the objectives.
- **Stage six:** Write the questionnaire.
- **Stage seven:** Re-pilot the questionnaire.
- **Stage eight:** Finalise the questionnaire.
- **Stage nine:** Code the questionnaire.

The survey design to be used in this instance is that of the descriptive survey as opposed to the analytical survey. The descriptive survey is, according to Collis and Hussey (2003:60-66), frequently used in business research in the form of attitude surveys. Furthermore the descriptive survey as defined by Ghauri, Grønhaug and Kristianslund (1995:60), has the characteristics of being able to indicate how many members of a particular population have a specific characteristic. Particular care must be taken to avoid bias in the formulation of the questions.

The statements in the surveys have been designed with the following principles in mind:

- Avoidance of double-barrelled statements.
- Avoidance of double-negative statements.
- Avoidance of prestige bias.
- Avoidance of leading statements.
- Avoidance of the assumption of prior knowledge.

Statements were formulated to allow the same respondents to respond to each of the four questionnaires, to determine if a paradigm shift occurred regarding the concept of 'waste management'.

4.8 VALIDITY AND RELIABILITY ISSUES

Denzin (1998:328), is of the opinion that qualitative research is biased, because interpretation produces understandings which are shaped by class, gender, race, and ethnicity. Malterud (1998:329-330), expresses the view that qualitative research presents a perspective that is always partial, and findings that represent only a temporary and limited view. According to Babbie (2005:285), survey research is generally weak on validity and strong on reliability.

In support of this, Berenson, Levine and Krehbiel (2004:21-22), state that surveys are subject to potential errors. The researcher endeavoured to minimise the effect of survey errors in the following ways:

- **Coverage error:** Although this error can never be completely eliminated, the author believes that the choice of sampling frame reflects the individuals with the broadest knowledge of, and responsibilities with regard to, the subject matter. Increasing the sampling frame may in fact increase sampling error and/or measurement error in the case where an individual has limited knowledge of the subject.
- **Non-response error or non-response bias:** The objective is to have a 100% return on questionnaires issued. Non-responses have been followed up on a regular basis.
- **Sampling error:** Refer to coverage error.

- **Measurement error:**
  - **Ambiguous wording of questions:** Respondents have been provided with operational definitions for key terms to foster common understanding. Questions have also been derived from the governance principles provided by best practice publications, as these publications normally reflect colloquial speech, and the possibility of error should be reduced.
  - **The halo effect:** The use of the self-administered questionnaires should minimise this effect.
  - **Respondent error:** This error may be reduced to some extent by inspecting the responses for obvious errors but will never be completely eliminated.

In spite of the above, the researcher acknowledges that "descriptions and explanations involve selective viewing and interpretation, and that they cannot be neutral, objective or total" (Mason, 1996:6).

4.9 THE RESEARCH QUESTIONNAIRE

In the opinion of Sammy (2008:85), a questionnaire is a quantitative data collection method which has several advantages, namely:

- It is relatively economical.
- It can ensure anonymity.
- It contains questions to cover specific considerations.
- Existing questionnaires can be used or modified.

The objective of these surveys is to determine the opinions of role players in the construction industry about waste management issues in this industry. The questionnaires in this research study are divided into four sections, namely:

- **Section 1:** Identifying the top three construction waste categories.
- **Section 2:** Identifying the sources and causes of construction waste.
- **Section 3:** Gauging the attitude of the construction workforce towards waste management.

- **Section 4:** Gauging the attitude of labour-only sub-contractors towards waste management.

A list of the questions in the research questionnaires is given below for ease of reference.

4.9.1 Section1: Identifying the three top construction waste categories questionnaire

This survey contains eleven possible waste categories that are present at construction projects, and respondents must rank these according to the cost impact or the occurrence and influence. Table 4.1 reflects the waste categories defined in Questionnaire One.

Table 4.1: Waste categories. (**Source:** Castelo Branco, 2007:52)

Description of waste categories	**Rank from 1 to 11**
1 – Wood	
2 – Painting	
3 – Drywall	
4 – Siding (vinyl, aluminium, or other material used to surface the outside of a building)	
5 – Cardboard (OCC)	
6 – Flooring	
7 – Concrete and Masonry	
8 – Tile	
9 – Metals	
10 – Trim	
11 – Other (Specify)	

4.9.2 Section 2: Identifying the sources and causes of the three top construction waste categories questionnaire

In Table 4.2 the possible causes of the waste categories are defined. In order to evaluate the degree of influence of each type of waste, this survey must identify the most frequent types of construction waste in order to determine the perceived possible causes, using a three-point scale as follows:

- 1 = (not significant).
- 2 = (moderately significant).

➢ 3 = highly significant).

Table 4.2: Possible causes. (**Source:** Castelo Branco, 2007:53)

Column 2, 3, 4 and 5 – Select the possible cause(s) of its occurrence from Table 1

Example

Types of waste:	**Cause(s)**				
	1	**2**	**3**	**4**	**5**
1 – Delays	2	b.1	b.4		
2 – Waste of materials	1	b.2			
3 – Deterioration of materials	3	a.2			
4 – Inefficient movement of workers	3	c.3	b.3	e.2	
5 – Material purchased with superior value	1				
6 – Work not done	1				
7 – Waiting or idle	2	b.3			
8 – Unnecessary work	1				
9 – Rework	3	a.1	b.2		
10 – Over allocation of materials	1	d.1			
11 – Waste of space on site	1	a.2			

Table 1:		
a)	**Project**	
	a.1	Poor design and specifications
	a.2	Poor project site layout
b)	**Management**	
	b.1	Unnecessary requirements
	b.2	Lack of control
	b.3	Poor planning
	b.4	Bureaucracy
c)	**Production**	
	c.1	Poor qualification of team work
	c.2	Ineffective work methods
	c.3	Poor arrangement if the working place
	c.4	Lack of work place available
	c.5	Lack of personal equipment
d)	**Resources**	
	d.1	Excessive quantity
	d.2	Insufficient quantity
	d.3	Inadequate use
	d.4	Poor distribution
	d.5	Poor quality
	d.6	Availability
	d.7	Inadequate storage
e)	**Information systems**	
	e.1	Unnecessary information
	e.2	Not enough information
	e.3	Ambiguous information
	e.4	Lack of integration between design and production
	e.5	Lack of finalisation on the project site

4.9.3 Section 3: Attitude of workforce towards waste management

A structured questionnaire survey was selected to understand and evaluate the attitude and perceptions of the construction workforce. The questionnaire was to be completed by estimators, site management, site engineers, site agents, foremen, labourers and any other respondents wishing to participate in the survey. This survey contained a number of statements about the attitude of the construction workforce towards waste management. The approach would be that respondents would make their choices by filling in the number in the answer block that most accurately fitted the extent of agreement with the statement description. If the respondent strongly agreed with a statement, he or she would fill in the number 1 in the answer column of the appropriate statement.

Conversely, should a respondent strongly disagree with the statement, he or she would fill in the number 5 in the answer column, etc. The degree to which the statement accurately described the current situation would be annotated on the Lickert scale. An individual in-depth interview would be conducted with the various levels of the construction workforce. Non-experts would be used who had some knowledge of the issues being discussed. In Table 4.3 the respondents were asked to circle only one statement which most accurately fitted the extent with which they agreed with the statement.

Table 4.3: Attitude of workforce towards waste management. (**Source:** Kulatunga, Amaratunga, Haigh & Rameezdeen , 2006:Adapted)

No.	Description	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Q1	Company performs well in the area of construction waste management	1	2	3	4	5
Q2	Company has a waste management strategy	1	2	3	4	5
Q3	Cost of waste does not have much effect on the project	1	2	3	4	5
Q4	Waste management is as important as other functions of construction management	1	2	3	4	5
Q5	Attention of waste management in the actual practice is not sufficient	1	2	3	4	5
Q6	Waste management is worthwhile irrespective of the cost gains	1	2	3	4	5

4.9.4 Section 4: Attitude of labour-only sub-contractors toward waste management

An attitudinal questionnaire was designed to determine the attitude of labour-only sub-contractors in the construction industry in the Western Cape. The degree to which the statement accurately described the current situation would be annotated on the Lickert scale as depicted in Table 4.4.

Table 4.4: Attitude of labour only sub-contractors towards waste management. (**Source:** Saunders, Wynn, 2004:Adapted)

No.	Description	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Q1	The industry should do more to reduce waste.	1	2	3	4	5
Q2	Site Management is the main factor affecting the levels of waste produced on site.	1	2	3	4	5
Q3	A waste level of 10 % is an acceptable level for the construction process.	1	2	3	4	5
Q4	It is the main contractors who are fully responsibility to segregate waste on site.	1	2	3	4	5
Q5	Sub-contractors should segregate waste.	1	2	3	4	5
Q6	Waste minimisation will be a major issue for sub-contractors in the future.	1	2	3	4	5
Q7	The Government should increase landfill tax to force waste reduction on site.	1	2	3	4	5
Q8	Sub-contractors should price for costs involved in waste reduction.	1	2	3	4	5
Q9	Sub –contractors should be penalised for waste produced on site.	1	2	3	4	5
Q10	Poorly off-loaded and incorrect stored materials are the major cause of wastage on site.	1	2	3	4	5
Q11	Lack of care by sub-contractors is the major cause of waste on site.	1	2	3	4	5
Q12	Main contractor should build in allowable waste percentages to sub-contractors packages.	1	2	3	4	5
Q13	Education of sub-contractors is the preferred method of reducing site wastage.	1	2	3	4	5
Q14	A financial incentive with financially benefits for sub-contractors will reduce waste.	1	2	3	4	5
Q15	The main contractor should employ operatives to sort and segregate waste on site.	1	2	3	4	5

The researcher distributed the questionnaires via email and discussed the contents by way of telephone interviews. The researcher provided respondents with an overview of the dissertation objectives and emphasised the confidentiality of the information provided.

4.10 CONCLUSION

In this chapter, the ‘construction waste management’ surveys ‘design’ and ‘methodology’ were addressed under the following functional headings:

- Introduction.
- Background.
- Survey environment.
- The target population/choice of sampling method.
- Data analysis.
- Measurement scales.
- Survey design.
- Validity and reliability issues.
- The research questionnaire.
- Conclusion.

In Chapter 5, results are given of a data analysis and interpretation of results conducted on the data gleaned from the research survey.

5 CHAPTER 5: DATA ANALYSIS AND INTERPRETATION OF SURVEY RESULTS

5.1 INTRODUCTION

Data analysis is "the process of bringing order, structure and meaning to the mass of collected data" (De Vos 2002:339). The aim of this study is to determine the quality factor which contributes to construction waste that should be addressed to increase sustainability, decrease cost and minimise environmental impact. This chapter discusses the results of the data analysis of the survey conducted at construction companies in the Western Cape. The data obtained from the completed questionnaires will be presented and analysed by means of various analyses (uni-variate, bi-variate and multivariate) as applicable.

In most social research the analysis entails three major steps performed in the following order:

- Cleaning and organising the information collected which is called the data preparation step.
- Describing the information collected (Descriptive Statistics).
- Testing the assumptions made through hypotheses and modelling (Inferential Statistics).

The responses to the four questionnaires developed by the researcher for the purpose of obtaining information regarding construction waste with specific reference to the three top categories responsible for construction waste, the critical sources and causes of construction waste, the attitudes and perceptions of the construction workforce regarding construction waste and the attitudes and perceptions of the sub-contractors (labour only) regarding construction waste, were analysed using SAS software.

5.2 METHOD OF ANALYSIS

5.2.1 Validation of survey results

A descriptive analysis of the survey results returned by the research questionnaire respondents is reflected below. The responses to the questions obtained through the questionnaires are indicated in Table format for ease of reference. Data validation is the process of ensuring that a programme operates on clean, correct and useful data. The construct validation can however, only be taken to the point where the questionnaire measures what it is supposed to measure. Construct validation should be addressed in the planning phases of the survey and when the questionnaire is developed. These questionnaires should measure the quality factors which contribute to construction waste at construction companies in the Western Cape.

5.2.2 Data format

The data was received in the form of four different questionnaires which were coded and captured on four databases developed on Microsoft Access for this purpose. These questionnaires were captured twice and then the two datasets for each of these four questionnaires were compared to make sure that the information was correctly captured. When these databases were developed, use was made of rules with respect to the questionnaire that set boundaries for the different variables (questions). For instance, one of the scales used (Lickert scale) is as follows:

- Strongly agree is coded as 1.
- Agree is coded as 2.
- Undecided is coded as 3.
- Disagree is coded as 4.
- Strongly disagree is coded as 5.

A boundary was set on Microsoft Access as less than 6. This means if the number 6, or greater than 6, was captured, an error would show until a number less than 6 was captured. It was then imported into SAS-format through the SAS ACCESS module. This information, which was double-checked for correctness, was then analysed by the custodian of this document.

The measurements of the sources and causes of construction waste were not mutually exclusive (respondents could select more than one of the categories as a cause) and thus each of the options was coded so that if the respondent selected the option, the coding would indicate 'yes'. If the option was not selected the coding would indicate 'no'. Thus each cause per type of waste was measured depending on whether it was a cause of the waste or not. Each of these options per type of waste would indicate a dichotomous variable. This was the only way to make sure that each cause that contributed to the type of waste would be counted.

5.2.3 Preliminary analysis

The reliability of the statements in the questionnaire posed to the respondents from the engineering faculty of CPUT in Western Cape was measured by using the Cronbach Alpha tests. (See paragraph 5.3.1). A uni-variate descriptive analysis was performed on all the original variables; displaying frequencies, percentages, cumulative frequencies and cumulative percentages. These descriptive statistics are discussed and displayed in paragraphs 5.3.2 and 5.3.3. (See also computer printout in Annexure B).

5.2.4 Inferential statistics

Inferential statistics that were used were:

- Cronbach Alpha test. Cronbach's Alpha is an index of reliability associated with the variation accounted for by the true score of the 'underlying construct'. Construct is the hypothetical variables that are being measured (Cooper & Schindler, 2003:216-217). Another way to put it would be that Cronbach's alpha measures how well a set of items (or variables) measures a single uni-dimensional latent construct. When data has a multidimensional structure, Cronbach's Alpha will usually be low.

- Chi-square tests for nominal data. The Chi-square (two-sample) tests are probably the most widely used nonparametric test of significance that is useful for tests involving nominal data, but it can be used for higher scales as well as cases where persons, events or objects are grouped in two or more nominal categories such as 'yes-no' or cases A, B, C, D. The technique is used to test for significant differences between the observed distribution of data among categories and the expected distribution based on the null hypothesis. It has to be calculated with actual counts rather than percentages (Cooper & Schindler, 2003:499).
- The SAS software computes a P-value (Probability value) that measures statistical significance when comparing variables with each other, determining the relationship between variables or determining the association between variables. Results will be regarded as significant if the p-values are smaller than 0.05 because this value presents an acceptable level on a 95% confidence interval ($p \leq 0.05$). The p-value is the probability of observing a sample value as extreme as, or more extreme than, the value actually observed, given that the null hypothesis is true. This area represents the probability of a Type 1 error that must be assumed if the null hypothesis is rejected (Cooper & Schindler, 2003:509).
- The p-value is compared to the significance level (α) and on this basis the null hypothesis is either rejected or not rejected. If the p value is less than the significance level, the null hypothesis is rejected (if p value $<\alpha$, reject null). If the p value is greater than or equal to the significance level, the null hypothesis is not rejected (if p value $\geq\alpha$, do not reject null). Thus with $\alpha=0.05$, if the p value is less than 0.05, the null hypothesis will be rejected. The p value is determined by using the standard normal distribution. The small p value represents the risk of rejecting the null hypothesis.
- A difference has statistical significance if there is good reason to believe the difference does not represent random sampling fluctuations only. Results will be regarded as significant if the p-values are smaller than 0.05, because this value is used as cut-off point in most behavioural science research.

5.2.5 Assistance to researcher

The conclusions made by the researcher, were validated by the statistical report. Help was given to interpret the outcomes of the data. The final report written by the researcher was validated and checked by the statistician to exclude any misleading interpretations. All inferential statistics are discussed in paragraph 5.2.4.

5.2.6 Sample

Four questionnaires were developed. The target population of the first questionnaire (which measured the most frequent construction waste categories), the second questionnaire (which measured types of waste and causes for the most frequent waste categories) and the third questionnaire (which measured the attitudes and perceptions of the workforce) was the relevant levels of 108 construction companies such as site management, foremen, labourers and estimators in the Western Cape. The sample that realised could be identified as a convenient sample drawn from the target population and might be biased as any of the construction companies' relevant levels could choose to answer. The target population for the fourth questionnaire (which measured the attitudes and perceptions of sub-contractors) were 57 sub-contacting companies in the Western Cape.

5.3 ANALYSIS

The samples that realised for the four questionnaires were:

- First questionnaire – 11.
- Second questionnaire – 24.
- Third questionnaire – 23.
- Fourth questionnaire – 21.

Descriptive statistics will be given for each variable in each questionnaire. Some data manipulations will take place to identify certain aspects which were required to answer certain research questions.

5.3.1 Reliability testing

Reliability tests (Cronbach's Alpha Coefficient) were conducted using the questions/statements that measured the attitudes and perceptions of the different construction companies in the Western Cape.

The 6 statements in questionnaire three measured the attitudes and perceptions of the workforce in the construction companies and the 15 statements in questionnaire four which measured the attitudes and perceptions of the sub-contracting companies (labour force) in the Western Cape.

The results of the Cronbach Alpha tests for the variables, in Questionnaire 3 are shown in Table 5.1 and Table 5.2; and in Questionnaire 4 are shown in Table 5.4. The computer printouts for these tests are also attached in Annexure A. They show the correlation between the respective item and the total sum score (without the respective item) and the internal consistency of the scale (coefficient alpha) if the respective item were to be deleted. By deleting the items (statements) one by one each time with the statement with the highest Cronbach Alpha value, the Alpha value would increase. In the right-most column of Table 5.1, it can be seen that the reliability of the scale would be higher if any of these statements was deleted.

For instance, if statement Q5 is deleted from this measuring scale then the Cronbach Alpha Coefficient will increase to 0.5513. This will be done to try and improve the scale as the overall Cronbach alpha is 0.1361, showing that this measuring instrument may not be reliable or exist out of multi constructs (measure more than one aspect). Table 5.2 will show the Cronbach alpha coefficients when question 5 is omitted from the measuring instrument.

Table 5.1: Cronbach's Alpha Coefficient for 6 items in questionnaire 3.

Statements (Test all statements without current one's input)	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
1. Company performs well in the area of construction waste management.	Q1	0.5258	-0.4380
2. Company has a waste management strategy.	Q2	0.1993	-0.0516
3. Cost of waste does not have much effect on the project.	Q3	-0.0459	0.2004
4. Waste management is as important as other functions of construction management.	Q4	0.3298	-0.1928
5. Attention of waste management in the actual practice is not sufficient.	Q5	-0.5314	0.5513
6. Waste management is worthwhile irrespective of the cost gains.	Q6	0.1221	0.0622
Cronbach's Coefficient Alpha for standardized variables			**0.1150**
Cronbach's Coefficient Alpha for raw variables			**0.1361**

Table 5.2: Cronbach's Alpha Coefficient for 5 remaining items in questionnaire 3.

Statements (Test all statements without current one's input)	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
1. Company performs well in the area of construction waste management.	Q1	0.6683	0.2538
2. Company has a waste management strategy.	Q2	0.2754	0.5228
3. Cost of waste does not have much effect on the project.	Q3	0.1110	0.5999
4. Waste management is as important as other functions of construction management.	Q4	0.4096	0.4337
6. Waste management is worthwhile irrespective of the cost gains.	Q6	0.1519	0.5747
Cronbach's Coefficient Alpha for standardized variables			**0.5395**
Cronbach's Coefficient Alpha for raw variables			**0.5513**

Although the reliability is higher, it is still not at an acceptable level of 0.70 (the acceptable level according to Nunnally, 1978*:*245). However, if statement 3 is deleted then the reliability will improve to 0.5999. After that, as the computer printout in Annexure A shows, if statement 6 is deleted the reliability can be increased to 0.7051 which will be acceptable and which will leave 3 statements as the measuring instrument of attitudes and perceptions of the workforce. After performing an exploratory factor analysis it was determined that this measuring instrument consisted of two constructs which grouped the items (statements) into two factors. Exploratory factor analysis was used to investigate the factor structure underlying the set of original observed (6) variables that represented the measurement items regarding attitude and perceptions of the workforce to determine the latent variables which it described.

By definition, factor analysis identifies the nature and number of latent factors responsible for co-variation in data analysis. Results, including the rotated factor pattern and communality estimates of the exploratory factor analysis are shown in Table 5.3. The SAS printout can be found in Annexure B. The communality refers to the percent of variance in an observed variable that is accounted for by the retained factors (Hatcher, 1994:13).

Table 5.3: Original variables and corresponding factor loadings from the rotated factor pattern.

Factor Pattern		**Final Communality Estimates**	**Questionnaire Statements**
1	**2**		
94	-28	0.8250	Q2
90	18	0.9256	Q1
16	66	0.5208	Q4
-12	51	0.2395	Q3
-13	41	0.1545	Q6
-28	-48	0.3775	Q5

- *Take note that all the loadings are multiplied by a 100 and rounded to the nearest integer.*

Measurements on quality strategies were subjected to an exploratory factor analysis using squared multiple correlations (SMC) as prior communality estimates. The principal factor method was used to extract the factors, followed by a promax (oblique) rotation. A scree test as well as an eigenvalue of more than one suggested two meaningful factors, so only these factors were retained for rotation. In interpreting the rotated factor pattern, an item was said to load on a given factor if the factor loading was 0.40 or greater for that factor, and was less than 0.40 for the other. Using these criteria, two items were found to load on the first factor, which was subsequently labelled the 'Companies policy' factor. Four items loaded on the second factor, which was labelled the 'Waste Management' factor. Thus the instrument that measures the attitudes and perceptions of the workforce consists out of two constructs and that is why if used as one measuring instrument it proves unreliable. The Cronbach alpha test is attached in Table 5.4 and Annexure A and shows the results for the two factors separately. Q6 may prove to be a problem in future analysis.

Table 5.4: Cronbach's Alpha Coefficient for 15 items in questionnaire 4.

Statements (Test all statements without current one's input)	**Variable nr.**	**Correlation with total**	**Cronbach's Alpha Coefficient**
1. The industry should do more to reduce waste.	Q01	0.5773	0.7623
2. Site Management is the main factor affecting the levels of waste produced on site.	Q02	0.4678	0.7606
3. A waste level of 10% is an acceptable level for the construction process.	Q03	0.5331	0.7520
4. It is the main contractors who are fully responsible to segregate waste on site.	Q04	0.2557	0.7755
5. Sub-contractors should segregate waste.	Q05	0.5940	0.7467
6. Waste minimisation will be a major issue for sub-contractors in future.	Q06	0.5825	0.7478
7. The Government should increase landfill tax to force waste reduction on site.	Q07	-0.2476	0.8150
8. Sub-contractors should price for costs involved in waste reduction.	Q08	0.4267	0.7630
9. Sub-contractors should be penalised for waste produced on site.	Q09	0.6099	0.4116
10. Poorly offloaded and incorrect stored materials are the major cause of wastage on site.	Q10	0.2814	0.7765
11. Lack of care by sub-contractors is the	Q11	0.6796	0.7367

Statements (Test all statements without current one's input)	Variable nr.	Correlation with total	Cronbach's Alpha Coefficient
major cause of waste on site.			
12. Main contractor should build in allowable waste percentages to sub-contractors packages.	Q12	0.4869	0.7661
13. Education of sub-contractors is the preferred method of reducing site wastage.	Q13	0.4504	0.7659
14. A financial incentive with financially benefits for sub-contractors will reduce waste.	Q14	0.4998	0.7634
15. The main contractor should employ operatives to sort and segregate waste on site.	Q15	-0.0513	0.7992
Cronbach's Coefficient Alpha for standardized variables			**0.8015**
Cronbach's Coefficient Alpha for raw variables			**0.7787**

The Cronbach's Alpha Coefficients for each item are more than 0.70 (the acceptable level according to Nunnally, 1978:245), and thus these items (statements) in the questionnaire prove to be reliable and consistent for all the items in the scale.

5.3.2 Descriptive statistics

Table 5.5 (Annexure G) shows the descriptive statistics for all the categorical demographic variables as well as the variables measuring the usage of productivity software and ability to use the software for the administration staff at the engineering faculty of CPUT with the frequencies in each category and the percentage out of the total number of questionnaires. The descriptive statistics are based on the total sample. These descriptive statistics are also shown in Annexure C.

Due to the voluminous nature of Table 5.5, it is for ease of reference, put into Annexure G

Table 5.6: Descriptive statistics for Questionnaire 1.

Variable	N	Mean	Median	Standard Deviation	Range
1.4 How long have you been employed by the contractor.	11	7.82	4.0	6.6003	18.0

The respondents to questionnaire 1 were employed on average for about 8 years by the contractor. In the next table the causes of waste are summarised differently from the other variables. Only the number of respondents who indicated a cause are noted, with the percentage calculated out of the total number of respondents in the survey. For instance if 10 people indicated the cause as 'A1' then the percentage was calculated as 10/24*100; as 24 was the total number of respondents in this survey. The reason for this is that the 10 people who indicated 'A1' in the first instance could indicate another cause, say 'B4' in the next instance.

Thus each cause chosen was not exclusive from choosing another cause and thus to determine which causes were the main causes, the percentage of respondents out of total respondents were taken for each cause. It means that if the causes for each waste were listed their percentage would not add up to a 100%, like the other variables whose category percentages added up to 100%. Only the four main causes are listed in Table 5.7 but a Table with the all the causes listed for each waste will be shown in Annexure D. Annexure F will also include the causes per category. Only the 3 main categories will be shown as the other categories were presented by only one respondent.

Due to the voluminous nature of Table 5.7 it is, for ease of reference, put into Annexure G. It seems that 'poor planning' was the major cause of most of the waste types in the questionnaire.

Due to the voluminous nature of Table 5.8 it is, for ease of reference, put into Annexure G.

Table 5.9: Descriptive statistics for Questionnaire 3

Variable	N	Mean	Median	Standard Deviation	Range
1.4 How long have you been employed by the contractor.	23	8.13	5.0	6.5803	22.0

The average time that the employees in this survey were employed by the construction company was 8 years.

Due to the voluminous nature of Table 5.10 it is, for ease of reference, put into Annexure G.

Table 5.11: Descriptive statistics for Questionnaire 4

Variable	N	Mean	Median	Standard Deviation	Range
1.4 How long have you been employed by the contractor.	21	7.57	5.0	6.7792	27.0

The average time that the respondents in this survey were employed by the sub-contractor was about 7.6 years.

5.4 UNI-VARIATE GRAPHS

5.4.1 Graphs for questionnaire 1

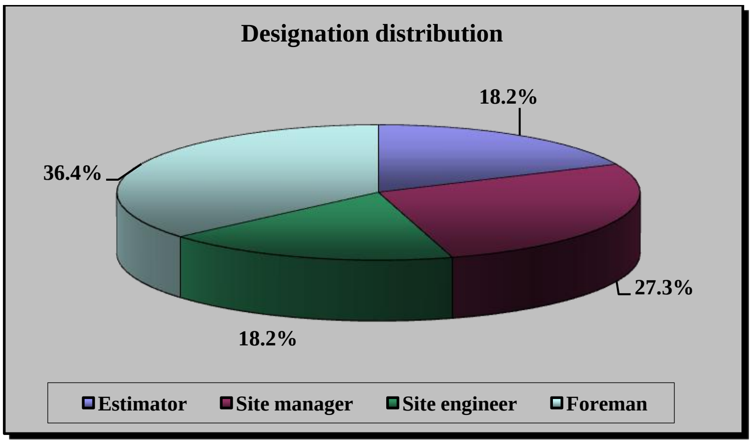

Figure 5.1: Designation distribution.

The designation was evenly distributed. The proportions of the designations were not statistically significant.

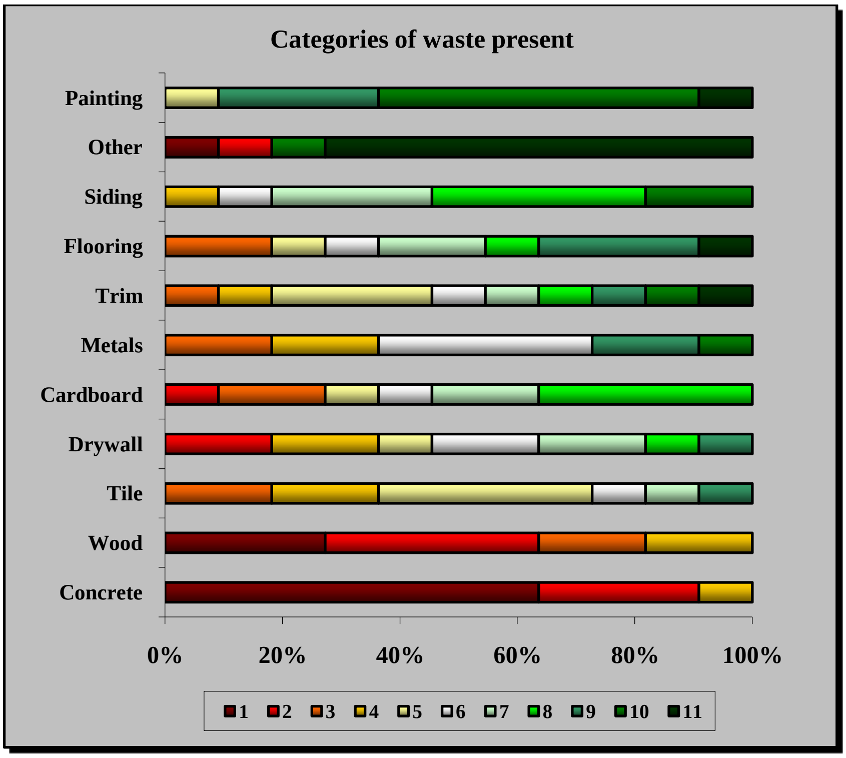

Figure 5.2: Categories of waste present.

The scoring was achieved by multiplying the rank by the number of respondents who indicated that rank and sum over these scores. The categories were then sorted from the lowest to highest score and then presented in Figure 5.2. The table with these rankings is attached in Annexure C for reference. The top 3 categories of waste present were concrete/masonry, wood and tile because they scored the lowest with respect to the ratings by the respondents. According to the rating procedure number 1 would indicate the most influential category of waste present.

5.4.2 Graphs for questionnaire 2

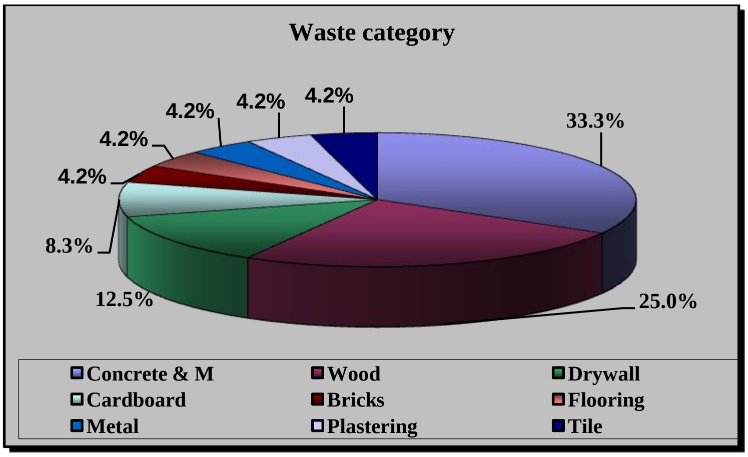

Figure 5.3: Waste categories.

The waste categories that were mostly represented by this survey were concrete and masonry (33.3%), wood (25.0%), drywall (12.5% and cardboard (8.3%).

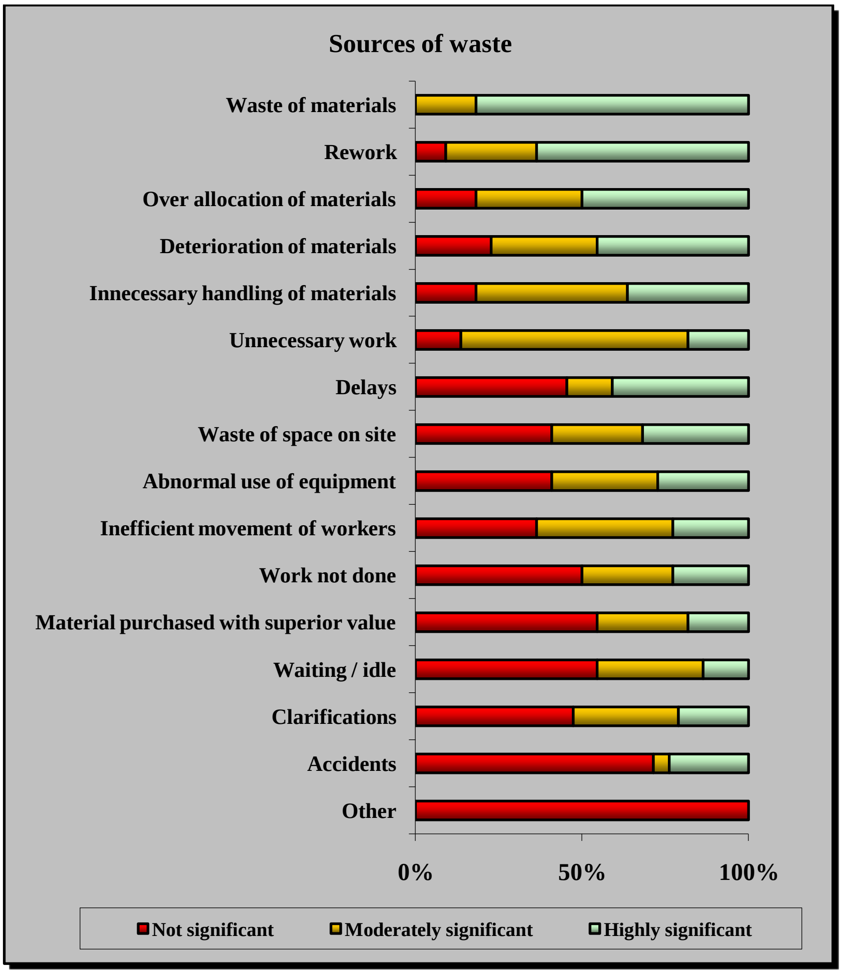

Figure 5.4: Sources of waste.

The following sources were the most critical of waste during construction:

- Waste of materials (75% highly significant).
- Rework (58.3% highly significant).
- Over-allocation of materials (45.8% highly significant).
- Deterioration of materials (41.7% highly significant).

It must be noted that the respondents indicated that most of the causes of these items of waste taking place were poor planning.

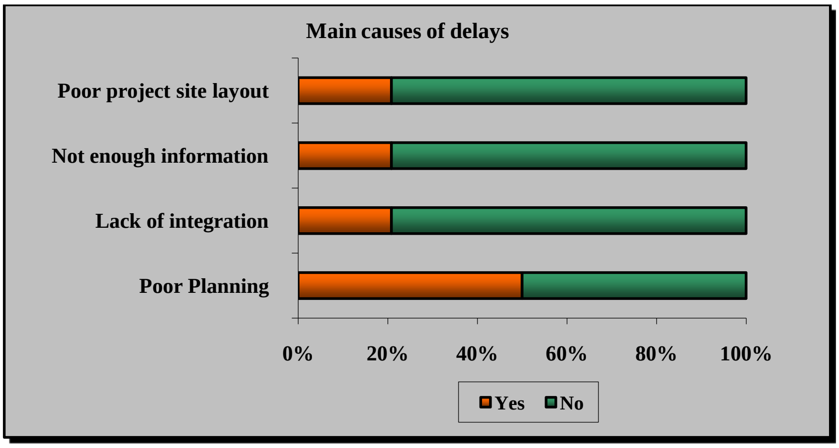

Figure 5.5: Main causes of delays.

In the case of delays the main cause of this waste was poor planning which fell into the management category.

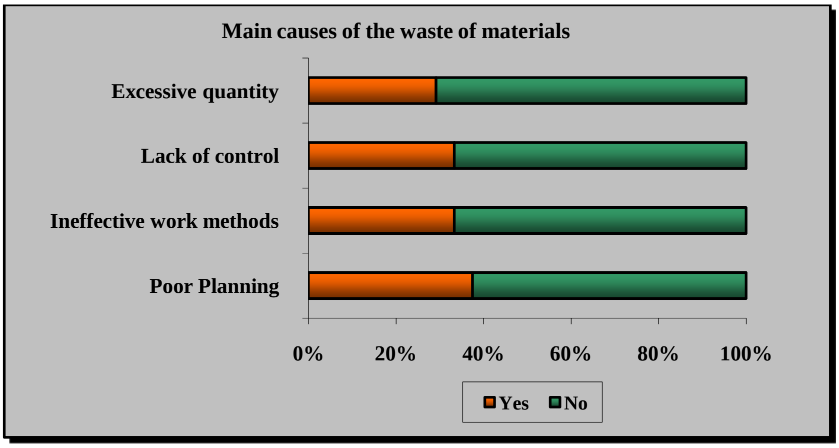

Figure 5.6: Main causes of the waste of material.

It seems that in about equal proportions 'poor planning', 'ineffective work methods', 'lack of control' and 'excessive quantity' were the main reasons given for wasting materials. The cause of this fell mainly into the resources category.

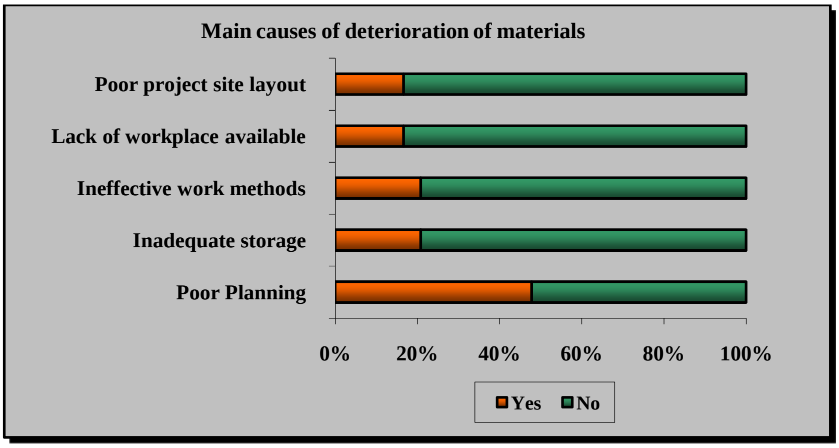

Figure 5.7: Main causes of deterioration of materials.

Deterioration of materials was mainly caused by poor planning and thus the main category of the cause was management.

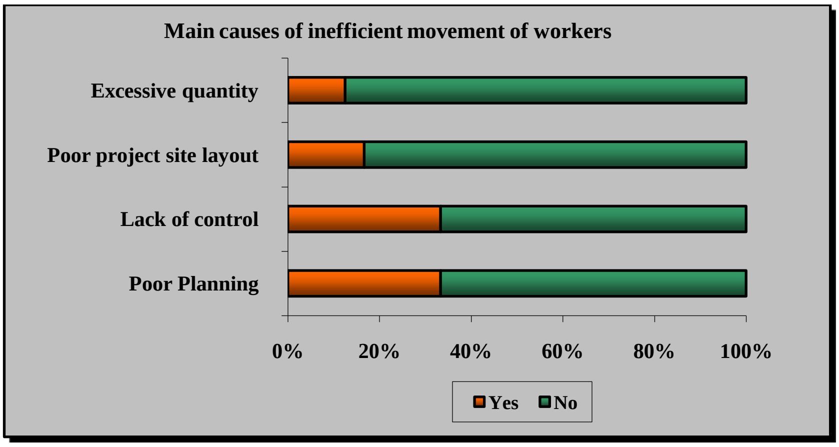

Figure 5.8: Main causes of inefficient movement of workers.

The main cause of inefficient movement of workers seemed to be poor planning and lack of control, which fell into the management category.

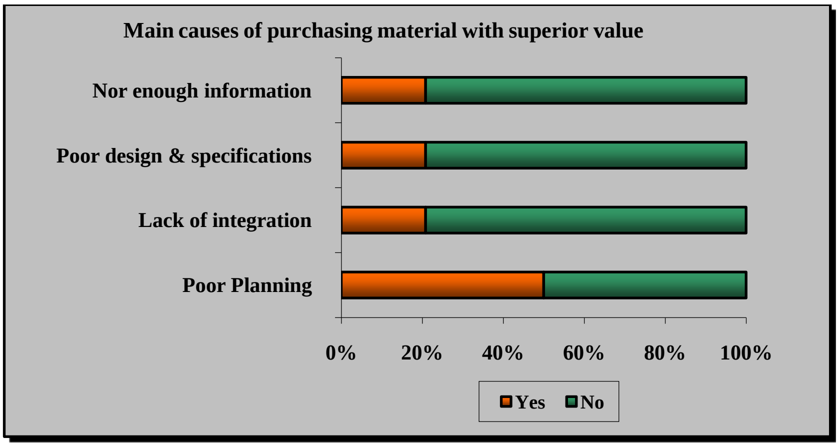

Figure 5.9: Main causes of purchasing material with superior value.

In the case of purchasing material with superior value it seem that the main cause of this waste was poor planning, but the main cause category was information systems.

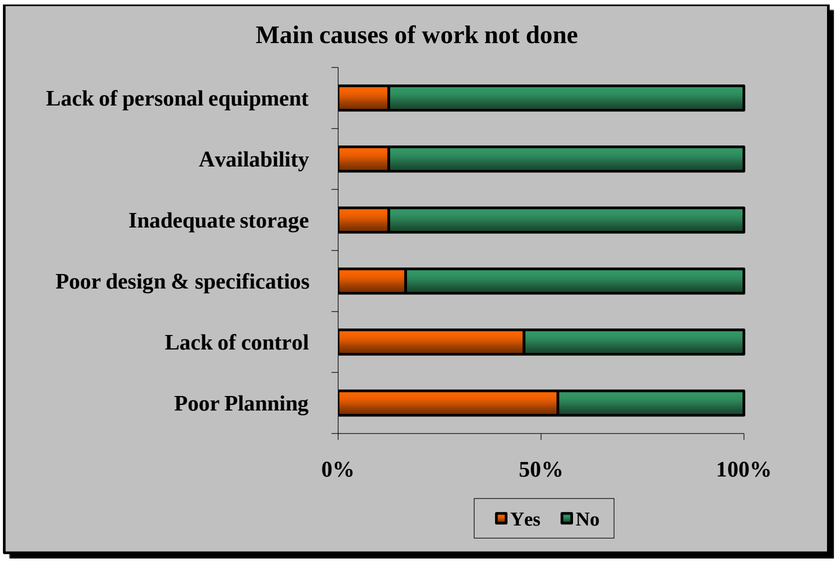

Figure 5.10: Main causes of work not done.

Poor planning and lack of control seemed to be the reason / cause for work not done and therefore management was the main cause of this waste.

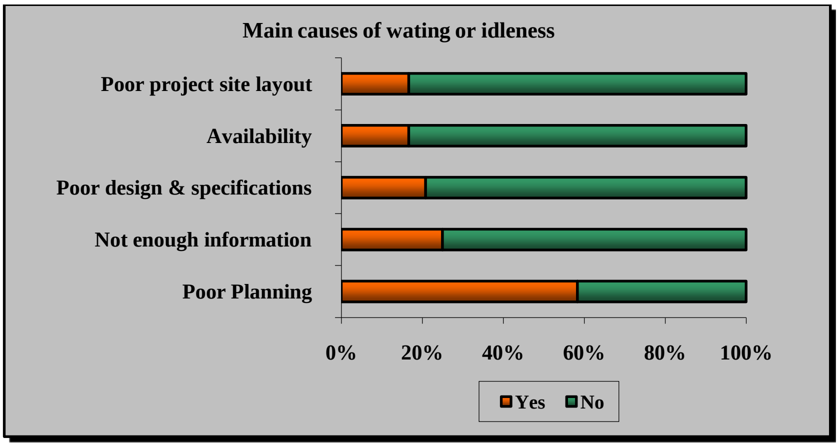

Figure 5.11: Main causes of waiting and idleness.

In the case of delays it seemed the main cause of this waste was poor planning which fell under the management category.

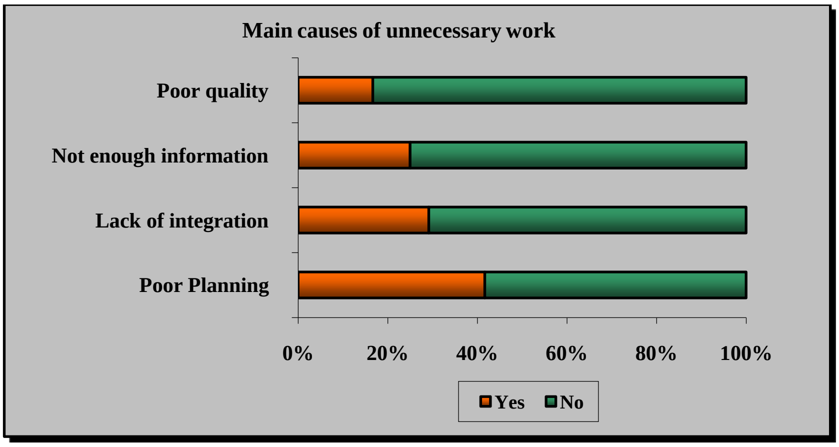

Figure 5.12: Main causes of unnecessary work.

In the case of delays it seemed the main cause of this waste was poor planning and the main cause category was information systems.

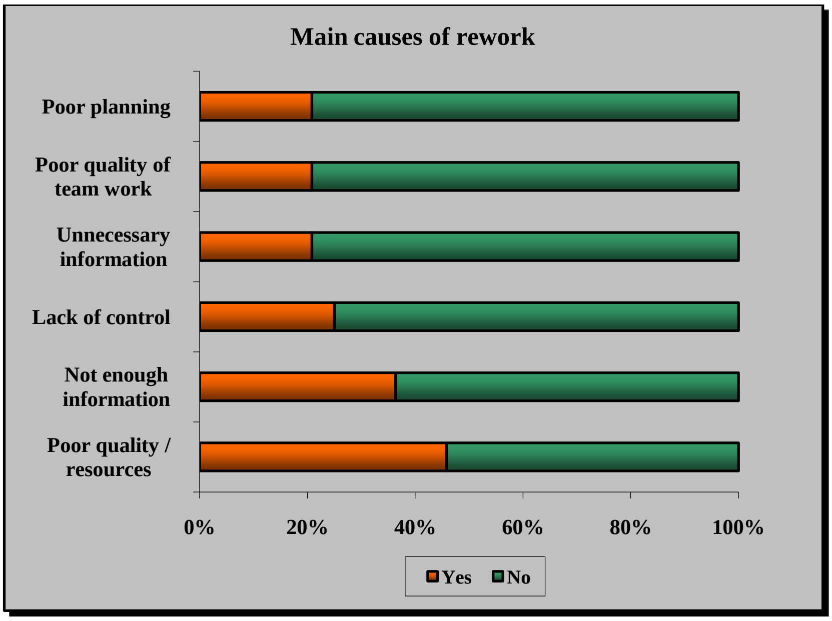

Figure 5.13: Main causes of rework.

Poor quality of resources and not enough information seemed to be the main cause of this waste and information systems were the main cause category.

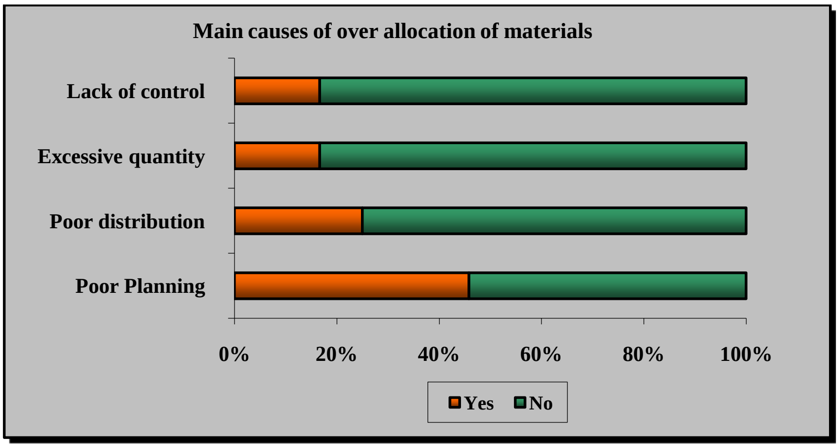

Figure 5.14: Main causes of over allocation of materials.

In the case of over-allocation of materials it seemed that the main cause of this waste was poor planning and the management category was its main cause.

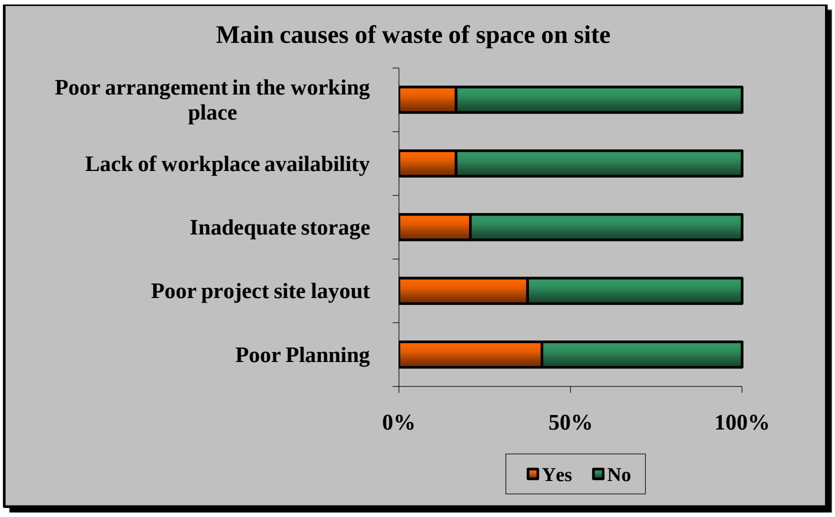

Figure 5.15: Main causes of waste of space on site.

The waste of space on site was mainly due to poor planning and poor project site layout. Management was the main cause category.

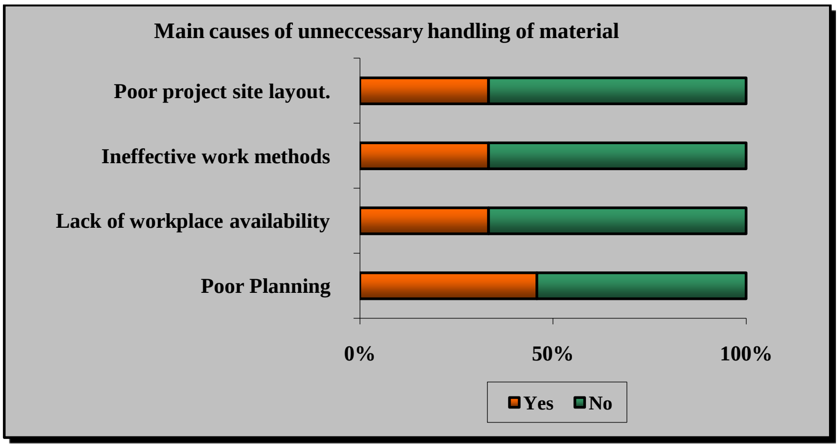

Figure 5.16: Main causes of unnecessary handling of material.

In the case of delays it seemed that the main cause of this waste was poor planning and production was the main cause category.

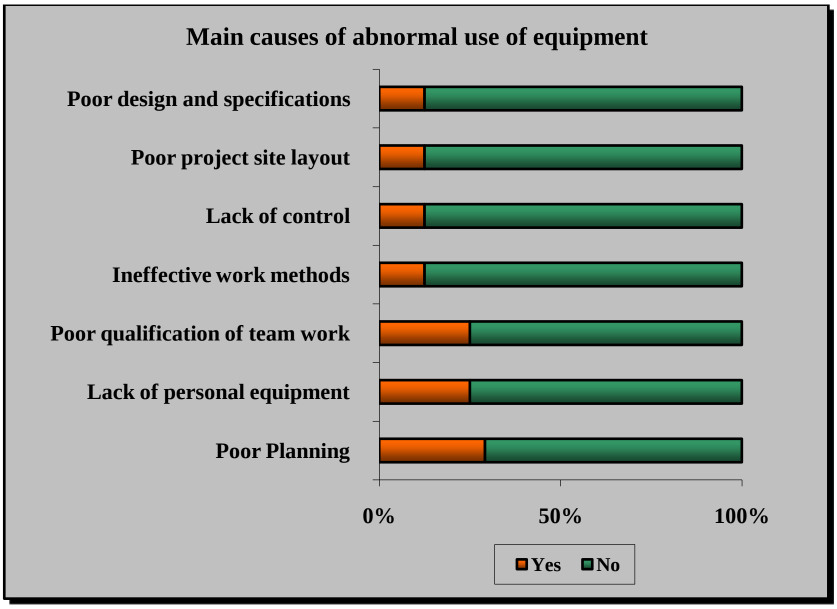

Figure 5.17: Main causes of abnormal use of equipment.

Although poor planning was the main cause of abnormal use of equipment, it seemed to be caused mainly by the production category.

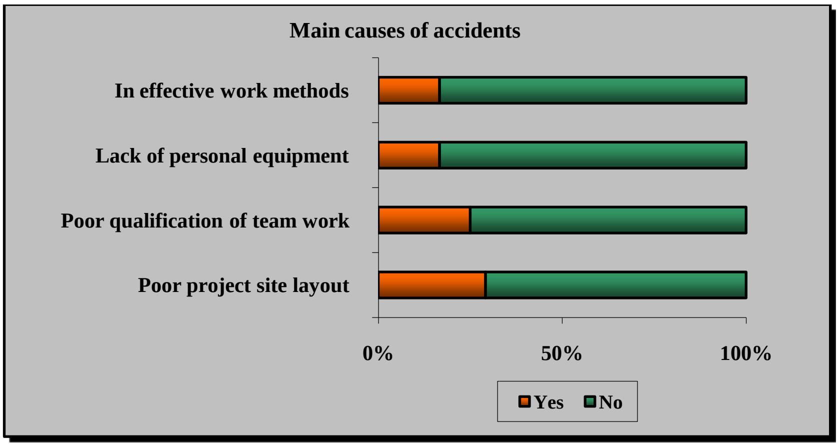

Figure 5.18: Main causes of accidents.

The main cause of accidents was poor project site layout and the main cause category was production.

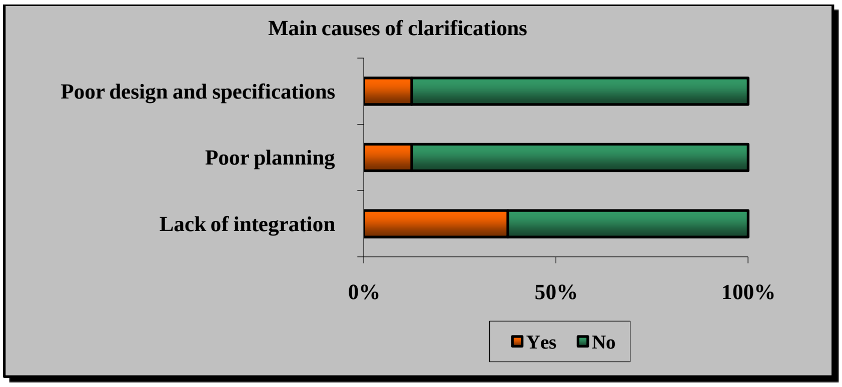

Figure 5.19: Main causes of clarifications.

In the case of clarifications it seemed the main cause of this waste was lack of integration between design and production and the main cause category was information systems.

5.4.3 Graphs for questionnaire 3

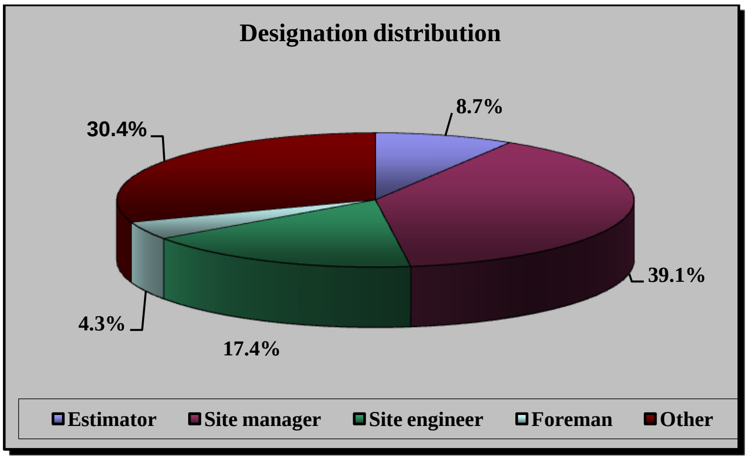

Figure 5.20: Designation distribution.

Nearly 40% of the respondents were site managers and 30.4% indicated other designations.

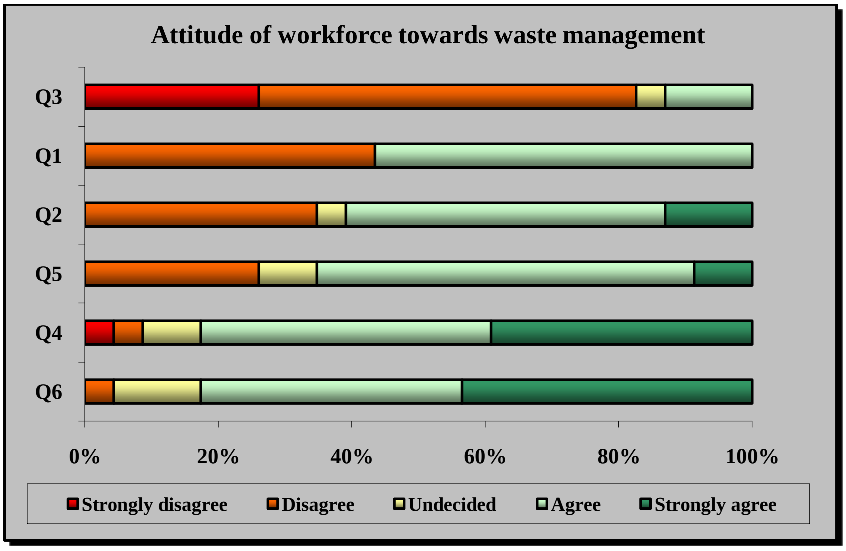

Figure 5.21: Attitude of workforce towards waste management.

Most of the respondents indicated agree to strongly agree with the following 2 statements:

- Waste management is worthwhile irrespective of cost gains (82.6% agree to strongly agree).
- Waste management is as important as other functions of construction management (82.6% agree to strongly agree). Most of the respondents disagreed to strongly disagreed with the statement 'Cost of waste does not have much effect on the project' (82.6% disagree to strongly disagree).

5.4.4 Graphs for questionnaire 4

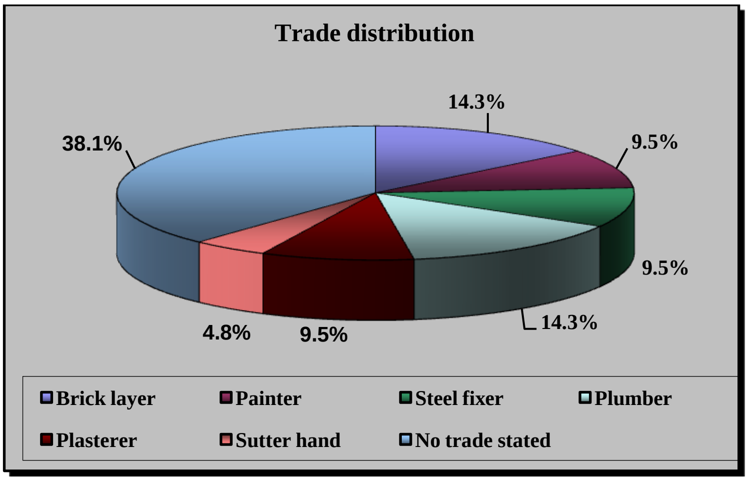

Figure 5.22: Trade distribution.

Nearly 40% of the respondents did not state their trade. The rest of the respondents were evenly distributed in the trades shown.

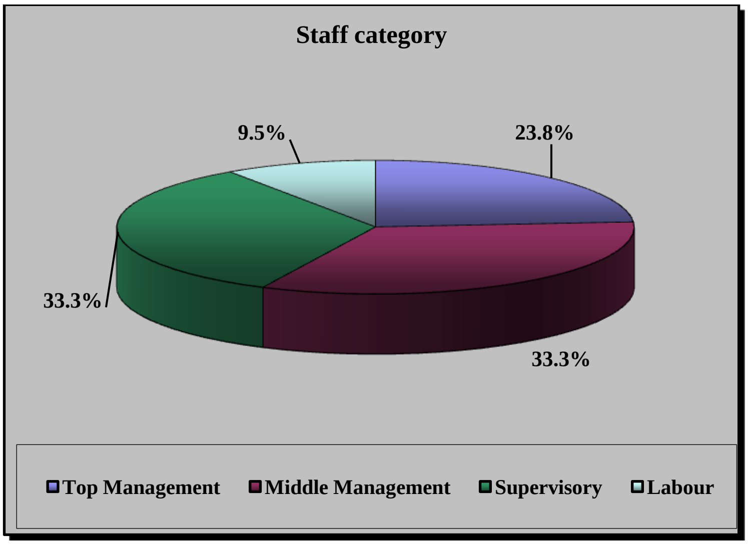

Figure 5.23: Staff category.

One third of the respondents were from middle management and one third of the respondents were supervisory. Only about 10% of the respondents were from the labour category. Thus the naming of Questionnaire 4 'attitude of labour-only sub-contractors towards waste management' may be misleading as mostly management and people in a supervisory capacity responded to this questionnaire.

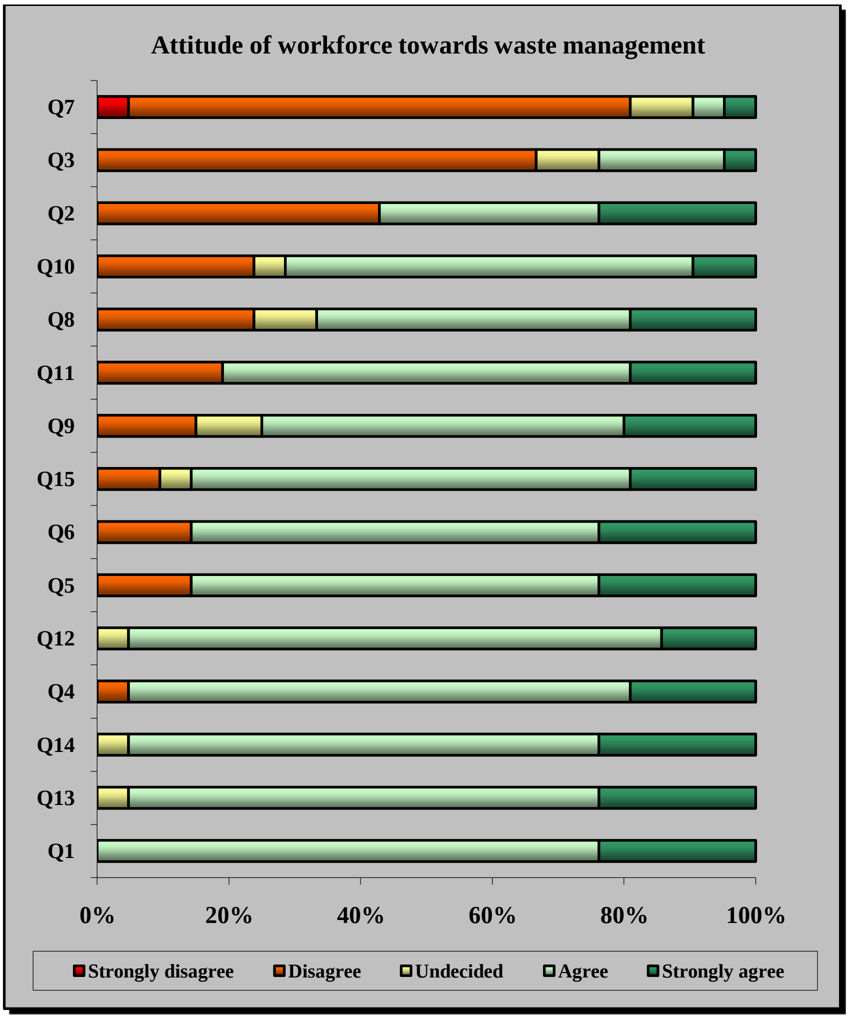

Figure 5.24: Attitude of workforce towards waste management.

Most of the respondents agreed to strongly agreed to the following statements:

- The industry should do more to reduce waste (100.0% agree to strongly agree).
- Education of sub-contractors is the preferred method of reducing site wastage (95.2% agree to strongly agree).
- A financial incentive with financially benefits for sub-contractor will reduce waste (95.2% agree to strongly agree).
- It is the main contractors who are fully responsible to segregate waste (95.2% agree to strongly agree).
- The main contractor should build in allowable waste percentages to sub-contractors' packages (95.2% agree to strongly agree).
- Sub-contractors should segregate waste (85.7% agree to strongly agree).
- Waste minimization will be a major issue for sub-contractors in future (85.7% agree to strongly agree).

- The main contractor should employ operatives to sort and segregate waste on site (85.7% agree to strongly agree).

Most of the respondents disagree to strongly disagree with the following statements:

- The government should increase landfill tax to force waste reduction on site (81.0% disagree to strongly disagree).
- A waste level of 10% is an acceptable level for the construction process (66.7% disagree to strongly disagree).

5.5 INFERENTIAL STATISTICS

Due to the fact that this study only required descriptive statistics, a comparison was made between the proportion of respondents who agreed with a statement and the proportion who did not agree with a statement.

The hypothesis being tested was then as follows:

- H_0 = There is no difference between the proportion who agreed to the statements and the proportion who did not agree with the statements.
- H_1 = There is a difference between the proportion who agreed to the statements and the proportion who did not agree with the statements.

The Pearson chi-square test was used to determine whether the proportions were equal and is shown in Annexure E. The tests which showed statistically significant differences between the proportions or statistically significant associations between variables will be discussed in this paragraph keeping the statements regarding the attitude statements in questionnaires three and four in mind.

When doing these comparisons using the existing scale, the chi-square test becomes invalid because of expected frequencies of less than 5 in some of the cells. To overcome the problem, categories that meant more or less the same were aggregated. For instance the categories 'strongly agree' and 'agree' used in the statements where attitude is tested were grouped together to form the category 'agree to strongly agree'. Thus, there will only be three categories:

- Agree to strongly agree.
- Undecided.
- Disagree to strongly disagree.

'Equal proportions' will mean indecision with regard to the statement, and if there are statistically significant differences it will mean one of the groups is larger than the other.

Since the expected counts in some of the table cells were still small, PROC FREQ gave a warning that the asymptotic chi-square tests might not be appropriate. In this case, the exact tests were appropriate and showed in Table 5.12.

Table 5.12: Statistically significant Chi-square test for equal proportions.

Question / Statement	Sample Size	Chi-Square	DF	P-Value
2. Company has a waste management strategy.	23	11.0435	2	0.0031**
3. Cost of waste does not have much effect on the project.	23	25.3913	2	<0.0001***
4. Waste management is as important as other functions of construction management.	23	25.1304	2	<0.0001***
5. Attention of waste management in the actual practice is not sufficient.	23	11.5652	2	0.0026**
6. Waste management is worthwhile irrespective of the cost gains.	23	25.3913	2	<0.0001***

* *Statistically significant at level 0.05*

** *Statistically significant at level 0.01*

*** *Statistically significant at level 0.001*

For statement 1 "company performs well in the area of construction waste management" all the respondents either 'agreed' or 'strongly agreed'. For the following statements a statistically significant number of respondents 'Agreed to strongly agreed compared to those who were ‘Undecided’ or ‘Disagreed to strongly disagreed:

- Company has a waste management strategy.
- Waste management is as important as other functions of construction management.
- Attention to waste management in actual practice is not sufficient.
- Waste management is worthwhile irrespective of the cost gains.

Statistically significantly more respondents ‘Disagreed to strongly disagreed’ with the statement ‘company has a waste management strategy’ than those who ‘Agreed to strongly agreed’ or were ‘Undecided’.

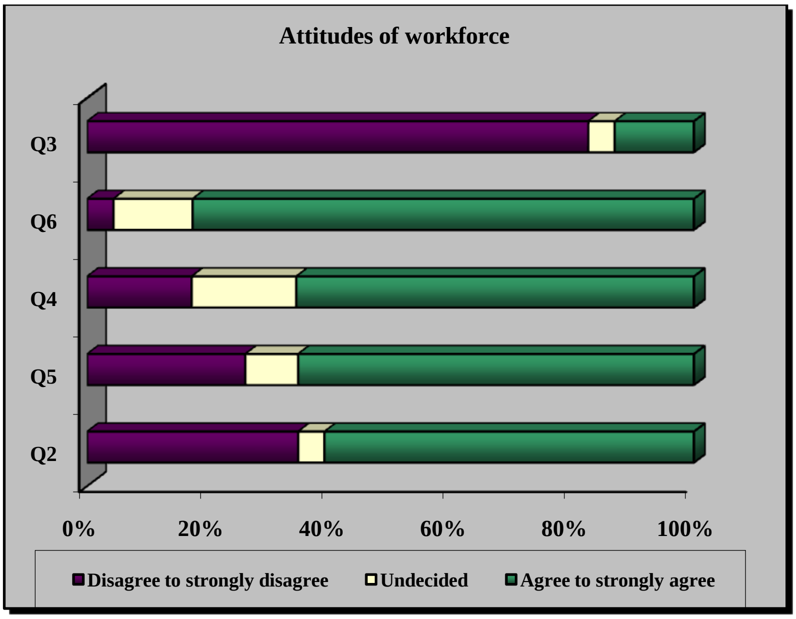

Figure 5.25: Attitudes of workforce.

Table 5.13: Statistically significant Chi-square test for equal proportions

Question / Statement	Sample Size	Chi-Square	DF	P-Value
3. A waste level of 10% is an acceptable level for the construction process.	21	11.1429	2	0.0034**
4. It is the main contractors who are fully responsible to segregate waste on site.	21	17.1905	1	0.0026**
5. Sub-contractors should segregate waste.	21	10.7143	1	0.0015**

Question / Statement	Sample Size	Chi-Square	DF	P-Value
6. Waste minimisation will be a major issue for sub-contractors in future.	21	10.7143	1	0.0015**
7. The Government should increase landfill tax to force waste reduction on site.	21	21.4286	2	<0.0001***
8. Sub-contractors should price for costs involved in waste reduction.	21	11.1429	2	0.0034**
9. Sub-contractors should be penalised for waste produced on site.	20	15.7000	2	0.0004***
10. Poorly offloaded and incorrect stored materials are the major cause of wastage on site.	21	14.8571	2	0.0006***
11. Lack of care by sub-contractors is the major cause of waste on site.	21	8.0476	1	0.0072**
12. Main contractor should build in allowable waste percentages to sub-contractors packages.	21	17.1905	1	<0.0001***
13. Education of sub-contractors is the preferred method of reducing site wastage.	21	17.1905	1	<0.0001***
14. A financial incentive with financially benefits for sub-contractors will reduce waste.	21	17.1905	1	<0.0001***
15. The main contractor should employ operatives to sort and segregate waste on site.	21	26.000	2	<0.0001***

** Statistically significant at level 0.05*

*** Statistically significant at level 0.01*

**** Statistically significant at level 0.001*

For the statement ‘the industry should do more to reduce waste’ all the respondents either ‘Agreed’ or ‘Strongly agreed’ and for the statement ‘site management is the main factor affecting the levels of waste produced on site’ the null hypothesis could not be rejected as p-value=0.6636 which meant the proportion who agreed to strongly agreed did not differ from the proportion who disagreed to strongly disagreed.

As the P-Values suggested in Table 5.13, the null hypotheses will be rejected and there are statistically significant differences between the groups. As for where these differences lie, the following graph shows that statistically significant more respondents 'disagreed to strongly disagreed' with the following statements:

- The government should increase landfill tax to force waste reduction on site.
- A waste level of 10% is an acceptable level for the construction process.

There were statistically significantly more respondents who 'Agreed to strongly agreed' than respondents that were 'Undecided' with the following statements:

- Main contractor should build in allowable waste percentages to sub-contractor's packages.
- Education of sub-contractors is the preferred method of reducing site wastage.
- A financial incentive with financial benefits for sub-contractors will reduce waste

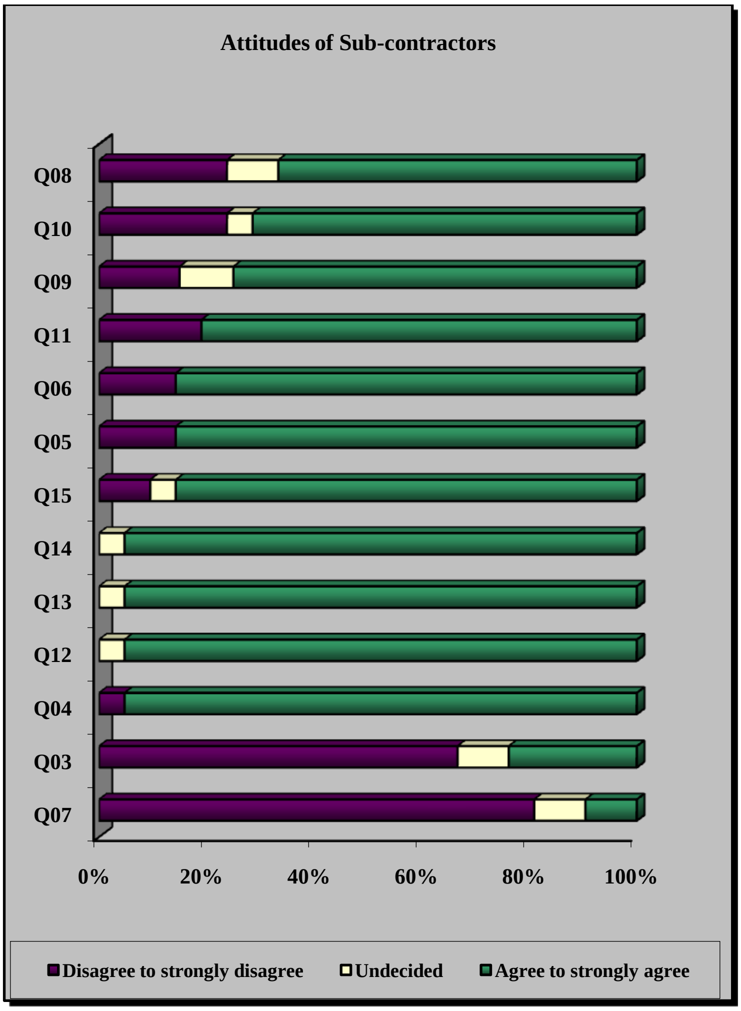

Figure 5.26: Attitude of sub-contractors.

There were statistically significantly more respondents who ‘agreed to strongly agreed’ than respondents that ‘disagreed to strongly disagreed’ than were ‘Undecided’ in some cases with the following statements:

- The main contractor should employ operatives to sort and segregate waste on site.
- Sub-contractors should segregate waste.
- Waste minimisation will be a major issue for sub-contractors in future.
- Lack of care by sub-contractors is the major cause of waste on site.
- Sub-contractors should be penalised for waste produced on site.
- Poorly off-loaded and incorrectly stored materials are the major cause of wastage on site.
- Sub-contractors should price for costs involved in waste reduction.

- It is the main contractors who are fully responsible to segregate waste on site.

5.6 DISCUSSIONS AND CONCLUSIONS

The object of this study was to determine the following:

- The three top categories responsible for construction waste.
- The critical sources and causes of construction waste.
- To evaluate the attitudes and perceptions of the construction workforces regarding construction waste.
- To evaluate attitudes and perceptions of the sub-contractors regarding construction waste.

The three top categories responsible for construction waste were:

- concrete and masonry,
- wood,
- drywall.

The critical sources of construction waste were:

- waste of materials,
- rework,
- over-allocation of materials,
- deterioration of materials.

The main causes for all these sources of waste were:

- poor planning,
- lack of control,
- poor design and specifications,
- poor project site layout,
- lack of integration between design and product,
- ineffective work methods.

With respect to the attitude of the workforce, the following analogies can be drawn from this research:

- Waste management is worthwhile, irrespective of costs involved.
- Waste management is as important as other functions of construction management.
- Cost of waste does have an effect on the project.

With respect to the attitude of the sub-contractors, the following analogies can be drawn from this research:

- The industry should do more to reduce waste.
- Education of sub-contractors is the preferred method of reducing site wastage.
- A financial incentive with financial benefits for sub-contractor will reduce waste.
- It is the main contractors who are fully responsible to segregate waste.
- The main contractor should build-in allowable waste percentages to sub-contractors' packages.
- Sub-contractors should segregate waste.
- Waste minimisation will be a major issue for sub-contractors in the future.
- The main contractor should employ operatives to sort and segregate waste on site.
- The government should not increase landfill tax to force waste reduction on site.
- A waste level of 10% is not an acceptable level for the construction process.

6 CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This final chapter presents the summary, recommendations and conclusions regarding the quality factors contributing to the generation of construction waste in the construction industry. This chapter reviews the key aspects of this research, namely the stated research problem, the research question and the sub-research questions, to demonstrate that the research objectives have been met.

6.2 THE RESEARCH THUS FAR

The research thus far has proven that the construction industry remains an important economic sector that has a vital role to play in ensuring economic development in the formal and informal sectors of the South African economy. It is commonly acknowledged that a very high level of waste exists in construction. Construction waste reduction has become an important issue to improve the performance of the construction industry in terms of economy, quality and sustainability. Because material waste in the construction industry is seldom measured and monitored, the management of waste is seen as a detailed and expensive process. The following chapters position this chapter in terms of the overall research thus far.

Chapter 1: In this chapter, the research problem, research questions, sub-questions and objectives of the research were discussed.

Chapter 2: In this chapter, the background to the research problem was discussed. This provided a holistic perspective of the construction industry by explaining the background to the research environment.

Chapter 3: In this chapter, a literature review was conducted under the following headings:

- Background to the construction industry.
- Commonly used terms.
- Definition of construction waste.

- Origin of construction waste.
- High waste rates of five principal materials.
- Causes of construction waste.
- Classification of waste.
- Measuring and ranking of construction waste.

Secondly, the literature review defined the following:

- The concept of the differences between international and South African legislation.
- The waste management hierarchy.
- The various types of waste.
- Waste identification during construction.
- Phases of a building's life through the life cycle of materials in the construction industry.
- Economic benefits and the benefits of contract specifications.
- Less important but interesting markets.
- The South African construction and demolition waste experience.

The third and final section of the literature review addressed the following areas:

- Quality relationships through partnering.
- Attitudes and perceptions of the construction workforce towards waste reduction.
- The role sub-contractors (labour only) play in construction waste.
- Construction waste avoidance and management.

Chapter 4: In this chapter, the research design and methodology were elaborated upon in detail.

Chapter 5: In this chapter, data gleaned from the surveys conducted in Chapter 4 were analysed and interpreted.

Chapter 6: In this concluding chapter, final analogies will be drawn and recommendations made to mitigate the research problem.

6.3 ANALOGIES DRAWN FROM THE DATA ANALYSIS

As for the results obtained through this survey, the following four objectives were set for this study:

- To determine the three top categories responsible for construction waste.
- To determine the critical sources and causes of construction waste.
- To evaluate the attitudes and perceptions of a construction workforce regarding construction waste.
- To evaluate attitudes and perceptions of sub-contractors regarding construction waste.

To answer these four research questions, the three top categories responsible for construction waste were given as:

- concrete and masonry,
- wood,
- drywall.

The critical sources of construction waste were:

- waste of materials,
- rework,
- over-allocation of materials,
- deterioration of materials.

The main causes for all these sources of waste were:

- poor planning,
- lack of control,
- poor design and specifications,
- poor project site layout,
- lack of integration between design and product,
- ineffective work methods.

With respect to the attitude of the workforce, the following analogies can be drawn from this research:

- Waste management is worthwhile, irrespective of costs incurred.

- Waste management is as important as other functions of construction management.
- Cost of waste does have an effect on the project.

With respect to the attitude of the sub-contractors, the following analogies can be drawn from this research:

- The industry should do more to reduce waste.
- Education of sub-contractors is the preferred method of reducing site wastage.
- A financial incentive with financial benefits for sub-contractors will reduce waste.
- It is the main contractors who are fully responsible to segregate waste.
- The main contractor should build in allowable waste percentages to sub-contractors' packages.
- Sub-contractors should segregate waste.
- Waste minimisation will be a major issue for sub-contractors in the future.
- The main contractor should employ operatives to sort and segregate waste on site.
- The government should not increase landfill tax to force waste reduction on site.
- A waste level of 10% is not an acceptable level for the construction process.

6.4 ANALOGIES DRAWN FROM THE LITERATURE REVIEW

According to CSIR (2004:3), the South African construction industry is capable of delivering the most innovative and complex projects at times. It is also acknowledged that the industry is underachieving in, amongst others, quality and efficiency, and the industry needs to radically improve the practice through which it delivers its projects. Chapter 3 provided an assessment of construction waste in building construction in the Western Cape. Managing building material waste can achieve higher construction productivity, save time and assist sustainability.

Many countries are experiencing an increase in construction waste, which creates growing tension for authorities, especially as the search for new landfill sites becomes an increasing priority (De Silva & Vithana 2008:188-198). Ekanayaka and Ofori (2000:1-6), explain that construction waste can be divided into three principal categories, namely material, labour and machinery waste. The origin of waste was depicted as coming from all stages of the construction process and is identified throughout the production phase (Keys *et al*, 1994:4). Various stages of the construction process create physical waste. Owing to complex and difficult construction projects currently undertaken in South Africa, the constraints of time, resources and performance must be managed effectively. According to Ekanayaka and Ofori (2000:2), economic development has resulted in an increase in volume of construction and demolition activities. This results in serious problems both locally and globally.

Construction waste at project level directly affects the contractor's profit. Waste classification and quantities may vary in type, size, method, material, and location of projects (CSIR 2008:**Online**). Waste weakens the efficiency, effectiveness, value and profitability of construction activities, calling for the need to identify the causes of waste and to control them within reasonable limits (Urio & Brent 2006:20). Waste in construction can culminate as a result of different causes and situations, and construction waste falls into different categories. Castelo Branco (2007:13), divides waste according to the type of resources consumed, according to its nature, and according to its control. According to Urio and Brent (2006:21), the ranking value of the causes of construction waste by project managers, contractors, site representatives and waste management supervisors is explained.

International and South African waste legislation reveals that the aim is to reduce waste volumes by re-using, recovering and recycling waste. Oelofse and Godfrey (2008:244), explains that in South Africa, the re-use of waste and its recovery is subjected to waste management regulations and controls that should be implemented throughout the life cycle of waste. The waste management hierarchy illustrates that the most important steps are reducing, re-using, recycling composting, burning, and as a last resort, land filling components (CSN 2008:**Online**). Waste types have been diagnosed to pinpoint the most frequent onsite waste categories affecting the final costs of the project. Waste identification involves many activities that have a high potential to generate waste

(Garas *et al.*, 2001:1-8). Mocozoma (2002:1), has discussed the life cycle of materials in construction and the inefficiencies related to building materials that extend throughout the phases of a building's life. Looking at the life cycle of materials in building construction, the inefficiencies that contribute to the construction industry's poor performance have been observed. The economic implications of the expenses related to waste disposal have been discussed (CSN 2008:**Online**). Builders, architects and engineers face increasing client demand for measures to reduce the bottom-line cost of projects; reducing waste will not only save money, but will enhance a company's reputation.

According to CSN (2008:**Online**), recycling and waste reduction specifications communicate to bidders 'what' the project involves and about the traditional waste management practices. The South African construction and demolition waste management plan has the potential to provide alternative resources for construction and to help improve the industry's resilience. Sub-contractors and suppliers are playing an increasingly important role in construction. This results in the main contractors being involved in managing their sub-contractors rather than employing direct labour (Matthews *et al*., 2000:493-510). Recent studies have indicated that the construction industry is concentrating on partnering, quality and lean production. According to Kulatunga *et al*. (2006:57-72), research has shown that the attitude and perception of the construction workforce towards waste minimisation are negative. The attitude towards waste reduction has become one of the reasons behind the difficulties of the management of waste in the construction industry. The attitude to waste also differs from one organisation to the next, based on their culture and waste management policies. Literature shows that the waste of materials by sub-contractors (labour-only) is higher than that of direct labour (Jayawardane 1994:41-5). Construction site waste can be avoided by prioritising waste management on site. This will result in efficiency and reduced cost.

According to CSIR (2004: **Online**), waste can only be reduced once all employees and sub-contractors are aware of the extent of the problem, and waste management is fully understood in the company. All employees must be trained in the waste management plan.

6.5 THE RESEARCH PROBLEM REVISITED

The research problem formulated in Chapter 1, Paragraph 1.2 reads as follows: "The generation of construction waste leads to a decrease in profitability and an increase in costs, culminating in low productivity of construction companies, and also impacts on the environment". The research conducted in terms of this dissertation has identified the relevant aspects that need to be addressed in order to mitigate the research problem, culminating in the literature review and the data analysis.

6.6 THE RESEARCH QUESTION REVISITED

The research question, which formed the crux of the research in this dissertation, formulated in Chapter 1, Paragraph 1.3.1, reads as follows: "What quality factors contributing to construction waste must be addressed to increase sustainability, decrease costs, and minimise environmental impact?" The literature review that was conducted in Chapter 3 together with the data analysis in Chapter 5 identified the relevant aspects that need to be addressed to provide an answer to the research question.

6.7 INVESTIGATIVE QUESTIONS REVISITED

In support of the research question, the following investigative questions were researched:

6.7.1 What are the top three waste categories in the construction industry?

Construction waste can be divided into three principal categories namely material, labour and machinery waste (Ekanayaka & Ofori 2000:1-6). Preliminary studies have shown that waste rates pertaining to concrete, mortar, bricks, cement and sand were found to be high. According to the Advanced Construction and Demolition Waste Management of Florida Builders (CSN) (2008:**Online**), waste classification and quantities may vary according to the type, size, method, materials and location of projects. The quantities and types of waste generated on site will be influenced by the exploration and development of waste management choices.

According to the data analysis conducted, the three top categories responsible for construction waste were given as:

- concrete and masonry (33.3 %),
- wood (25.0 %), and
- drywall (12.5%)

6.7.2 What are the possible sources and causes of waste generation for these top three selected categories of waste?

Gavilan and Bernold (1994:536-55), classify the causes of waste into six categories, namely:

- Design.
- Procurement.
- Material handling.
- Operation.
- Residual-related.
- Other.

Waste weakens the efficiency, effectiveness, value and profitability of construction activities, calling for the need to identify the causes of waste and to control them within reasonable limits. According to Garas *et al*. (2001:5), the dominant causes of waste generation in the Egyptian construction industry, are:

- Late information.
- Incomplete design.
- Inadequate information.
- Poor control.
- Unnecessary people moves.
- Untrained labour.
- Work not done.
- Poor technology of equipment.
- Changes to design.

- Damages during transport.

According to the data analysis conducted, the following sources of waste are the most critical during construction:

- Waste of materials (75% highly significant).
- Rework (58.3% highly significant).
- Over-allocation of materials (45.8% highly significant).
- Deterioration of materials (41.7% highly significant).

It was determined than ‘poor planning’ is the major cause of most of the waste types in the questionnaire. It seems that in about equal proportions ‘poor planning’, ‘ineffective work methods’, ‘lack of control’ and ‘excessive quantity’ are major reasons for wasting materials. The cause of this falls mainly under the resources category. Secondly, ‘poor quality of resources’ and ‘not enough information’ are likely to be the main cause of this waste and ‘information systems’ are also in the main cause category. In the case of over-allocation of materials, it seems that the main cause of this waste is ‘poor planning’ and the ‘management’ categories are the main cause of it. Deterioration of materials is mainly caused by poor planning and thus the main category of the cause is ‘management’.

The main causes for all these sources of waste are:

- poor planning,
- lack of control,
- poor design and specifications,
- poor project site layout,
- lack of integration between design and product,
- ineffective work methods.

6.7.3 What is the attitude and perception of the construction workforce regarding construction waste?

It is argued that the causes of construction waste are directly or indirectly affected by the attributes and perceptions of the personnel involved in the construction industry. Kulatunga *et al*. (2006:57-72), identify worker involvement during the pre-contract stage as a major influence on the prevention of waste. Research has also shown that the attitudes of construction labourers towards waste minimisation activities are negative. To measure attitude, people must be assessed during work, either because the project is intended to change people's attitude or because people needs to be more appreciation. Hussey and Skoyles (1974:91-4), believe "a change in this attitude rather than a change in techniques is likely to have most effect overall". Teo and Loosemore (2001:741-9), find that attitudes towards waste reduction have become one of the reasons behind the difficulties of the management of waste in the construction industry. The attitudes on waste also differ from one organisation to the next, based on their culture and waste management policies.

According to the data analysis conducted, most of the respondents 'agree to strongly agree' to the following two statements:

- Waste management is worthwhile, irrespective of cost gains (82.6% agree to strongly agree).
- Waste management is as important as other functions of construction management (82.6% agree to strongly agree).

Most of the respondents 'disagree to strongly disagree' with the statement; 'cost of waste does not have much effect on the project' (82.6% disagree to strongly disagree).

6.7.4 What is the attitude and perception of subcontractors (labour only) regarding construction waste?

Jayawardane (1994:41-5), found that when sub-contractors are involved in projects for shorter periods, the waste of materials are higher than that of direct labour. This research found that sub-contractors are reluctant to accept some of the costs for waste reduction. Johnston and Mincks (1995:31-40), indicate that waste reduction should be considered as a potential profit, with the financial benefits at all levels on site. Sub-contractors accepted that more should be done to reduce waste and that it has become more of an issue. Their attitude was that the main contractor has the responsibility for waste management. Saunders and Wynn (2004:148-155), found the main causes of waste were due to poor off-loading and storage of materials although poor design was also accepted as a major cause. Poor workmanship was least likely to be the cause of wastage. According to Saunders and Wynn (2004:148-155), sub-contractors contribute to delays in site operations, are responsible for untidy site conditions and lower overall productivity. These problems not only control profit of the sub-contractors, but also disturb the progress of the main project.

According to the data analysis conducted, most of the respondents 'agree to strongly agree' to the following statements:

- The industry should do more to reduce waste (100.0% agree to strongly agree).
- Education of sub-contractors is the preferred method of reducing site wastage (95.2% agree to strongly agree).
- A financial incentive with financial benefits for sub-contractor will reduce waste (95.2% agree to strongly agree).
- It is the main contractors who are fully responsible to segregate waste (95.2% agree to strongly agree).
- The main contractor should build in allowable waste percentages to sub-contractors' packages (95.2% agree to strongly agree).
- Sub-contractors should segregate waste (85.7% agree to strongly agree).
- Waste minimisation will be a major issue for sub-contractors in the future (85.7% agree to strongly agree).
- The main contractor should employ operatives to sort and segregate waste on site (85.7% agree to strongly agree).

Most of the respondents 'disagree to strongly disagree' with the following statements:

- The government should increase landfill tax to force waste reduction on site (81.0% disagree to strongly disagree).
- A waste level of 10% is an acceptable level for the construction process (66.7% disagree to strongly disagree).

With respect to the attitude of the sub-contractors, the following analogies can be drawn from this research:

- The industry should do more to reduce waste.
- Education of sub-contractors is the preferred method of reducing site wastage.
- A financial incentive with financial benefits for sub-contractors will reduce waste.
- It is the main contractors who are fully responsible to segregate waste.
- The main contractor should build in allowable waste percentages to sub-contractors' packages.
- Sub-contractors should segregate waste.
- Waste minimisation will be a major issue for sub-contractors in the future.
- The main contractor should employ operatives to sort and segregate waste on site.
- The government should not increase landfill tax to force waste reduction on site.
- A waste level of 10% is not an acceptable level for the construction process.

6.8 KEY RESEARCH OBJECTIVES REVISITED

The key research objectives which were formulated in Chapter 1, Paragraph 1.3.3 read as follows:

- To identify the three top categories responsible for construction waste.
- To identify the critical sources and causes of construction waste.
- To evaluate attitudes and perceptions of the construction workforce regarding construction waste.

- To evaluate attitudes and perceptions of the sub-contractors (labour only) regarding construction waste.

The key objectives were reviewed and were all addressed through the investigative questions.

6.9 RECOMMENDATIONS FOR FUTURE STUDIES

6.9.1 JIT productivity and ISO 9001 for construction industry development

According to Sui Pheng (1998:1-11), achieving high productivity and quality standards is a challenge for construction industry development in South Africa. Construction companies have already established quality management systems (QMS) within their organisations to comply with the ISO 9001 requirements. Construction companies are adopting the Just-In-Time (JIT) philosophy in operations to achieve high productivity. There are many similarities between ISO 9001 requirements and JIT principles. By expanding the ISO 9001 template, JIT principles can be effective in construction organisations without extra resources.

Manpower, quality and productivity can be managed with the JIT philosophy by providing JIT techniques, while ISO 9000 provides a system for JIT to operate on. The implementation of JIT depends on the contractor's 'flexibility', 'users stability', 'total management', 'employee commitment' and 'teamwork'. The seven principles of JIT used to overcome the problem of waste elimination are:

- **Elimination of waste:** Waste can be classified as waste from over-production, waste from delays, waste from transportation, waste from unnecessary processing, waste from excess inventory, waste from unnecessary motion and waste from defects.
- **The Kanban or Pull System:** The 'pull system' allows organisations to produce on demand whereas the 'push system' allows the organisations demand or maintain the stock level. Figure 6.1 graphically depicts the JIT model linked to the ISO 9001 systems model.

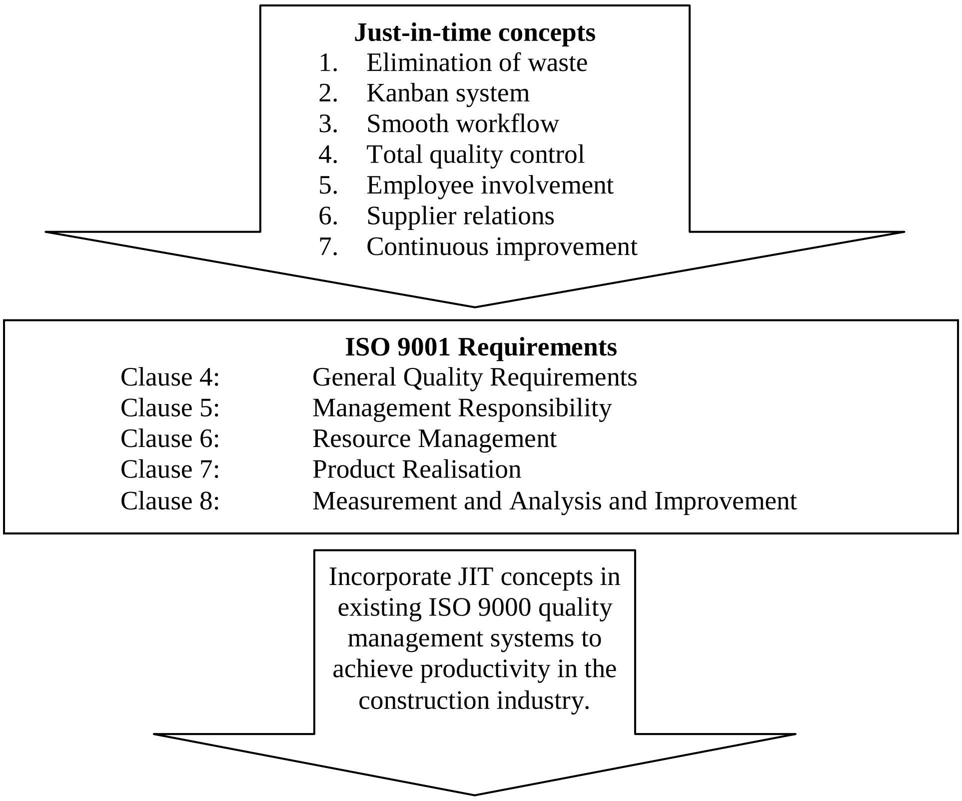

Figure 6.1: Integrating JIT and ISO 9001 (**Source:** Sui Peng:1998:**Online**)

- **Uninterrupted workflow:** Rationalisation and simplification of the production process is necessary.
- **Total Quality Control (TQC):** Zero inventories are achieved by eliminating errors and defective components in each task.
- **Employee involvement:** The success of JIT depends on the teamwork and commitment of every employee. Involvement can be extended to suggestion schemes and participation in quality improvement teams.
- **Supplier relations:** It has become a necessity to build good supplier-user relationships. The quality of the supplier is a critical factor to the quality of the finished product.
- **Continuous improvement:** To maintain competitiveness, organisations should continuously strive to improve operations and the ways in which activities are carried out.

The following advantages will be achieved by implementing the seven principles:

- Reduction in inventory level.
- Reduction in storage space.
- Reduction in overheads.
- Reduction in production costs.
- Reduction in ratification works.
- Improvement in quality.
- Improvement in productivity.

Including JIT into the existing ISO 9001 QMS will achieve productivity, resulting in matching the technical components between ISO 9001 requirements and JIT concepts. Table 6.1 illustrates the matrix for integrating ISO 9001 and the JIT concepts.

Table 6.1: Technical comparison of ISO 9001 requirements and JIT concepts. (**Source:** Sui Pheng, 1998:Adapted)

		Just-in-Time Concepts						
ISO 9001 QMS Requirements		**Elimination of waste**	**Kanban system**	**Smooth workflow**	**Total quality control**	**Employee involvement**	**Supplier relations**	**Continuous improvement**
4	**Quality Management System**							
4.1	General requirements				x			
4.2	Documentation requirements	x	x	x	x	x	x	
5	**Management Responsibility**							
5.1	Management Commitment				x		x	
5.2	Customer focus	x			x			
5.3	Quality Policy	x			x	x	x	
5.4	Planning	x	x	x	x	x	x	
5.5	Responsibility, authority and communication		x	x	x	x	x	
5.6	Management Review	x	x	x	x	x	x	x
6	**Resource Management**							
6.1	Provision of resources	x	x	x	x	x	x	
6.2	Human Resources	x	x	x	x	x	x	
6.3	Infrastructure	x		x				
6.4	Work Environment	x		x		x		
7	**Product realisation**							
7.1	Planning of product realisation	x	x	x	x	x	x	x

7.2	Customer-related processes	x	x	x	x	x		
7.3	Design and development	x	x	x	x	x	x	
7.4	Purchasing	x	x	x	x	x	x	x
7.5	Production and service provision	x	x	x	x	x	x	x
7.6	Control and monitoring of measurement equipment			x	x			
8	**Measurement, analysis and improvement**							
8.1	General	x						
8.2	Monitoring and measurement	x	x	x	x	x	x	x
8.3	Control of nonconforming products	x			x	x	x	
8.4	Analysis of data		x		x	x	x	x
8.5	Improvement	x	x	x	x	x	x	x

The automotive industry has a similar mandatory certification to the TS16949:2002 Technical Specification above the ISO 9001 requirements to deliver products to clients like Toyota, VW or BMW. ISO 9001 QMS can be extended to incorporate JIT principles to achieve productivity in the construction industry. Mandatory certification to ISO 9001 requirements will help to raise quality and productivity standards in the construction industry. Best-practice behaviour must be created within this industry.

6.9.2 Performance improvement programmes and lean construction

This is the manufacturing system developed by Toyota which pursues optimum reformation throughout the entire system through the thorough elimination of Muda (waste), and aims to build quality into the manufacturing process while recognising the principle of cost reduction. Figure 6.2 graphically depicts the lean philosophy which is based on the Toyota production system that has been adopted throughout the world:

- **Flexible manning:** Maintaining productivity despite demand fluctuations.
- **Jidoka:** The principle of stopping a process immediately an abnormality occurs**.**
- **Just In Time:** Linking production rate to customer demand**.**
- **Standardised work:** Common work methods to ensure safety and quality.

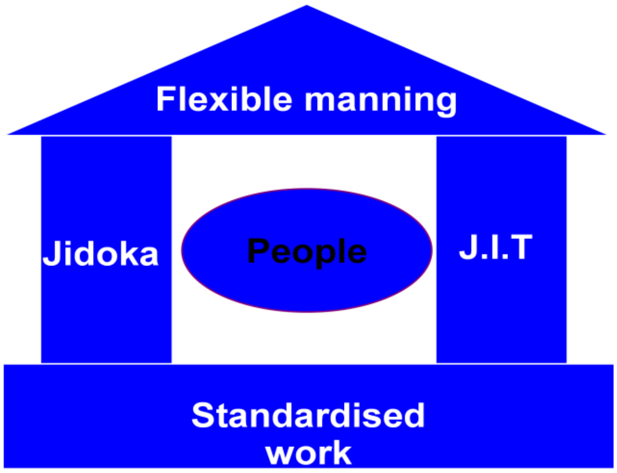

Figure 6.2: Lean is based on the Toyota Production System. (**Source:** Lean Philosophy Eskom Module 1:2010)

6.9.3 Construction Management Systems

Construction Management Systems (CMS) is ISO 9001 construction industry software specially designed and built for this complex industry. CMS manages the digital and paper upload, revision history, distribution and archiving of drawings and schedules. It manages site instructions and tracks issue and close out status of important documents.

CMS is built to cover the high-risk items of construction first and this includes eliminating waste on construction sites. This too implements ISO 9001 across all satellite operations or multiple construction sites spread over a large geographical area. The client, project owner, engineer, architect and contractor all benefit in cost, time and quality from this system as it provides professional services in quality management and quality control to the construction industry. It shares and tests the quality of data and plots these data in acceptance criteria charts.

This system also allows for consulting in matters of concrete technology and concrete failures can be prevented and analysed in details to determine the root causes. The system collects, collates, stores and processes concrete test data and automatically reports the status of the results. A quality assurance procedure lists the key performance areas required by the ISO 9001 system for the construction industry and estimates work load. The system is currently implemented on a major construction site with the estimated value of R1.8 billion to test the functionality and reliability of data. This system will measure the waste allowable compared with the actual waste and determine the causes of the waste. The module to measure and monitor waste will allow the company to estimate more accurate waste rates for the main contractor as well as for sub-contractors on the project. Future studies are required to determine the outcome of the project.

'Quality leads to better business results'. Construction companies need to understand the relationship between quality and other variables. Foster (2007:126), explains that these variables affect profitability, and construction companies must realise that, even if they produce high-quality products the quality management system is unlikely to save the company if nobody buys the product. The following variables have been identified as having a relationship with quality:

- Quality and price.
- Quality and cost.
- Quality and productivity.
- Quality and profitability.
- Quality and the environment.

6.10 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations result from the data analysis:

- **Conclusion 1:** 82% of the workforces agreed that waste management is worthwhile irrespective of cost. However, the behaviour of the construction workforce in the actual workplace indicates a lack of a positive attitude and behaviour towards waste minimisation. This lack of practice of waste management application was found to be caused by other priorities during pre- and post-construction stages, such as profit, time, cost, etc.
- **Recommendation 1:** Waste can only be reduced once all employees and sub-contractors are fully aware of the extent of the problem in the company. Each construction employee must be trained on waste management. This training may include green helmet stickers displayed on the employees' hardhats with the words 'waste management induction training' to reinforce the importance

of waste minimisation practices. Adequate communication strategies from the top to the bottom levels of organisations, the use of reliable practices (work studies) to establish waste allowances and the introduction of incentives for better waste management practices would help to develop and implement waste management applications in the construction industry and thereby improve their performance.

- **Conclusion 2:** Sub-contractors strongly agreed that it is the main contractors' responsibility to segregate waste. The literature review also concluded that the main contractor should be held responsible for waste management. All the respondents agreed that the industry should do more to reduce waste and that education of sub-contractors is the preferred method of reducing site wastage.
- **Recommendation 2:** Education of sub-contractors regarding waste management is an important factor in reducing site wastage. The sub-contractors must be made aware of the waste management plan at the tender stage to ensure compliance with the requirements. A financial incentive which benefits the sub-contractor will reduce waste, and an incentive scheme must be implemented to engender a willingness to carry some of the responsibility for waste management. This should also include an equitable share of benefits arising from the treatment of waste management as a profit centre.
- **Conclusion 3:** 'Poor planning' was identified as the major cause of most types of waste.
- **Recommendation 3:** Implement a waste management plan to address poor planning. It is critical that the first efforts be met with success; otherwise employees will be discouraged and lose motivation and enthusiasm for this initiative. Secondly, a waste Quality Control Plan (QCP) can be implemented by main contractors' to define the activities required for waste management.

The following key elements are essential for the success of the waste management plan implementation:

- Train all employees on the Waste Management Plan.
- Ensure appropriate and adequate container placement.
- Identify the reporting procedure.
- Identify the procedure for correcting any disposal errors.

- Recognition strategies for employees and their sites that meet their goals.
- Strategies for continued visibility and awareness.

The objective of the implementation plan is to get the word out about the waste management plan by making exciting communication channels available which can include (but is not limited to) the following:

- Newsletters.
- E-mails.
- Management meetings.
- Bulletin boards.
- Payslip inserts.

The preparation of a waste management plan at the early stages of a project is essential to facilitate suitable arrangements for proper management of waste and a sequence of operations to sort and segregate materials. Transportation associated with the movement of materials and waste should also be considered. Deconstruction and salvage opportunities must be identified for the most critical materials. Re-cycling of materials is essential. Bricks and other materials will be purchased and stored on site, palletised and the waste must be re-used or re-sold as a product to outside sources. Prior to starting construction, a listing of quantities and types of materials that will be generated on site, must be formulated by site management.

Each bidding sub-contractor must be clearly notified of their duties and responsibilities in respect to waste management. This must be incorporated into their contractual obligations. Sites need to present a 'waste totals to date' on a monthly basis. On-site supervision of the waste management plan is critical to the success of the programme.

Management must provide the resources and be actively involved in the programme to ensure its success. Regular waste management audits must be conducted to ensure that corrective actions bring about waste reduction. A tracking system should indicate the success or failures of corrective actions.

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ANNEXURE A:

Cronbach Alpha Coefficients

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q1	23	2.86957	1.01374	66.00000	2.00000	4.00000	Q1
Q2	23	2.60870	1.11759	60.00000	1.00000	4.00000	Q2
Q3	23	3.95652	0.92826	91.00000	2.00000	5.00000	Q3
Q4	23	1.91304	1.04067	44.00000	1.00000	5.00000	Q4
Q5	23	2.52174	0.99405	58.00000	1.00000	4.00000	Q5
Q6	23	1.78261	0.85048	41.00000	1.00000	4.00000	Q6

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.136090
Standardized	0.115019

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label
Q1	0.525761	-.437976	0.453787	-.371574	Q1
Q2	0.199275	-.051626	0.175377	-.035321	Q2
Q3	-.045915	0.200425	-.032617	0.171124	Q3
Q4	0.329821	-.192850	0.350140	-.237820	Q4
Q5	-.531419	0.551273	-.532875	0.539535	Q5
Q6	0.122071	0.062185	0.133590	0.009047	Q6

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.551273
Standardized	0.539535

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label
Q1	0.668288	0.253813	0.604460	0.282207	Q1
Q2	0.275410	0.522757	0.252711	0.513793	Q2
Q3	0.110964	0.599929	0.127109	0.584141	Q3
Q4	0.409600	0.433702	0.426731	0.405869	Q4
Q6	0.151856	0.574676	0.162604	0.564876	Q6

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.599929
Standardized	0.584141

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label
Q1	0.765514	0.188348	0.707397	0.206766	Q1
Q2	0.368469	0.542297	0.348679	0.525949	Q2
Q4	0.374914	0.533531	0.398239	0.486581	Q4
Q6	0.083982	0.705112	0.088222	0.710195	Q6

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.705112
Standardized	0.710195

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label
Q1	0.905578	0.090615	0.898969	0.090835	Q1
Q2	0.480113	0.671642	0.485777	0.671795	Q2
Q4	0.280202	0.883721	0.292022	0.886064	Q4

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum	Label
Q01	21	1.76190	0.43644	37.00000	1.00000	2.00000	Q01
Q02	21	2.61905	1.28360	55.00000	1.00000	4.00000	Q02
Q03	21	3.38095	0.97346	71.00000	1.00000	4.00000	Q03
Q04	21	1.90476	0.62488	40.00000	1.00000	4.00000	Q04
Q05	21	2.04762	0.92066	43.00000	1.00000	4.00000	Q05
Q06	21	2.04762	0.92066	43.00000	1.00000	4.00000	Q06
Q07	21	3.71429	0.84515	78.00000	1.00000	5.00000	Q07
Q08	21	2.38095	1.07127	50.00000	1.00000	4.00000	Q08
Q09	20	2.20000	0.95145	44.00000	1.00000	4.00000	Q09
Q10	21	2.42857	0.97834	51.00000	1.00000	4.00000	Q10
Q11	21	2.19048	0.98077	46.00000	1.00000	4.00000	Q11
Q12	21	1.90476	0.43644	40.00000	1.00000	3.00000	Q12
Q13	21	1.80952	0.51177	38.00000	1.00000	3.00000	Q13
Q14	21	1.80952	0.51177	38.00000	1.00000	3.00000	Q14
Q15	21	2.04762	0.80475	43.00000	1.00000	4.00000	Q15

Cronbach Coefficient Alpha

Variables	Alpha
Raw	0.778673
Standardized	0.801477

Cronbach Coefficient Alpha with Deleted Variable

Deleted Variable	Raw Variables: Correlation with Total	Raw Variables: Alpha	Standardized Variables: Correlation with Total	Standardized Variables: Alpha	Label

ƒƒ

Q01	0.577274	0.762257	0.618067	0.774237	Q01
Q02	0.467846	0.760614	0.476603	0.785198	Q02
Q03	0.533095	0.751982	0.560710	0.778728	Q03
Q04	0.255737	0.775456	0.274570	0.800187	Q04
Q05	0.593988	0.746708	0.645942	0.772030	Q05
Q06	0.582535	0.747815	0.585794	0.776772	Q06
Q07	-.247555	0.814998	-.311284	0.839474	Q07
Q08	0.426679	0.762999	0.367327	0.793401	Q08
Q09	0.609856	0.744553	0.629599	0.773326	Q09
Q10	0.281369	0.776533	0.255871	0.801536	Q10
Q11	0.679558	0.736686	0.686239	0.768814	Q11
Q12	0.486942	0.766164	0.530602	0.781060	Q12
Q13	0.450417	0.765889	0.498861	0.783499	Q13
Q14	0.499821	0.763385	0.543806	0.780039	Q14
Q15	-.051292	0.799238	-.068552	0.823925	Q15

ANNEXURE B:

Factor analysis for measuring instrument of Questionnaire 3

```
                    The FACTOR Procedure
      Means and Standard Deviations from 23 Observations
             Variable          Mean       Std Dev
             Q1           2.8695652     1.0137396
             Q2           2.6086957     1.1175920
             Q3           3.9565217     0.9282565
             Q4           1.9130435     1.0406748
             Q5           2.5217391     0.9940535
             Q6           1.7826087     0.8504823

             Initial Factor Method: Principal Factors
               Prior Communality Estimates: SMC
         Q1             Q2             Q3             Q4             Q5             Q6
 0.87496611     0.81301073     0.24377075     0.63485555     0.40086205     0.13738028

   Eigenvalues of the Reduced Correlation Matrix: Total = 3.10484548  Average = 0.51747425
                    Eigenvalue    Difference    Proportion    Cumulative
               1    2.04036666    1.03788630        0.6572        0.6572
               2    1.00248036    0.63077853        0.3229        0.9800
               3    0.37170183    0.34601083        0.1197        1.0997
               4    0.02569101    0.16429399        0.0083        1.1080
               5    -.13860298    0.05818842       -0.0446        1.0634
               6    -.19679140                     -0.0634        1.0000
              2 factors will be retained by the NFACTOR criterion.

             Initial Factor Method: Principal Factors
                          Factor Pattern
                           Factor1      Factor2
              Q1    Q1          95 *        -15
              Q2    Q2          73 *        -55 *
              Q4    Q4          53 *         49 *
              Q5    Q5         -54 *        -30
              Q3    Q3          17           46 *
              Q6    Q6          11           38
              Printed values are multiplied by
              100 and rounded to the nearest
              integer.  Values greater than 0.4
              are flagged by an '*'.

                 Variance Explained by Each Factor
                        Factor1         Factor2
                      2.0403667       1.0024804

               Final Communality Estimates: Total = 3.042847
         Q1             Q2             Q3             Q4             Q5             Q6
 0.92561062     0.82498430     0.23948963     0.52082550     0.37745747     0.15447950


                Rotation Method: Promax (power = 3)
             Target Matrix for Procrustean Transformation
                           Factor1      Factor2
              Q1    Q1          95 *          2
              Q2    Q2         100 *         -1
              Q4    Q4           6           80 *
              Q3    Q3           0          100 *
              Q6    Q6           0           97 *
              Q5    Q5         -22          -53 *

              Procrustean Transformation Matrix
                                 1              2
                  1      1.03928931     -0.1377876
                  2      -0.1723097     1.45606742

             Normalized Oblique Transformation Matrix
                                 1              2
                  1         0.85272        0.34797
                  2        -0.58555        0.97413

                  Inter-Factor Correlations
                           Factor1      Factor2
              Factor1          100 *         26
              Factor2           26          100 *

     Rotated Factor Pattern (Standardized Regression Coefficients)
                           Factor1      Factor2
              Q2    Q2          94 *        -28
              Q1    Q1          90 *         18
              Q4    Q4          16           66 *
              Q3    Q3         -12           51 *
              Q6    Q6         -13           41 *
              Q5    Q5         -28          -48 *

                 Reference Axis Correlations
                           Factor1      Factor2
              Factor1          100 *        -26
              Factor2          -26          100 *

           Reference Structure (Semipartial Correlations)
                           Factor1      Factor2
              Q2    Q2          91 *        -27
              Q1    Q1          87 *         18
              Q4    Q4          16           64 *
              Q3    Q3         -12           49 *
              Q6    Q6         -12           39
              Q5    Q5         -28          -46 *

     Variance Explained by Each Factor Eliminating Other Factors
                        Factor1         Factor2
                      1.7077904       1.1199261

                 Factor Structure (Correlations)
                           Factor1      Factor2
              Q2    Q2          87 *         -4
              Q1    Q1          95 *         41 *
              Q4    Q4          33           70 *
              Q3    Q3           1           48 *
              Q6    Q6          -2           37
```

Q5	Q5	-41 *	-55 *

Variance Explained by Each Factor Ignoring Other Factors

Factor1	Factor2
1.9229209	1.3350566

Rotation Method: Promax (power = 3)

Final Communality Estimates: Total = 3.042847

Q1	Q2	Q3	Q4	Q5	Q6
0.92561062	0.82498430	0.23948963	0.52082550	0.37745747	0.15447950

Rotation Method: Promax (power = 3)

Scoring Coefficients Estimated by Regression

Squared Multiple Correlations of the Variables with Each Factor

Factor1	Factor2
0.93375275	0.74063184

Standardized Scoring Coefficients

		Factor1	Factor2
Q2	Q2	0.22806	-0.52238
Q1	Q1	0.81901	0.56797
Q4	Q4	-0.09301	0.29130
Q3	Q3	0.02123	0.21884
Q6	Q6	0.00614	0.15493
Q5	Q5	0.01877	-0.21621

ANNEXURE C:

Descriptive statistics: Questionnaire 1

A1_1	Frequency
Ben Schoeman Harbour - LSC	1
Brand Eng	1
Estimating	1
GVK	1
Grand Build	1
Greenpoint Stadium	1
Icon	1
M&R	1
NMC OBZ Square	1
Power Construction	1
The Lecasy - Cape Town	1

A1_1	Percent
Ben Schoeman Harbour - LSC	9.09
Brand Eng	9.09
Estimating	9.09
GVK	9.09
Grand Build	9.09
Greenpoint Stadium	9.09
Icon	9.09
M&R	9.09
NMC OBZ Square	9.09
Power Construction	9.09
The Lecasy - Cape Town	9.09

A1_1	Cumulative Frequency
Ben Schoeman Harbour - LSC	1
Brand Eng	2
Estimating	3
GVK	4
Grand Build	5
Greenpoint Stadium	6
Icon	7
M&R	8
NMC OBZ Square	9
Power Construction	10
The Lecasy - Cape Town	11

A1_1	Cumulative Percent
Ben Schoeman Harbour - LSC	9.09
Brand Eng	18.18
Estimating	27.27
GVK	36.36
Grand Build	45.45
Greenpoint Stadium	54.55
Icon	63.64
M&R	72.73

NMC OBZ Square
81.82
Power Construction
90.91
The Lecasy - Cape Town
100.00

A1_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Estimator	2	18.18	2	18.18
Site Management	3	27.27	5	45.45
Site Engineer	2	18.18	7	63.64
Foreman	4	36.36	11	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	1.0000
DF	3
Pr > ChiSq	0.8013

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 11

A1_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Permanent	11	100.00	11	100.00

A1_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	3	27.27	3	27.27
3	1	9.09	4	36.36
4	2	18.18	6	54.55
6	1	9.09	7	63.64
13	1	9.09	8	72.73
15	2	18.18	10	90.91
20	1	9.09	11	100.00

A1_5_01	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	27.27	3	27.27
2	4	36.36	7	63.64
3	2	18.18	9	81.82
4	2	18.18	11	100.00

A1_5_02	Frequency	Percent	Cumulative Frequency	Cumulative Percent
5	1	9.09	1	9.09
9	3	27.27	4	36.36
10	6	54.55	10	90.91
11	1	9.09	11	100.00

A1_5_03	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	2	18.18	2	18.18
4	2	18.18	4	36.36
5	1	9.09	5	45.45
6	2	18.18	7	63.64
7	2	18.18	9	81.82
8	1	9.09	10	90.91
9	1	9.09	11	100.00

A1_5_04	Frequency	Percent	Cumulative Frequency	Cumulative Percent
4	1	9.09	1	9.09
6	1	9.09	2	18.18
7	3	27.27	5	45.45
8	4	36.36	9	81.82
10	2	18.18	11	100.00

A1_5_05	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	1	9.09	1	9.09
3	2	18.18	3	27.27
5	1	9.09	4	36.36
6	1	9.09	5	45.45
7	2	18.18	7	63.64
8	4	36.36	11	100.00

A1_5_06	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	9.09	1	9.09
3	2	18.18	3	27.27
5	1	9.09	4	36.36
6	1	9.09	5	45.45
7	2	18.18	7	63.64
8	1	9.09	8	72.73
9	3	27.27	11	100.00

A1_5_07	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	7	63.64	7	63.64
2	3	27.27	10	90.91
4	1	9.09	11	100.00

Cumulative Cumulative

A1_5_08	Frequency	Percent	Frequency	Percent
3	2	18.18	2	18.18
4	2	18.18	4	36.36
5	4	36.36	8	72.73
6	1	9.09	9	81.82
7	1	9.09	10	90.91
9	1	9.09	11	100.00

A1_5_09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	2	18.18	2	18.18
4	2	18.18	4	36.36
6	4	36.36	8	72.73
9	2	18.18	10	90.91
10	1	9.09	11	100.00

A1_5_10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
3	1	9.09	1	9.09
4	1	9.09	2	18.18
5	3	27.27	5	45.45
6	1	9.09	6	54.55
7	1	9.09	7	63.64
8	1	9.09	8	72.73
9	1	9.09	9	81.82
10	1	9.09	10	90.91
11	1	9.09	11	100.00

A1_5_11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	18.18	2	18.18
1	1	9.09	3	27.27
2	1	9.09	4	36.36
10	1	9.09	5	45.45
11	6	54.55	11	100.00

Variable: A1_4 (A1_4)

N	11	Sum Weights	11
Mean	7.81818182	Sum Observations	86
Std Deviation	6.60027548	Variance	43.5636364
Skewness	0.79390373	Kurtosis	-1.0293789
Uncorrected SS	1108	Corrected SS	435.636364
Coeff Variation	84.4221282	Std Error Mean	1.99005793

Basic Statistical Measures

Location		Variability	
Mean	7.818182	Std Deviation	6.60028
Median	4.000000	Variance	43.56364
Mode	2.000000	Range	18.00000
		Interquartile Range	13.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.92862	Pr > |t|	0.0028
Sign	M	5.5	Pr >= |M|	0.0010
Signed Rank	S	33	Pr >= |S|	0.0010

Quantiles (Definition 5)

Quantile	Estimate
100% Max	20
99%	20
95%	20
90%	15
75% Q3	15
50% Median	4
25% Q1	2
10%	2
5%	2
1%	2
0% Min	2

Descriptive statistics: Questionnaire 2

Category_nr	Category_name	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	Concrete & Masonry	8	33.33	8	33.33
2	Wood	6	25.00	14	58.33
3	Metal	1	4.17	15	62.50
4	Cardboard	2	8.33	17	70.83
5	Drywall	3	12.50	20	83.33
6	Plastering	1	4.17	21	87.50
7	Flooring	1	4.17	22	91.67
8	Bricks	1	4.17	23	95.83
9	Tile	1	4.17	24	100.00

WT1_01_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	10	41.67	12	50.00
Moderately Significant	3	12.50	15	62.50
Highly significant	9	37.50	24	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	8.3333
DF	3
Pr > ChiSq	0.0396

Sample Size = 24

WT1_01_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	9.52	2	9.52
a2	2	9.52	4	19.05
b2	3	14.29	7	33.33
b3	7	33.33	14	66.67
c3	1	4.76	15	71.43
d5	1	4.76	16	76.19
d6	1	4.76	17	80.95
e2	2	9.52	19	90.48
e4	2	9.52	21	100.00

WT1_01_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	14.29	2	14.29
b3	5	35.71	7	50.00
c1	2	14.29	9	64.29
c5	1	7.14	10	71.43
e1	1	7.14	11	78.57
e2	2	14.29	13	92.86
e4	1	7.14	14	100.00

WT1_01_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	16.67	1	16.67
c1	1	16.67	2	33.33
c2	1	16.67	3	50.00
d5	1	16.67	4	66.67
e2	1	16.67	5	83.33
e4	1	16.67	6	100.00

WT1_01_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	20.00	1	20.00
c3	1	20.00	2	40.00
d6	1	20.00	3	60.00
e3	1	20.00	4	80.00
e4	1	20.00	5	100.00

WT1_02_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Moderately Significant	4	16.67	6	25.00
Highly significant	18	75.00	24	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	19.0000
DF	2
Pr > ChiSq	<.0001

Sample Size = 24

Cumulative

WT1_02_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	8.33	2	8.33
a2	2	8.33	4	16.67
b1	2	8.33	6	25.00
b2	5	20.83	11	45.83
c1	4	16.67	15	62.50
c3	1	4.17	16	66.67
d1	4	16.67	20	83.33
d3	1	4.17	21	87.50
d5	2	8.33	23	95.83
e2	1	4.17	24	100.00

WT1_02_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b1	1	4.55	1	4.55
b2	2	9.09	3	13.64
b3	7	31.82	10	45.45
c2	5	22.73	15	68.18
c3	1	4.55	16	72.73
c4	1	4.55	17	77.27
c5	1	4.55	18	81.82
d1	1	4.55	19	86.36
d4	1	4.55	20	90.91
d7	2	9.09	22	100.00

WT1_02_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	8.33	1	8.33
b3	1	8.33	2	16.67
c2	2	16.67	4	33.33
c3	2	16.67	6	50.00
d4	1	8.33	7	58.33
d5	4	33.33	11	91.67
d7	1	8.33	12	100.00

WT1_02_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	14.29	1	14.29
c2	1	14.29	2	28.57
d1	2	28.57	4	57.14
d7	2	28.57	6	85.71
e3	1	14.29	7	100.00

WT1_03_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	5	20.83	7	29.17
Moderately Significant	7	29.17	14	58.33
Highly significant	10	41.67	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	5.6667
DF	3
Pr > ChiSq	0.1290

Sample Size = 24

WT1_03_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	4.55	1	4.55
a2	3	13.64	4	18.18
b1	2	9.09	6	27.27
b2	1	4.55	7	31.82
b3	7	31.82	14	63.64
c2	2	9.09	16	72.73
c4	1	4.55	17	77.27
d1	2	9.09	19	86.36
d5	1	4.55	20	90.91
d7	2	9.09	22	100.00

WT1_03_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	4	25.00	4	25.00
c1	1	6.25	5	31.25
c2	3	18.75	8	50.00
c3	1	6.25	9	56.25
c4	1	6.25	10	62.50
d1	1	6.25	11	68.75
d4	1	6.25	12	75.00
d5	1	6.25	13	81.25
d7	1	6.25	14	87.50
e4	2	12.50	16	100.00

WT1_03_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	14.29	1	14.29
c3	2	28.57	3	42.86
c4	2	28.57	5	71.43
d4	1	14.29	6	85.71
e4	1	14.29	7	100.00

Cumulative

WT1_03_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d7	2	100.00	2	100.00

WT1_04_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	8	33.33	10	41.67
Moderately Significant	9	37.50	19	79.17
Highly significant	5	20.83	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	5.0000
DF	3
Pr > ChiSq	0.1718

Sample Size = 24

WT1_04_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	10.00	2	10.00
b2	7	35.00	9	45.00
b3	3	15.00	12	60.00
c1	2	10.00	14	70.00
c2	1	5.00	15	75.00
c3	1	5.00	16	80.00
c4	1	5.00	17	85.00
d4	1	5.00	18	90.00
d6	2	10.00	20	100.00

WT1_04_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	8.33	1	8.33
b2	1	8.33	2	16.67
b3	5	41.67	7	58.33
c3	1	8.33	8	66.67
d1	3	25.00	11	91.67
d5	1	8.33	12	100.00

WT1_04_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	50.00	1	50.00
e4	1	50.00	2	100.00

WT1_04_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_05_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	12	50.00	14	58.33
Moderately Significant	6	25.00	20	83.33
Highly significant	4	16.67	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	9.3333
DF	3
Pr > ChiSq	0.0252

Sample Size = 24

WT1_05_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	6	28.57	6	28.57
b2	1	4.76	7	33.33
b3	5	23.81	12	57.14
c5	1	4.76	13	61.90
d6	1	4.76	14	66.67
d7	1	4.76	15	71.43
e1	1	4.76	16	76.19
e2	2	9.52	18	85.71
e4	3	14.29	21	100.00

WT1_05_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b1	1	10.00	1	10.00
b3	4	40.00	5	50.00
d5	1	10.00	6	60.00
e3	1	10.00	7	70.00
e4	2	20.00	9	90.00
e5	1	10.00	10	100.00

WT1_05_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	20.00	1	20.00
b3	1	20.00	2	40.00

e4	3	60.00	5	100.00

WT1_05_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_06_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	11	45.83	13	54.17
Moderately Significant	6	25.00	19	79.17
Highly significant	5	20.83	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	7.0000
DF	3
Pr > ChiSq	0.0719

Sample Size = 24

WT1_06_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	4	20.00	4	20.00
a2	1	5.00	5	25.00
b2	3	15.00	8	40.00
b3	5	25.00	13	65.00
c1	2	10.00	15	75.00
d6	2	10.00	17	85.00
d7	2	10.00	19	95.00
e2	1	5.00	20	100.00

WT1_06_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	7.14	1	7.14
b2	3	21.43	4	28.57
b3	6	42.86	10	71.43
c2	1	7.14	11	78.57
c5	1	7.14	12	85.71
d3	1	7.14	13	92.86
e4	1	7.14	14	100.00

WT1_06_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	20.00	1	20.00
c4	2	40.00	3	60.00
d6	1	20.00	4	80.00
d7	1	20.00	5	100.00

WT1_06_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c5	2	100.00	2	100.00

WT1_07_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	12	50.00	14	58.33
Moderately Significant	7	29.17	21	87.50
Highly significant	3	12.50	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	10.3333
DF	3
Pr > ChiSq	0.0159

Sample Size = 24

WT1_07_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	4	20.00	4	20.00
a2	3	15.00	7	35.00
b2	1	5.00	8	40.00
b3	4	20.00	12	60.00
c2	1	5.00	13	65.00
d6	3	15.00	16	80.00
d7	1	5.00	17	85.00
e2	3	15.00	20	100.00

WT1_07_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	5.88	1	5.88
a2	1	5.88	2	11.76
b2	2	11.76	4	23.53
b3	7	41.18	11	64.71
c1	1	5.88	12	70.59
c4	1	5.88	13	76.47
d4	2	11.76	15	88.24
d6	1	5.88	16	94.12
e4	1	5.88	17	100.00

WT1_07_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	3	42.86	3	42.86
c1	1	14.29	4	57.14
e2	2	28.57	6	85.71
e4	1	14.29	7	100.00

WT1_07_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e2	1	100.00	1	100.00

WT1_08_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	3	12.50	5	20.83
Moderately Significant	15	62.50	20	83.33
Highly significant	4	16.67	24	100.00

Chi-Square Test for Equal Proportions

Chi-Square	18.3333
DF	3
Pr > ChiSq	0.0004

Sample Size = 24

WT1_08_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	3	14.29	3	14.29
b2	2	9.52	5	23.81
b3	4	19.05	9	42.86
c1	2	9.52	11	52.38
c2	1	4.76	12	57.14
d5	4	19.05	16	76.19
e2	3	14.29	19	90.48
e4	2	9.52	21	100.00

WT1_08_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	6.25	1	6.25
b1	1	6.25	2	12.50
b2	1	6.25	3	18.75
b3	5	31.25	8	50.00
c2	1	6.25	9	56.25
c4	1	6.25	10	62.50
e1	1	6.25	11	68.75
e2	2	12.50	13	81.25
e4	3	18.75	16	100.00

WT1_08_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	11.11	1	11.11
e1	2	22.22	3	33.33
e2	1	11.11	4	44.44
e3	2	22.22	6	66.67
e4	2	22.22	8	88.89
e5	1	11.11	9	100.00

WT1_08_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e3	1	100.00	1	100.00

WT1_09_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	2	8.33	4	16.67
Moderately Significant	6	25.00	10	41.67
Highly significant	14	58.33	24	100.00

Chi-Square Test for Equal Proportions

Chi-Square	16.0000
DF	3
Pr > ChiSq	0.0011

Sample Size = 24

WT1_09_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	3	13.04	3	13.04
b2	2	8.70	5	21.74
c1	3	13.04	8	34.78
c2	1	4.35	9	39.13
c3	1	4.35	10	43.48
d5	7	30.43	17	73.91
e1	4	17.39	21	91.30
e2	1	4.35	22	95.65
e4	1	4.35	23	100.00

Cumulative
Cumulative

WT1_09_3	Frequency	Percent	Frequency	Percent
a1	1	5.26	1	5.26
b2	3	15.79	4	21.05
b3	3	15.79	7	36.84
c1	1	5.26	8	42.11
c2	2	10.53	10	52.63
c3	2	10.53	12	63.16
d1	2	10.53	14	73.68
d5	2	10.53	16	84.21
e1	1	5.26	17	89.47
e2	2	10.53	19	100.00

WT1_09_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	9.09	1	9.09
b3	1	9.09	2	18.18
c1	1	9.09	3	27.27
d5	2	18.18	5	45.45
e2	5	45.45	10	90.91
e3	1	9.09	11	100.00

WT1_09_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	25.00	1	25.00
e3	2	50.00	3	75.00
e4	1	25.00	4	100.00

WT1_10_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	4	16.67	6	25.00
Moderately Significant	7	29.17	13	54.17
Highly significant	11	45.83	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	7.6667
DF	3
Pr > ChiSq	0.0534

Sample Size = 24

WT1_10_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	4.35	1	4.35
a2	2	8.70	3	13.04
b1	1	4.35	4	17.39
b2	4	17.39	8	34.78
b3	7	30.43	15	65.22
d1	2	8.70	17	73.91
d4	1	4.35	18	78.26
d7	1	4.35	19	82.61
e2	2	8.70	21	91.30
e4	2	8.70	23	100.00

WT1_10_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	5.88	1	5.88
a2	1	5.88	2	11.76
b1	1	5.88	3	17.65
b3	3	17.65	6	35.29
c4	1	5.88	7	41.18
d1	2	11.76	9	52.94
d4	5	29.41	14	82.35
d6	1	5.88	15	88.24
e2	1	5.88	16	94.12
e3	1	5.88	17	100.00

WT1_10_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	20.00	1	20.00
c4	1	20.00	2	40.00
d5	1	20.00	3	60.00
d7	2	40.00	5	100.00

WT1_10_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_11_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	9	37.50	11	45.83
Moderately Significant	6	25.00	17	70.83
Highly significant	7	29.17	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	4.3333
DF	3
Pr > ChiSq	0.2276

Sample Size = 24

WT1_11_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	9	40.91	9	40.91
b2	2	9.09	11	50.00
b3	5	22.73	16	72.73
c2	1	4.55	17	77.27
c4	2	9.09	19	86.36
d1	1	4.55	20	90.91
d7	2	9.09	22	100.00

WT1_11_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	7.14	1	7.14
b3	5	35.71	6	42.86
c3	1	7.14	7	50.00
c4	1	7.14	8	57.14
d4	2	14.29	10	71.43
d5	1	7.14	11	78.57
d6	1	7.14	12	85.71
d7	2	14.29	14	100.00

WT1_11_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c3	3	60.00	3	60.00
c4	1	20.00	4	80.00
d7	1	20.00	5	100.00

WT1_11_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_12_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	4	16.67	6	25.00
Moderately Significant	10	41.67	16	66.67
Highly significant	8	33.33	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	6.6667
DF	3
Pr > ChiSq	0.0833

Sample Size = 24

WT1_12_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	6	26.09	6	26.09
b1	1	4.35	7	30.43
b2	4	17.39	11	47.83
b3	3	13.04	14	60.87
c1	1	4.35	15	65.22
c2	1	4.35	16	69.57
c4	3	13.04	19	82.61
c5	2	8.70	21	91.30
d1	1	4.35	22	95.65
d7	1	4.35	23	100.00

WT1_12_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	5.26	1	5.26
b3	6	31.58	7	36.84
c1	1	5.26	8	42.11
c2	6	31.58	14	73.68
c3	3	15.79	17	89.47
d1	1	5.26	18	94.74
d5	1	5.26	19	100.00

WT1_12_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	18.18	2	18.18
c2	1	9.09	3	27.27
c3	1	9.09	4	36.36
c4	5	45.45	9	81.82
d7	2	18.18	11	100.00

WT1_12_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	66.67	2	66.67
c3	1	33.33	3	100.00

WT1_13_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	8.33	2	8.33
Not Significant	9	37.50	11	45.83
Moderately Significant	7	29.17	18	75.00

Highly significant	6	25.00	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	4.3333
DF	3
Pr > ChiSq	0.2276

Sample Size = 24

WT1_13_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	3	14.29	3	14.29
a2	2	9.52	5	23.81
b2	1	4.76	6	28.57
b3	4	19.05	10	47.62
c1	4	19.05	14	66.67
c2	1	4.76	15	71.43
c3	1	4.76	16	76.19
c5	4	19.05	20	95.24
d1	1	4.76	21	100.00

WT1_13_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	8.33	1	8.33
b1	2	16.67	3	25.00
b2	2	16.67	5	41.67
b3	2	16.67	7	58.33
c2	1	8.33	8	66.67
c5	2	16.67	10	83.33
d5	1	8.33	11	91.67
e2	1	8.33	12	100.00

WT1_13_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	16.67	1	16.67
c1	2	33.33	3	50.00
c2	1	16.67	4	66.67
c4	1	16.67	5	83.33
e3	1	16.67	6	100.00

WT1_13_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_14_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	3	12.50	3	12.50
Not Significant	15	62.50	18	75.00
Moderately Significant	1	4.17	19	79.17
Highly significant	5	20.83	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	19.3333
DF	3
Pr > ChiSq	0.0002

Sample Size = 24

WT1_14_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	5.26	1	5.26
a2	7	36.84	8	42.11
b2	2	10.53	10	52.63
c1	5	26.32	15	78.95
c2	2	10.53	17	89.47
c4	1	5.26	18	94.74
c5	1	5.26	19	100.00

WT1_14_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	8.33	1	8.33
b3	2	16.67	3	25.00
c1	1	8.33	4	33.33
c2	1	8.33	5	41.67
c3	2	16.67	7	58.33
c5	3	25.00	10	83.33
d4	1	8.33	11	91.67
d5	1	8.33	12	100.00

WT1_14_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c2	1	25.00	1	25.00
c3	1	25.00	2	50.00
d1	1	25.00	3	75.00
d7	1	25.00	4	100.00

WT1_14_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

c4	2	100.00	2	100.00

WT1_15_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	5	20.83	5	20.83
Not Significant	9	37.50	14	58.33
Moderately Significant	6	25.00	20	83.33
Highly significant	4	16.67	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	2.3333
DF	3
Pr > ChiSq	0.5062

Sample Size = 24

WT1_15_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	11.76	2	11.76
a2	1	5.88	3	17.65
b2	1	5.88	4	23.53
b3	1	5.88	5	29.41
c2	1	5.88	6	35.29
c3	1	5.88	7	41.18
d4	1	5.88	8	47.06
d5	1	5.88	9	52.94
e1	1	5.88	10	58.82
e4	7	41.18	17	100.00

WT1_15_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	11.11	1	11.11
b1	1	11.11	2	22.22
b2	1	11.11	3	33.33
b3	2	22.22	5	55.56
c3	1	11.11	6	66.67
e2	1	11.11	7	77.78
e3	1	11.11	8	88.89
e4	1	11.11	9	100.00

WT1_15_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e1	1	33.33	1	33.33
e3	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_15_5	Frequency	Percent	Frequency	Percent
e2	1	100.00	1	100.00

WT1_16_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	15	62.50	15	62.50
Not Significant	9	37.50	24	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	1.5000
DF	1
Pr > ChiSq	0.2207

Sample Size = 24

WT1_16_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	50.00	2	50.00
a2	1	25.00	3	75.00
c2	1	25.00	4	100.00

WT1_16_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	100.00	1	100.00

WT1_16_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_16_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_16_6	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Descriptive statistics: Questionnaire 3

A1_1	Frequency
Ben Schoeman	2
Ben Schoeman Harbour	1
Brand Engineering	1
Cape Town Container Terminal	1
Coastal Berth	1
De Ville Centre	1
Estimating	1
GRS	1
Groups Khailitcha	1
Groups Liberty	1
Kylemore	1
Lecoy Cape Town	1
M & R Nova Park	1
Milnerton Police Station	1
NMC - Howard Peel	1
PDC Tableview	1
Power Construction / Dromedaris	2
Stocks / Graig Sheenan	1
WBHO	2

A1_1	Percent
Ben Schoeman	9.09
Ben Schoeman Harbour	4.55
Brand Engineering	4.55
Cape Town Container Terminal	4.55
Coastal Berth	4.55
De Ville Centre	4.55
Estimating	4.55
GRS	4.55
Groups Khailitcha	4.55
Groups Liberty	4.55
Kylemore	4.55
Lecoy Cape Town	4.55
M & R Nova Park	4.55
Milnerton Police Station	4.55
NMC - Howard Peel	4.55
PDC Tableview	4.55
Power Construction / Dromedaris	9.09
Stocks / Graig Sheenan	4.55
WBHO	9.09

A1_1	Cumulative Frequency
Ben Schoeman	2
Ben Schoeman Harbour	3
Brand Engineering	4
Cape Town Container Terminal	5
Coastal Berth	6
De Ville Centre	7
Estimating	8
GRS	9
Groups Khailitcha	

10
Groups Liberty
11
Kylemore
12
Lecoy Cape Town
13
M & R Nova Park
14
Milnerton Police Station
15
NMC - Howard Peel
16
PDC Tableview
17
Power Construction / Dromedaris
19
Stocks / Graig Sheenan
20
WBHO
22

Cumulative
A1_1
Percent

ƒƒ
Ben Schoeman
9.09
Ben Schoeman Harbour
13.64
Brand Engineering
18.18
Cape Town Container Terminal
22.73
Coastal Berth
27.27
De Ville Centre
31.82
Estimating
36.36
GRS
40.91
Groups Khailitcha
45.45
Groups Liberty
50.00
Kylemore
54.55
Lecoy Cape Town
59.09
M & R Nova Park
63.64
Milnerton Police Station
68.18
NMC - Howard Peel
72.73
PDC Tableview
77.27
Power Construction / Dromedaris
86.36
Stocks / Graig Sheenan
90.91
WBHO
100.00

A1_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Estimator	2	8.70	2	8.70
Site Management	9	39.13	11	47.83
Site Engineer	4	17.39	15	65.22
Foreman	1	4.35	16	69.57
Other	7	30.43	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	9.8261
DF	4
Pr > ChiSq	0.0435

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 23

A1_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Permanent	22	95.65	22	95.65
Temorary	1	4.35	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	19.1739
DF	1
Pr > ChiSq	<.0001

Sample Size = 23

Q1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	13	56.52	13	56.52
Disagree	10	43.48	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	0.3913
DF	1
Pr > ChiSq	0.5316

Sample Size = 23

Q2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	3	13.04	3	13.04
Agree	11	47.83	14	60.87
Undecided	1	4.35	15	65.22
Disagree	8	34.78	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	10.9130
DF	3
Pr > ChiSq	0.0122

Sample Size = 23

Q3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree	3	13.04	3	13.04
Undecided	1	4.35	4	17.39
Disagree	13	56.52	17	73.91
Strongly disagree	6	26.09	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	14.3913
DF	3
Pr > ChiSq	0.0024

Sample Size = 23

Q4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	9	39.13	9	39.13
Agree	10	43.48	19	82.61
Undecided	2	8.70	21	91.30
Disagree	1	4.35	22	95.65
Strongly disagree	1	4.35	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	17.6522
DF	4
Pr > ChiSq	0.0014

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.

Sample Size = 23

Q5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	8.70	2	8.70
Agree	13	56.52	15	65.22
Undecided	2	8.70	17	73.91
Disagree	6	26.09	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	14.0435
DF	3
Pr > ChiSq	0.0028

Sample Size = 23

Q6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	10	43.48	10	43.48
Agree	9	39.13	19	82.61
Undecided	3	13.04	22	95.65
Disagree	1	4.35	23	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	10.2174
DF	3
Pr > ChiSq	0.0168

Sample Size = 23

Variable: A1_4 (A1_4)

N	23	Sum Weights	23
Mean	8.13043478	Sum Observations	187
Std Deviation	6.58030358	Variance	43.3003953
Skewness	1.14201728	Kurtosis	0.29837932
Uncorrected SS	2473	Corrected SS	952.608696
Coeff Variation	80.9342152	Std Error Mean	1.37208815

Basic Statistical Measures

Location		Variability	
Mean	8.130435	Std Deviation	6.58030
Median	5.000000	Variance	43.30040
Mode	4.000000	Range	22.00000
		Interquartile Range	9.00000

Descriptive statistics: Questionnaire 4

Q1_1	Frequency
AC Flooring	1
AMD	1
Abacus	1
Atlantic Plumbing	1
BICE	1
Blackheath	1
Bloem	1
Bloem Builders	1
Coverland Roofing	1
E de Wet Plasterers	1
Grinstead Plumbing	1
Haroun Plasterer	1
Headline	1
Kalley Flooring	1
Kost ENG	1
Mazor ENG	1
Modern plumbing	1
Pean Painting	1
Sunningdale Tableview	1
Uvuyo Consulting	1
WC	1

Q1_1	Percent
AC Flooring	4.76
AMD	4.76
Abacus	4.76
Atlantic Plumbing	4.76
BICE	4.76
Blackheath	4.76
Bloem	4.76
Bloem Builders	4.76
Coverland Roofing	4.76
E de Wet Plasterers	4.76
Grinstead Plumbing	4.76
Haroun Plasterer	4.76
Headline	4.76
Kalley Flooring	4.76
Kost ENG	4.76
Mazor ENG	4.76
Modern plumbing	4.76
Pean Painting	4.76
Sunningdale Tableview	4.76
Uvuyo Consulting	4.76
WC	4.76

Q1_1	Cumulative Frequency
AC Flooring	1
AMD	2
Abacus	3
Atlantic Plumbing	4
BICE	5
Blackheath	

6
Bloem
7
Bloem Builders
8
Coverland Roofing
9
E de Wet Plasterers
10
Grinstead Plumbing
11
Haroun Plasterer
12
Headline
13
Kalley Flooring
14
Kost ENG
15
Mazor ENG
16
Modern plumbing
17
Pean Painting
18
Sunningdale Tableview
19
Uvuyo Consulting
20
WC
21

Cumulative
Q1_1
Percent
ƒƒ
ƒƒƒƒƒ
AC Flooring
4.76
AMD
9.52
Abacus
14.29
Atlantic Plumbing
19.05
BICE
23.81
Blackheath
28.57
Bloem
33.33
Bloem Builders
38.10
Coverland Roofing
42.86
E de Wet Plasterers
47.62
Grinstead Plumbing
52.38
Haroun Plasterer
57.14
Headline
61.90
Kalley Flooring
66.67
Kost ENG
71.43
Mazor ENG
76.19
Modern plumbing
80.95
Pean Painting
85.71
Sunningdale Tableview
90.48
Uvuyo Consulting
95.24
WC
100.00

Q1_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Brick layer	3	14.29	3	14.29
Painter	2	9.52	5	23.81
Steel fixer	2	9.52	7	33.33
Plumber	3	14.29	10	47.62
Plasterer	2	9.52	12	57.14
Sutter hand	1	4.76	13	61.90
No trade stated	8	38.10	21	100.00

Chi-Square Test
for Equal Proportions
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

Chi-Square	10.6667
DF	6
Pr > ChiSq	0.0992

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 21

Q1_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Top Management	5	23.81	5	23.81
Middle Management	7	33.33	12	57.14
Supervisory	7	33.33	19	90.48
Labour	2	9.52	21	100.00

Chi-Square Test
for Equal Proportions
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

Chi-Square	3.1905
DF	3

Pr > ChiSq 0.3632
Sample Size = 21

Q1_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	4.76	1	4.76
2	2	9.52	3	14.29
3	3	14.29	6	28.57
4	2	9.52	8	38.10
5	4	19.05	12	57.14
6	1	4.76	13	61.90
8	3	14.29	16	76.19
9	1	4.76	17	80.95
14	1	4.76	18	85.71
15	1	4.76	19	90.48
21	1	4.76	20	95.24
28	1	4.76	21	100.00

Q01	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	23.81	5	23.81
Agree	16	76.19	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	5.7619
DF	1
Pr > ChiSq	0.0164

Sample Size = 21

Q02	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	23.81	5	23.81
Agree	7	33.33	12	57.14
Disagree	9	42.86	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	1.1429
DF	2
Pr > ChiSq	0.5647

Sample Size = 21

Q03	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	4.76	1	4.76
Agree	4	19.05	5	23.81
Undecided	2	9.52	7	33.33
Disagree	14	66.67	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	20.3333
DF	3
Pr > ChiSq	0.0001

Sample Size = 21

Q04	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	19.05	4	19.05
Agree	16	76.19	20	95.24
Disagree	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	18.0000
DF	2
Pr > ChiSq	0.0001

Sample Size = 21

Q05	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	23.81	5	23.81
Agree	13	61.90	18	85.71
Disagree	3	14.29	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	8.0000
DF	2
Pr > ChiSq	0.0183

Sample Size = 21

Q06	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	23.81	5	23.81
Agree	13	61.90	18	85.71
Disagree	3	14.29	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	8.0000
DF	2
Pr > ChiSq	0.0183

Sample Size = 21

Q07	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	1	4.76	1	4.76

Agree	1	4.76	2	9.52
Undecided	2	9.52	4	19.05
Disagree	16	76.19	20	95.24
Strongly disagree	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	41.6190
DF	4
Pr > ChiSq	<.0001

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 21

Q08	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	19.05	4	19.05
Agree	10	47.62	14	66.67
Undecided	2	9.52	16	76.19
Disagree	5	23.81	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	6.6190
DF	3
Pr > ChiSq	0.0851

Sample Size = 21

Q09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	4.76	1	4.76
Strongly agree	4	19.05	5	23.81
Agree	11	52.38	16	76.19
Undecided	2	9.52	18	85.71
Disagree	3	14.29	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	14.9524
DF	4
Pr > ChiSq	0.0048

WARNING: The table cells have expected counts less than 5. Chi-Square may not be a valid test.
Sample Size = 21

Q10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	2	9.52	2	9.52
Agree	13	61.90	15	71.43
Undecided	1	4.76	16	76.19
Disagree	5	23.81	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	16.9048
DF	3
Pr > ChiSq	0.0007

Sample Size = 21

Q11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	19.05	4	19.05
Agree	13	61.90	17	80.95
Disagree	4	19.05	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	7.7143
DF	2
Pr > ChiSq	0.0211

Sample Size = 21

Q12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	3	14.29	3	14.29
Agree	17	80.95	20	95.24
Undecided	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	21.7143
DF	2
Pr > ChiSq	<.0001

Sample Size = 21

Q13	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	23.81	5	23.81
Agree	15	71.43	20	95.24
Undecided	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	14.8571
DF	2
Pr > ChiSq	0.0006

Sample Size = 21

Q14	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	5	23.81	5	23.81
Agree	15	71.43	20	95.24
Undecided	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	14.8571
DF	2
Pr > ChiSq	0.0006

Sample Size = 21

Q15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Strongly agree	4	19.05	4	19.05
Agree	14	66.67	18	85.71
Undecided	1	4.76	19	90.48
Disagree	2	9.52	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	20.3333
DF	3
Pr > ChiSq	0.0001

Sample Size = 21

Variable: Q1_4 (Q1_4)

N	21	Sum Weights	21
Mean	7.57142857	Sum Observations	159
Std Deviation	6.77916978	Variance	45.9571429
Skewness	1.87072841	Kurtosis	3.4323464
Uncorrected SS	2123	Corrected SS	919.142857
Coeff Variation	89.5362046	Std Error Mean	1.47933613

Basic Statistical Measures

Location		Variability	
Mean	7.571429	Std Deviation	6.77917
Median	5.000000	Variance	45.95714
Mode	5.000000	Range	27.00000

Interquartile Range 5.00000

ANNEXURE D:

A table with data manipulations to determine main waste causes.

	1		2		3		4		5		6		7		8		9		10		11		12		13
b1	0	b4	0	b4	0	a1	0	a2	0	b1	0	b1	0	a2	0	a2	0	a1	0	a1	0	a1	0	b4	0
b4	0	d2	0	c5	0	b1	0	b4	0	b4	0	b4	0	b4	0	b1	0	b4	0	b1	0	b4	0	d2	0
c4	0	d6	0	d2	0	b4	0	c1	0	c3	0	c3	0	c3	0	b4	0	c1	0	b4	0	d2	0	d3	0
d1	0	e1	0	d3	0	c5	0	c2	0	d1	0	c5	0	c5	0	c4	0	c2	0	c1	0	d3	0	d4	0
d2	0	e4	0	d6	0	d2	0	c3	0	d2	0	d1	0	d1	0	c5	0	c3	0	c5	0	d4	0	d6	0
d3	0	e5	0	e1	0	d3	0	c4	0	d4	0	d2	0	d2	0	d2	0	c5	0	d2	0	d6	0	d7	0
d4	0	c4	1	e2	0	d7	0	d1	0	d5	0	d3	0	d3	0	d3	0	d2	0	d3	0	e1	0	e1	0
d7	0	c5	1	e3	0	e1	0	d2	0	e1	0	d5	0	d4	0	d4	0	d3	0	e1	0	e2	0	e4	0
e5	0	d3	1	e5	0	e2	0	d3	0	e3	0	e1	0	d6	0	d6	0	e1	0	e2	0	e3	0	e5	0
c2	1	e2	1	a1	1	e3	0	d4	0	e5	0	e3	0	d7	0	d7	0	e5	0	e3	0	e4	0	c3	1
c5	1	e3	1	b2	1	e5	0	b1	1	c2	1	e5	0	b1	1	e5	0	d5	1	e4	0	e5	0	c4	1
e1	1	a1	2	c1	1	c2	1	b2	1	d3	1	c2	1	c4	1	d1	2	d6	1	e5	0	b1	1	d1	1
e3	1	a2	2	b1	2	c4	1	c5	1	e2	1	c4	1	e5	1	e4	2	e3	1	c2	1	d5	1	d5	1
a1	2	d4	2	d4	2	d4	1	d5	1	e4	1	d7	1	c1	2	c2	3	b1	2	d1	1	c1	2	e2	1
c3	2	b1	3	d5	2	d5	1	d6	1	a2	2	c1	2	c2	2	c3	3	c4	2	d5	1	c5	2	e3	1
d5	2	c1	4	c3	3	e4	1	d7	1	c1	2	d4	2	b2	3	e3	3	e4	2	d6	1	d1	2	b1	2
d6	2	c3	4	d1	3	c1	2	e1	1	c4	2	e4	2	e1	3	a1	4	a2	3	d4	2	d7	3	a1	3
b2	3	d7	5	e4	3	c3	2	e3	1	c5	3	b2	3	e3	3	b3	5	d7	3	b2	3	b2	5	a2	3
c1	3	d5	6	a2	4	d6	2	e5	1	d6	3	a2	4	a1	4	c1	5	e2	3	c3	4	c3	5	b2	3
a2	5	d1	7	c4	4	d1	3	e2	2	d7	3	d6	4	d5	4	e1	5	b2	4	c4	4	a2	8	c2	3
e2	5	b2	8	c2	5	a2	4	a1	7	a1	4	a1	5	e2	6	b2	6	d1	4	d7	5	c2	8	c1	6
e4	5	c2	8	d7	5	b2	8	e4	8	b2	6	e2	6	e4	7	e2	8	d4	6	a2	9	c4	8	c5	6
b3	12	b3	9	b3	11	b3	8	b3	10	b3	12	b3	14	b3	10	d5	11	b3	11	b3	10	b3	11	b3	7
0.208333	45	0.291667	65	0.166667	47	0.125	34	0.083333	36	0.125	41	0.166667	45	0.166667	47	0.208333	57	0.166667	43	0.166667	41	0.333333	56	0.125	39
0.208333	27	0.333333	32	0.208333	25	0.166667	23	0.291667	27	0.166667	25	0.208333	29	0.25	27	0.25	30	0.166667	25	0.208333	28	0.333333	35	0.25	22
0.208333	0.6	0.333333	0.5	0.208333	0.5	0.333333	0.7	0.333333	0.8	0.25	0.6	0.25	0.6	0.291667	0.6	0.333333	0.5	0.25	0.6	0.375	0.7	0.333333	0.6	0.25	0.6
0.5		0.375		0.458333		0.333333		0.416667		0.5		0.583333		0.416667		0.458333		0.458333		0.416667		0.458333		0.291667	
	1		2		3		4		5		6		7		8		9		10		11		12		13
Production	7	Informatio	2	Informatio	3	Informatio	1	Production	1	Informatio	2	Production	4	Project	4	Project	4	Production	2	Informatio	0	Informatio	0	Resource	2
Project	8	Project	4	Project	5	Project	4	Resource	3	Project	6	Resource	7	Resource	4	Manageme	11	Project	5	Production	9	Resource	6	Informatio	2
Resource	11	Production	18	Resource	12	Production	6	Project	7	Resource	7	Informatio	8	Production	5	Production	11	Informatio	6	Resource	10	Project	8	Project	6
Informatio	12	Manageme	20	Production	13	Resource	7	Manageme	12	Production	8	Project	9	Manageme	14	Resource	13	Resource	15	Project	13	Manageme	17	Manageme	12
Manageme	15	Resource	21	Manageme	14	Manageme	16	Informatio	13	Manageme	21	Manageme	17	Informatio	20	Informatio	18	Manageme	17	Manageme	13	Production	25	Production	17
0.625	53	0.875	65	0.583333	47	0.666667	34	0.541667	36	0.875	44	0.708333	45	0.833333	47	0.75	57	0.708333	45	0.541667	45	1.041667	56	0.708333	39
	0.3		0.3		0.3		0.5		0.4		0.5		0.4		0.4		0.3		0.4		0.3		0.4		0.4

ANNEXURE E:

Chi-Square tests to determine equality of proportions for attitudes Questionnaire 3

Q1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	13	56.52	13	56.52
Disagree-Strongly disagree	10	43.48	23	100.00

Chi-Square Test for Equal Proportions

Chi-Square	0.3913
DF	1
Asymptotic Pr > ChiSq	0.5316
Exact Pr >= ChiSq	0.6776

Sample Size = 23

Q2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	14	60.87	14	60.87
Undecided	1	4.35	15	65.22
Disagree-Strongly disagree	8	34.78	23	100.00

Chi-Square Test for Equal Proportions

Chi-Square	11.0435
DF	2
Asymptotic Pr > ChiSq	0.0040
Exact Pr >= ChiSq	0.0031

Sample Size = 23

Q3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	3	13.04	3	13.04
Undecided	1	4.35	4	17.39
Disagree-Strongly disagree	19	82.61	23	100.00

Chi-Square Test for Equal Proportions

Chi-Square	25.3913
DF	2
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	3.307E-06

Sample Size = 23

Q4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	19	82.61	19	82.61
Undecided	2	8.70	21	91.30
Disagree-Strongly disagree	2	8.70	23	100.00

Chi-Square Test for Equal Proportions

Chi-Square	25.1304
DF	2
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	5.000E-06

Sample Size = 23

Q5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	15	65.22	15	65.22
Undecided	2	8.70	17	73.91
Disagree-Strongly disagree	6	26.09	23	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	11.5652
DF	2
Asymptotic Pr > ChiSq	0.0031
Exact Pr >= ChiSq	0.0026

Sample Size = 23

Q6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	19	82.61	19	82.61
Undecided	3	13.04	22	95.65
Disagree-Strongly disagree	1	4.35	23	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	25.3913
DF	2
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	3.307E-06

Sample Size = 23

Questionnaire 4

Q01	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	21	100.00	21	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	0.0000
DF	0
Asymptotic Pr > ChiSq	.
Exact Pr >= ChiSq	1.0000

Sample Size = 21

Q02	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	12	57.14	12	57.14
Disagree-Strongly disagree	9	42.86	21	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	0.4286
DF	1
Asymptotic Pr > ChiSq	0.5127
Exact Pr >= ChiSq	0.6636

Sample Size = 21

Q03	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	5	23.81	5	23.81
Undecided	2	9.52	7	33.33
Disagree-Strongly disagree	14	66.67	21	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	11.1429
DF	2
Asymptotic Pr > ChiSq	0.0038
Exact Pr >= ChiSq	0.0034

Sample Size = 21

Q04	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	20	95.24	20	95.24
Disagree-Strongly disagree	1	4.76	21	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	17.1905
DF	1
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	2.098E-05

Sample Size = 21

Q05	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	18	85.71	18	85.71
Disagree-Strongly disagree	3	14.29	21	100.00

Chi-Square Test for Equal Proportions	
Chi-Square	10.7143
DF	1
Asymptotic Pr > ChiSq	0.0011
Exact Pr >= ChiSq	0.0015

Sample Size = 21

Q06	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	18	85.71	18	85.71
Disagree-Strongly disagree	3	14.29	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square		10.7143
DF		1
Asymptotic Pr >	ChiSq	0.0011
Exact	Pr >= ChiSq	0.0015

Sample Size = 21

Q07	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	2	9.52	2	9.52
Undecided	2	9.52	4	19.05
Disagree-Strongly disagree	17	80.95	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square		21.4286
DF		2
Asymptotic Pr >	ChiSq	<.0001
Exact	Pr >= ChiSq	3.077E-05

Sample Size = 21

Q08	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	14	66.67	14	66.67
Undecided	2	9.52	16	76.19
Disagree-Strongly disagree	5	23.81	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square		11.1429
DF		2
Asymptotic Pr >	ChiSq	0.0038
Exact	Pr >= ChiSq	0.0034

Sample Size = 21

Q09	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	15	75.00	15	75.00
Undecided	2	10.00	17	85.00
Disagree-Strongly disagree	3	15.00	20	100.00

Chi-Square Test
for Equal Proportions

Chi-Square		15.7000
DF		2
Asymptotic Pr >	ChiSq	0.0004
Exact	Pr >= ChiSq	5.021E-04

Effective Sample Size = 20
Frequency Missing = 1

Q10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	15	71.43	15	71.43
Undecided	1	4.76	16	76.19
Disagree-Strongly disagree	5	23.81	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square		14.8571
DF		2
Asymptotic Pr >	ChiSq	0.0006
Exact	Pr >= ChiSq	4.354E-04

Sample Size = 21

Q11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	17	80.95	17	80.95
Disagree-Strongly disagree	4	19.05	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square		8.0476
DF		1
Asymptotic Pr >	ChiSq	0.0046
Exact	Pr >= ChiSq	0.0072

Sample Size = 21

Q12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	20	95.24	20	95.24
Undecided	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	17.1905
DF	1
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	2.098E-05

Sample Size = 21

Q13	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	20	95.24	20	95.24
Undecided	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	17.1905
DF	1
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	2.098E-05

Sample Size = 21

Q14	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	20	95.24	20	95.24
Undecided	1	4.76	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	17.1905
DF	1
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	2.098E-05

Sample Size = 21

Q15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Agree - Strongly agree	18	85.71	18	85.71
Undecided	1	4.76	19	90.48
Disagree-Strongly disagree	2	9.52	21	100.00

Chi-Square Test
for Equal Proportions

Chi-Square	26.0000
DF	2
Asymptotic Pr > ChiSq	<.0001
Exact Pr >= ChiSq	3.305E-06

Sample Size = 21

ANNEXURE F:

Descriptive statistics for the 3 main waste categories separately.

--- Category_nr=Concrete & Masonry--

WT1_01_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	4	50.00	5	62.50
Moderately Significant	1	12.50	6	75.00
Highly significant	2	25.00	8	100.00

WT1_01_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	25.00	2	25.00
b2	1	12.50	3	37.50
b3	4	50.00	7	87.50
d5	1	12.50	8	100.00

WT1_01_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	40.00	2	40.00
c1	1	20.00	3	60.00
e2	2	40.00	5	100.00

WT1_01_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c1	1	33.33	1	33.33
e2	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_01_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	33.33	1	33.33
c3	1	33.33	2	66.67
e3	1	33.33	3	100.00

WT1_02_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Moderately Significant	1	12.50	2	25.00
Highly significant	6	75.00	8	100.00

WT1_02_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	12.50	1	12.50
a2	1	12.50	2	25.00
b2	2	25.00	4	50.00
c1	1	12.50	5	62.50
d1	3	37.50	8	100.00

WT1_02_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	14.29	1	14.29
b3	2	28.57	3	42.86
c2	2	28.57	5	71.43
c4	1	14.29	6	85.71
d4	1	14.29	7	100.00

WT1_02_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c2	2	40.00	2	40.00
d4	1	20.00	3	60.00
d5	2	40.00	5	100.00

WT1_02_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	33.33	1	33.33
d1	2	66.67	3	100.00

WT1_03_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	3	37.50	4	50.00
Highly significant	4	50.00	8	100.00

WT1_03_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	4	57.14	4	57.14
c2	2	28.57	6	85.71
c4	1	14.29	7	100.00

WT1_03_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	20.00	1	20.00
d1	1	20.00	2	40.00
d4	1	20.00	3	60.00
d5	1	20.00	4	80.00
e4	1	20.00	5	100.00

WT1_03_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	33.33	1	33.33
d4	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_03_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_04_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	3	37.50	4	50.00
Moderately Significant	2	25.00	6	75.00
Highly significant	2	25.00	8	100.00

WT1_04_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	28.57	2	28.57
b2	2	28.57	4	57.14
c1	1	14.29	5	71.43
d4	1	14.29	6	85.71
d6	1	14.29	7	100.00

WT1_04_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	50.00	2	50.00
c3	1	25.00	3	75.00
d1	1	25.00	4	100.00

WT1_04_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e4	1	100.00	1	100.00

WT1_05_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	5	62.50	6	75.00
Moderately Significant	2	25.00	8	100.00

WT1_05_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	3	50.00	3	50.00
b3	2	33.33	5	83.33
e1	1	16.67	6	100.00

WT1_05_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	50.00	1	50.00
e4	1	50.00	2	100.00

WT1_05_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e4	1	100.00	1	100.00

WT1_05_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_06_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	28.57	2	28.57
b2	1	14.29	3	42.86
b3	2	28.57	5	71.43
c1	2	28.57	7	100.00

WT1_06_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	50.00	2	50.00
c2	1	25.00	3	75.00
d3	1	25.00	4	100.00

WT1_06_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c4	1	100.00	1	100.00

WT1_06_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c5	1	100.00	1	100.00

WT1_07_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	3	37.50	4	50.00
Moderately Significant	1	12.50	5	62.50
Highly significant	3	37.50	8	100.00

WT1_07_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	14.29	1	14.29
a2	1	14.29	2	28.57
b2	1	14.29	3	42.86
b3	3	42.86	6	85.71
d6	1	14.29	7	100.00

WT1_07_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	4	80.00	4	80.00
d4	1	20.00	5	100.00

WT1_07_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c1	1	33.33	1	33.33
e2	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_07_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e2	1	100.00	1	100.00

WT1_08_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	2	25.00	3	37.50
Moderately Significant	3	37.50	6	75.00
Highly significant	2	25.00	8	100.00

WT1_08_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	14.29	1	14.29
b3	2	28.57	3	42.86
c2	1	14.29	4	57.14
d5	1	14.29	5	71.43
e2	2	28.57	7	100.00

WT1_08_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	20.00	1	20.00
b1	1	20.00	2	40.00
b3	1	20.00	3	60.00
e4	2	40.00	5	100.00

WT1_08_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e1	1	50.00	1	50.00
e3	1	50.00	2	100.00

WT1_08_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_09_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Moderately Significant	1	12.50	2	25.00
Highly significant	6	75.00	8	100.00

WT1_09_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	12.50	1	12.50
c2	1	12.50	2	25.00
c3	1	12.50	3	37.50
d5	3	37.50	6	75.00
e1	1	12.50	7	87.50
e2	1	12.50	8	100.00

WT1_09_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	16.67	1	16.67
b2	1	16.67	2	33.33
b3	2	33.33	4	66.67
c2	1	16.67	5	83.33
c3	1	16.67	6	100.00

WT1_09_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	20.00	1	20.00
c1	1	20.00	2	40.00
d5	1	20.00	3	60.00
e2	1	20.00	4	80.00
e3	1	20.00	5	100.00

WT1_09_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	50.00	1	50.00
e4	1	50.00	2	100.00

WT1_10_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	1	12.50	2	25.00
Moderately Significant	2	25.00	4	50.00
Highly significant	4	50.00	8	100.00

WT1_10_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	12.50	1	12.50
b1	1	12.50	2	25.00
b2	1	12.50	3	37.50
b3	3	37.50	6	75.00
d4	1	12.50	7	87.50
e4	1	12.50	8	100.00

WT1_10_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	25.00	1	25.00
c4	1	25.00	2	50.00
d4	1	25.00	3	75.00
d6	1	25.00	4	100.00

WT1_10_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	50.00	1	50.00
d7	1	50.00	2	100.00

WT1_10_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_11_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	3	37.50	4	50.00
Moderately Significant	2	25.00	6	75.00
Highly significant	2	25.00	8	100.00

WT1_11_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	3	42.86	3	42.86
b3	2	28.57	5	71.43
c4	2	28.57	7	100.00

WT1_11_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	33.33	2	33.33
c3	1	16.67	3	50.00
c4	1	16.67	4	66.67
d6	1	16.67	5	83.33
d7	1	16.67	6	100.00

WT1_11_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c3	1	33.33	1	33.33
c4	1	33.33	2	66.67
d7	1	33.33	3	100.00

WT1_11_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_12_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	1	12.50	2	25.00
Moderately Significant	3	37.50	5	62.50
Highly significant	3	37.50	8	100.00

WT1_12_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	3	37.50	3	37.50
b1	1	12.50	4	50.00
b3	1	12.50	5	62.50
c2	1	12.50	6	75.00
c4	1	12.50	7	87.50
c5	1	12.50	8	100.00

WT1_12_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	28.57	2	28.57
c2	2	28.57	4	57.14
c3	2	28.57	6	85.71
d1	1	14.29	7	100.00

WT1_12_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c4	4	100.00	4	100.00

WT1_12_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_13_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	3	37.50	4	50.00
Moderately Significant	2	25.00	6	75.00
Highly significant	2	25.00	8	100.00

WT1_13_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	14.29	1	14.29
a2	1	14.29	2	28.57
b3	1	14.29	3	42.86
c1	1	14.29	4	57.14
c2	1	14.29	5	71.43
c5	2	28.57	7	100.00

WT1_13_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b1	1	33.33	1	33.33
b3	1	33.33	2	66.67
d5	1	33.33	3	100.00

WT1_13_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c1	1	50.00	1	50.00
c4	1	50.00	2	100.00

WT1_13_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_14_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	12.50	1	12.50
Not Significant	5	62.50	6	75.00
Highly significant	2	25.00	8	100.00

WT1_14_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	3	42.86	3	42.86
b2	1	14.29	4	57.14
c1	2	28.57	6	85.71
c5	1	14.29	7	100.00

WT1_14_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	25.00	1	25.00
c1	1	25.00	2	50.00
c3	1	25.00	3	75.00
c5	1	25.00	4	100.00

WT1_14_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d1	1	50.00	1	50.00
d7	1	50.00	2	100.00

WT1_14_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_15_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	2	25.00	2	25.00
Not Significant	3	37.50	5	62.50
Moderately Significant	1	12.50	6	75.00
Highly significant	2	25.00	8	100.00

WT1_15_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	2	33.33	2	33.33
d4	1	16.67	3	50.00
e1	1	16.67	4	66.67
e4	2	33.33	6	100.00

WT1_15_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b1	1	33.33	1	33.33
b3	1	33.33	2	66.67
e3	1	33.33	3	100.00

WT1_15_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e1	1	50.00	1	50.00
e4	1	50.00	2	100.00

WT1_15_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

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ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        e2                                                            1      100.00            1        100.00

                                                                                  Cumulative    Cumulative
                                            WT1_16_1    Frequency     Percent     Frequency      Percent
                      ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
                                                   0            4       50.00             4        50.00
                      Not Significant                           4       50.00             8       100.00

        WT1_16_2                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a1                                                            1      100.00            1        100.00

                                                                                                Cumulative
Cumulative
        WT1_16_3                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

                                                                                                Cumulative
Cumulative
        WT1_16_4                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

                                                                                                Cumulative
Cumulative
        WT1_16_5                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

------------------------------------------------- Category_nr=Wood ------------------------------------------
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                                                                                  Cumulative    Cumulative
                                            WT1_01_1    Frequency     Percent     Frequency      Percent
                      ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
                      Not Significant                           3       50.00             3        50.00
                      Highly significant                        3       50.00             6       100.00

                                                                                                Cumulative
Cumulative
        WT1_01_2                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a2                                                            1       25.00            1         25.00
        b2                                                            1       25.00            2         50.00
        b3                                                            1       25.00            3         75.00
        e4                                                            1       25.00            4        100.00

                                                                                                Cumulative
Cumulative
        WT1_01_3                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a2                                                            1       50.00            1         50.00
        b3                                                            1       50.00            2        100.00

                                                                                                Cumulative
Cumulative
        WT1_01_4                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a2                                                            1      100.00            1        100.00

                                                                                                Cumulative
Cumulative
        WT1_01_5                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        e4                                                            1      100.00            1        100.00

                                                                                  Cumulative    Cumulative
                                            WT1_02_1    Frequency     Percent     Frequency      Percent
                      ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
                      Moderately Significant                    1       16.67             1        16.67
                      Highly significant                        5       83.33             6       100.00

                                                                                                Cumulative
Cumulative
        WT1_02_2                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a1                                                            1       16.67            1         16.67
        b1                                                            2       33.33            3         50.00
        b2                                                            1       16.67            4         66.67
        d1                                                            1       16.67            5         83.33
        d3                                                            1       16.67            6        100.00

                                                                                                Cumulative
Cumulative
        WT1_02_3                                                    Frequency     Percent      Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        b3                                                            3       50.00            3         50.00
        c2                                                            1       16.67            4         66.67
        d7                                                            2       33.33            6        100.00

                                                                                                Cumulative
Cumulative
        WT1_02_4                                                    Frequency     Percent      Frequency
Percent
```

	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c3	2	66.67	2	66.67
d5	1	33.33	3	100.00

WT1_02_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d7	2	66.67	2	66.67
e3	1	33.33	3	100.00

WT1_03_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	16.67	1	16.67
Moderately Significant	3	50.00	4	66.67
Highly significant	2	33.33	6	100.00

WT1_03_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	16.67	1	16.67
b1	2	33.33	3	50.00
b3	1	16.67	4	66.67
d1	1	16.67	5	83.33
d7	1	16.67	6	100.00

WT1_03_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	50.00	2	50.00
c2	2	50.00	4	100.00

WT1_03_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c3	2	66.67	2	66.67
c4	1	33.33	3	100.00

WT1_03_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d7	2	100.00	2	100.00

WT1_04_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	2	33.33	2	33.33
Moderately Significant	4	66.67	6	100.00

WT1_04_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	2	50.00	2	50.00
b3	2	50.00	4	100.00

WT1_04_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
b3	1	33.33	2	66.67
d1	1	33.33	3	100.00

WT1_04_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	100.00	1	100.00

WT1_04_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_05_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	2	33.33	2	33.33
Moderately Significant	2	33.33	4	66.67
Highly significant	2	33.33	6	100.00

WT1_05_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	16.67	1	16.67
b3	2	33.33	3	50.00
d7	1	16.67	4	66.67
e2	1	16.67	5	83.33

e4	1	16.67	6	100.00

WT1_05_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	66.67	2	66.67
e5	1	33.33	3	100.00

WT1_05_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e4	1	100.00	1	100.00

WT1_05_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_06_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	4	66.67	4	66.67
Moderately Significant	1	16.67	5	83.33
Highly significant	1	16.67	6	100.00

WT1_06_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	25.00	1	25.00
b2	1	25.00	2	50.00
d7	1	25.00	3	75.00
e2	1	25.00	4	100.00

WT1_06_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	25.00	1	25.00
b3	2	50.00	3	75.00
e4	1	25.00	4	100.00

WT1_06_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c4	1	33.33	1	33.33
d6	1	33.33	2	66.67
d7	1	33.33	3	100.00

WT1_06_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c5	1	100.00	1	100.00

WT1_07_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	4	66.67	4	66.67
Moderately Significant	2	33.33	6	100.00

WT1_07_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	25.00	1	25.00
d6	1	25.00	2	50.00
d7	1	25.00	3	75.00
e2	1	25.00	4	100.00

WT1_07_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	33.33	1	33.33
b2	1	33.33	2	66.67
d4	1	33.33	3	100.00

WT1_07_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	100.00	2	100.00

WT1_07_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Cumulative Cumulative

WT1_08_1	Frequency	Percent	Frequency	Percent
Moderately Significant	6	100.00	6	100.00

WT1_08_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	20.00	1	20.00
b2	1	20.00	2	40.00
b3	2	40.00	4	80.00
c1	1	20.00	5	100.00

WT1_08_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	25.00	1	25.00
b3	1	25.00	2	50.00
c2	1	25.00	3	75.00
e2	1	25.00	4	100.00

WT1_08_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	33.33	1	33.33
e3	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_08_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_09_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	16.67	1	16.67
Highly significant	5	83.33	6	100.00

WT1_09_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	16.67	1	16.67
b2	2	33.33	3	50.00
c1	1	16.67	4	66.67
d5	1	16.67	5	83.33
e1	1	16.67	6	100.00

WT1_09_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c1	1	20.00	1	20.00
c2	1	20.00	2	40.00
d1	2	40.00	4	80.00
e2	1	20.00	5	100.00

WT1_09_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	33.33	1	33.33
e2	2	66.67	3	100.00

WT1_09_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e3	2	100.00	2	100.00

WT1_10_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	16.67	1	16.67
Moderately Significant	3	50.00	4	66.67
Highly significant	2	33.33	6	100.00

WT1_10_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	16.67	1	16.67
b2	3	50.00	4	66.67
b3	1	16.67	5	83.33
d7	1	16.67	6	100.00

WT1_10_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	16.67	1	16.67
d1	2	33.33	3	50.00
d4	1	16.67	4	66.67

e2	1	16.67	5	83.33
e3	1	16.67	6	100.00

WT1_10_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d5	1	100.00	1	100.00

WT1_10_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_11_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	2	33.33	2	33.33
Moderately Significant	1	16.67	3	50.00
Highly significant	3	50.00	6	100.00

WT1_11_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	3	50.00	3	50.00
b2	2	33.33	5	83.33
b3	1	16.67	6	100.00

WT1_11_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
b3	1	33.33	2	66.67
d7	1	33.33	3	100.00

WT1_11_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_11_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_12_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	16.67	1	16.67
Moderately Significant	3	50.00	4	66.67
Highly significant	2	33.33	6	100.00

WT1_12_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	33.33	2	33.33
b2	2	33.33	4	66.67
b3	1	16.67	5	83.33
c1	1	16.67	6	100.00

WT1_12_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	20.00	1	20.00
c1	1	20.00	2	40.00
c2	3	60.00	5	100.00

WT1_12_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	50.00	2	50.00
d7	2	50.00	4	100.00

WT1_12_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	100.00	2	100.00

WT1_13_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	16.67	1	16.67
Moderately Significant	3	50.00	4	66.67
Highly significant	2	33.33	6	100.00

WT1_13_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent

a1	1	20.00	1	20.00
b2	1	20.00	2	40.00
c1	1	20.00	3	60.00
c3	1	20.00	4	80.00
c5	1	20.00	5	100.00

WT1_13_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	25.00	1	25.00
b3	1	25.00	2	50.00
c2	1	25.00	3	75.00
e2	1	25.00	4	100.00

WT1_13_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	50.00	1	50.00
e3	1	50.00	2	100.00

WT1_13_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_14_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	16.67	1	16.67
Not Significant	4	66.67	5	83.33
Highly significant	1	16.67	6	100.00

WT1_14_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	2	66.67	2	66.67
b2	1	33.33	3	100.00

WT1_14_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	50.00	1	50.00
c5	1	50.00	2	100.00

WT1_14_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c2	1	100.00	1	100.00

WT1_14_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c4	1	100.00	1	100.00

WT1_15_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1	16.67	1	16.67
Not Significant	3	50.00	4	66.67
Moderately Significant	1	16.67	5	83.33
Highly significant	1	16.67	6	100.00

WT1_15_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
e4	2	66.67	3	100.00

WT1_15_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	50.00	1	50.00
e2	1	50.00	2	100.00

WT1_15_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e3	1	100.00	1	100.00

WT1_15_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_16_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	6	100.00	6	100.00

WT1_16_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_16_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_16_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_16_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

-- Category_nr=Drywall --

WT1_01_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	33.33	1	33.33
Moderately Significant	1	33.33	2	66.67
Highly significant	1	33.33	3	100.00

WT1_01_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
e2	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_01_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	50.00	1	50.00
c1	1	50.00	2	100.00

WT1_01_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d5	1	100.00	1	100.00

WT1_01_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_02_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Moderately Significant	1	33.33	1	33.33
Highly significant	2	66.67	3	100.00

WT1_02_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
c1	1	33.33	2	66.67
d5	1	33.33	3	100.00

WT1_02_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	33.33	1	33.33
c2	2	66.67	3	100.00

WT1_02_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	50.00	1	50.00
d5	1	50.00	2	100.00

WT1_02_5	Frequency	Percent	Cumulative Frequency	Cumulative

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Percent
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                                                      Cumulative    Cumulative
                 WT1_03_1    Frequency     Percent     Frequency      Percent
 ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
 Moderately Significant           1       33.33             1        33.33
 Highly significant               2       66.67             3       100.00

                                                                    Cumulative
Cumulative
        WT1_03_2                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a2                                               2       66.67             2        66.67
        d5                                               1       33.33             3       100.00

                                                                    Cumulative
Cumulative
        WT1_03_3                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        c2                                               1       33.33             1        33.33
        c4                                               1       33.33             2        66.67
        e4                                               1       33.33             3       100.00

                                                                    Cumulative
Cumulative
        WT1_03_4                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        c4                                               1      100.00             1       100.00

                                                                    Cumulative
Cumulative
        WT1_03_5                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

                                                      Cumulative    Cumulative
                 WT1_04_1    Frequency     Percent     Frequency      Percent
 ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
 Not Significant                  1       33.33             1        33.33
 Highly significant               2       66.67             3       100.00

                                                                    Cumulative
Cumulative
        WT1_04_2                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        b2                                               3      100.00             3       100.00

                                                                    Cumulative
Cumulative
        WT1_04_3                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        b3                                               1       50.00             1        50.00
        d1                                               1       50.00             2       100.00

                                                                    Cumulative
Cumulative
        WT1_04_4                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

                                                                    Cumulative
Cumulative
        WT1_04_5                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ

                                                      Cumulative    Cumulative
                 WT1_05_1    Frequency     Percent     Frequency      Percent
 ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
 Not Significant                  3      100.00             3       100.00

                                                                    Cumulative
Cumulative
        WT1_05_2                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        a1                                               2       66.67             2        66.67
        e4                                               1       33.33             3       100.00


                                                                    Cumulative
Cumulative
        WT1_05_3                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        e4                                               1      100.00             1       100.00

                                                                    Cumulative
Cumulative
        WT1_05_4                                  Frequency     Percent     Frequency
Percent

ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
        b3                                               1      100.00             1       100.00

                                                                    Cumulative
Cumulative
        WT1_05_5                                  Frequency     Percent     Frequency
Percent
```

WT1_06_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	2	66.67	2	66.67
Moderately Significant	1	33.33	3	100.00

WT1_06_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	33.33	1	33.33
b2	1	33.33	2	66.67
b3	1	33.33	3	100.00

WT1_06_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	50.00	1	50.00
b3	1	50.00	2	100.00

WT1_06_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_06_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_07_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	33.33	1	33.33
Moderately Significant	2	66.67	3	100.00

WT1_07_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	33.33	1	33.33
a2	1	33.33	2	66.67
e2	1	33.33	3	100.00

WT1_07_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	33.33	1	33.33
c4	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_07_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e2	1	100.00	1	100.00

WT1_07_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_08_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Moderately Significant	3	100.00	3	100.00

WT1_08_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
e2	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_08_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	100.00	2	100.00

WT1_08_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e1	1	50.00	1	50.00
e4	1	50.00	2	100.00

Cumulative
Cumulative

WT1_08_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_09_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Moderately Significant	1	33.33	1	33.33
Highly significant	2	66.67	3	100.00

WT1_09_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d5	1	33.33	1	33.33
e1	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_09_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	2	66.67	2	66.67
b3	1	33.33	3	100.00

WT1_09_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
e2	1	100.00	1	100.00

WT1_09_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_10_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Moderately Significant	2	66.67	2	66.67
Highly significant	1	33.33	3	100.00

WT1_10_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	33.33	1	33.33
d1	1	33.33	2	66.67
e4	1	33.33	3	100.00

WT1_10_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	2	66.67	2	66.67
d4	1	33.33	3	100.00

WT1_10_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
d7	1	100.00	1	100.00

WT1_10_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_11_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Moderately Significant	2	66.67	2	66.67
Highly significant	1	33.33	3	100.00

WT1_11_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	33.33	1	33.33
d1	1	33.33	2	66.67
d7	1	33.33	3	100.00

WT1_11_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	50.00	1	50.00
d5	1	50.00	2	100.00

WT1_11_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent

c3	1	100.00	1	100.00

WT1_11_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_12_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Moderately Significant	1	33.33	1	33.33
Highly significant	2	66.67	3	100.00

WT1_12_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b2	1	33.33	1	33.33
b3	1	33.33	2	66.67
d1	1	33.33	3	100.00

WT1_12_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
b3	1	33.33	1	33.33
c2	1	33.33	2	66.67
d5	1	33.33	3	100.00

WT1_12_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c2	1	50.00	1	50.00
c3	1	50.00	2	100.00

WT1_12_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_13_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	33.33	1	33.33
Moderately Significant	1	33.33	2	66.67
Highly significant	1	33.33	3	100.00

WT1_13_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a1	1	33.33	1	33.33
c1	1	33.33	2	66.67
d1	1	33.33	3	100.00

WT1_13_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	50.00	1	50.00
b1	1	50.00	2	100.00

WT1_13_4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
c1	1	100.00	1	100.00

WT1_13_5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

WT1_14_1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Significant	1	33.33	1	33.33
Moderately Significant	1	33.33	2	66.67
Highly significant	1	33.33	3	100.00

WT1_14_2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
a2	1	33.33	1	33.33
c1	1	33.33	2	66.67
c4	1	33.33	3	100.00

WT1_14_3	Frequency	Percent	Cumulative Frequency	Cumulative Percent

```
        c2                                                            1      33.33            1        33.33
        c3                                                            1      33.33            2        66.67
        c5                                                            1      33.33            3       100.00

                                                                                     Cumulative
Cumulative
        WT1_14_4                                                Frequency     Percent     Frequency
Percent

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                                                                                     Cumulative
Cumulative
        WT1_14_5                                                Frequency     Percent     Frequency
Percent

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                                                                       Cumulative    Cumulative
                                  WT1_15_1    Frequency     Percent     Frequency      Percent
                      ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
                                         0           1       33.33             1        33.33
                      Not Significant                1       33.33             2        66.67
                      Moderately Significant         1       33.33             3       100.00

                                                                                     Cumulative
Cumulative
        WT1_15_2                                                Frequency     Percent     Frequency
Percent

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        c3                                                            1      50.00            1        50.00
        e4                                                            1      50.00            2       100.00

                                                                                     Cumulative
Cumulative
        WT1_15_3                                                Frequency     Percent     Frequency
Percent

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        e4                                                            1     100.00            1       100.00

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Cumulative
        WT1_15_4                                                Frequency     Percent     Frequency
Percent

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                                                                                     Cumulative
Cumulative
        WT1_15_5                                                Frequency     Percent     Frequency
Percent

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                                                                       Cumulative    Cumulative
                                  WT1_16_1    Frequency     Percent     Frequency      Percent
                      ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
                                         0           3      100.00             3       100.00

                                                                                     Cumulative
Cumulative
        WT1_16_2                                                Frequency     Percent     Frequency
Percent

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                                                                                     Cumulative
Cumulative
        WT1_16_3                                                Frequency     Percent     Frequency
Percent

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                                                                                     Cumulative
Cumulative
        WT1_16_4                                                Frequency     Percent     Frequency
Percent

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                                                                                     Cumulative
Cumulative
        WT1_16_5                                                Frequency     Percent     Frequency
Percent

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Percent
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ANNEXURE G:

Table 5.5: Descriptive statistics for questionnaire 1.

Variables	Categories / Ratings	Frequency	Percentage out of total
1.2 Designation	Estimator	2	18.2%
	Site manager	3	27.3%
	Site engineer	2	18.2%
	Foreman	4	36.4%
1.3 Are you permanent or temporary staff?	Permanent	11	100.0%
	Temporary	0	0.0%
1.5 Rank the categories of waste present in your project according to their cost impact or their occurrence.			
1.5.1 Wood	1	3	27.3%
	2	4	36.4%
	3	2	18.2%
	4	2	18.2%
1.5.2 Painting	5	1	9.1%
	9	3	27.3%
	10	6	54.6%
	11	1	9.1%
1.5.3 Drywall	2	2	18.2%
	4	2	18.2%
	5	1	9.1%
	6	2	18.2%
	7	2	18.2%
	8	1	9.1%
	9	1	9.1%
1.5.4 Siding	4	1	9.1%
	6	1	9.1%
	7	3	27.3%
	8	4	36.4%
	9	2	18.2%
1.5.5 Cardboard	2	1	9.1%
	3	2	18.2%
	5	1	9.1%
	6	1	9.1%
	7	2	18.2%
	8	4	36.4%
1.5.6 Flooring	3	2	18.2%
	4	1	9.1%
	5	1	9.1%
	6	2	18.2%
	7	1	9.1%
	8	3	27.3%
	Unknown	1	9.1%

Variables	Categories / Ratings	Frequency	Percentage out of total
1.5.7 Concrete and Masonry	1	7	63.6%
	2	3	27.3%
	4	1	9.1%
1.5.8 Tile	3	2	18.2%
	4	2	18.2%
	5	4	36.4%
	6	1	9.1%
	7	1	9.1%
	9	1	9.1%
1.5.9 Metals	3	2	18.2%
	4	2	18.2%
	6	4	36.4%
	9	2	18.2%
	10	1	9.1%
1.5.10 Trim	3	1	9.1%
	4	1	9.1%
	5	3	27.3%
	6	1	9.1%
	7	1	9.1%
	8	1	9.1%
	9	1	9.1%
	10	1	9.1%
	11	1	9.1%
1.5.11 Other	1	1	9.1%
	2	1	9.1%
	10	1	9.1%
	11	6	54.6%
	Unknown	2	18.2%

Table 5.7: Descriptive statistics for questionnaire 2.

Variables	Categories	Frequency	Percentage out of total
First Category	Concrete & Masonry	8	33.3%
	Wood	6	25.0%
	Tile	1	4.2%
	Drywall	3	12.5%
	Cardboard	2	8.3%
	Metal	1	4.2%
	Flooring	1	4.2%
	Plastering	1	4.2%
	Bricks	1	4.2%
Degree of influence for type of waste as well as major causes.			
1.1.1 Delays	Not significant	10	41.7%
	Moderately significant	3	12.5%

Variables	Categories	Frequency	Percentage out of total
	Highly significant	9	37.5%
	Unknown	2	8.3%
1.1.2 Main causes of delays.	B3. Poor Planning.	12	50.0%
	E4. Lack of integration.	5	20.8%
	E2. Not enough information.	5	20.8%
	A2. Poor project site layout.	5	20.8%
1.1.6 Main cause category of waste.	Management	15	62.5%
1.2.1 Waste of materials	Not significant	0	0.0%
	Moderately significant	4	16.7%
	Highly significant	18	75.0%
	Unknown	2	8.3%
1.2.2 Main causes of the waste of materials.	B3. Poor Planning.	9	37.5%
	C2. Ineffective work methods	8	33.3%
	B2. Lack of control.	8	33.3%
	D1. Excessive quantity.	7	29.2%
1.2.6 Main cause category of waste.	Resources	21	87.5%
1.3.1 Deterioration of materials	Not significant	5	20.8%
	Moderately significant	7	29.2%
	Highly significant	10	41.7%
	Unknown	2	8.3%
1.3.2 Main causes of the deterioration of materials	B3. Poor Planning.	11	45.8%
	D7. Inadequate storage.	5	20.8%
	C2. Ineffective work methods	5	20.8%
	C4. Lack of workplace available.	4	16.7%
	A2. Poor project site layout.	4	16.7%
1.3.6 Main cause category of waste.	Management	14	58.3%
1.4.1 Inefficient movement of workers	Not significant	8	33.3%
	Moderately significant	9	37.5%
	Highly significant	5	20.8%
	Unknown	2	8.3%
1.4.2 Main causes of the inefficient movement of workers	B3. Poor Planning.	8	33.3%
	B2. Lack of control.	8	33.3%
	A2. Poor project site layout.	4	16.7%
	D1. Excessive quantity.	3	12.5%
1.4.6 Main cause category of waste.	Management	16	66.7%
1.5.1 Material purchased with superior value.	Not significant	12	50.0%
	Moderately significant	6	25.0%
	Highly significant	4	16.7%
	Unknown	2	8.3%
1.5.2 Main causes of material purchased with superior value.	B3. Poor Planning.	10	41.7%
	E4. Lack of integration.	8	33.3%
	A1. Poor design and specifications.	7	29.2%
	E2. Not enough information.	2	8.3%
1.5.6 Main cause category of waste.	Information systems	13	54.2%
1.6.1 Work not done.	Not significant	11	45.8%
	Moderately significant	6	25.0%

Variables	Categories	Frequency	Percentage out of total
	Highly significant	5	20.8%
	Unknown	2	8.3%
1.6.2 Main causes of the work not done.	B3. Poor Planning.	12	50.0%
	B2. Lack of control.	6	25.0%
	A1. Poor design and specifications.	4	16.7%
	D7. Inadequate storage.	3	12.5%
	D6. Availability.	3	12.5%
	C5. Lack of personal equipment.	3	12.5%
1.6.6 Main cause category of waste.	Management	21	87.5%
1.7.1 Waiting or idle.	Not significant	12	50.0%
	Moderately significant	7	29.2%
	Highly significant	3	12.5%
	Unknown	2	8.3%
4.7.2 Main causes of the waiting or idle.	B3. Poor Planning.	14	58.3%
	E2. Not enough information	6	25.0%
	A1. Poor design and specifications.	5	20.8%
	D6. Availability.	4	16.7%
	A2. Poor project site layout.	4	16.7%
1.7.6 Main cause category of waste.	Management	17	70.8%
1.8.1 Unnecessary work.	Not significant	3	12.5%
	Moderately significant	15	62.5%
	Highly significant	4	16.7%
	Unknown	2	8.3%
1.8.2 Main causes of the unnecessary work.	B3. Poor Planning.	10	41.7%
	E4. Lack of integration.	7	29.2%
	E2. Not enough information.	6	25.0%
	D5. Poor quality.	4	16.7%
	A1. Poor design and specifications.	4	16.7%
1.8.6 Main cause category of waste.	Information systems	20	83.3%
1.9.1 Rework.	Not significant	2	8.3%
	Moderately significant	6	25.0%
	Highly significant	14	58.3%
	Unknown	2	8.3%
1.9.2 Main causes of the rework.	D5. Poor quality.	11	45.8%
	E2. Not enough information.	8	33.3%
	B2. Lack of control.	6	25.0%
	E1. Unnecessary information.	5	20.8%
	C1. Poor quality of team work.	5	20.8%
	B3. Poor Planning.	5	20.8%
1.9.6 Main cause category of waste.	Information systems	18	75.0%
1.10.1 Over allocations of materials.	Not significant	4	16.7%
	Moderately significant	7	29.2%
	Highly significant	11	45.8%
	Unknown	2	8.3%
1.10.2 Main causes of the over allocations of materials.	B3. Poor Planning.	11	45.8%
	D4. Poor distribution.	6	25.0%

Variables	Categories	Frequency	Percentage out of total
	D1. Excessive quantity.	4	16.7%
	B2. Lack of control.	4	16.7%
1.10.6 Main cause category of waste.	Management	17	70.8%
1.11.1 Waste of space on site	Not significant	9	37.5%
	Moderately significant	6	25.0%
	Highly significant	7	29.2%
	Unknown	2	8.3%
1.11.2 Main causes of the waste of space on site	B3. Poor Planning.	10	41.7%
	A2. Poor project site layout.	9	37.5%
	D7. Inadequate storage.	5	20.8%
	C4. Lack of workplace availability.	4	16.7%
	C3. Poor arrangement in the working place.	4	16.7%
1.11.6 Main cause category of waste.	Management	13	54.2%
1.12.1 Unnecessary handling of material.	Not significant	4	16.7%
	Moderately significant	10	41.7%
	Highly significant	8	33.3%
	Unknown	2	8.3%
1.12.2 Main causes of the unnecessary handling of material.	B3. Poor Planning.	11	45.8%
	C4. Lack of workplace availability.	8	33.3%
	C2. Ineffective work methods.	8	33.3%
	A2. Poor project site layout.	8	33.3%
1.12.6 Main cause category of waste.	Production	24	100.0%
1.13.1 Abnormal use of equipment.	Not significant	9	37.5%
	Moderately significant	7	29.2%
	Highly significant	6	25.0%
	Unknown	2	8.3%
1.13.2 Main causes of the abnormal use of equipment.	B3. Poor Planning.	7	29.2%
	C5. Lack of personal equipment.	6	25.0%
	C1. Poor qualification of team work.	6	25.0%
	C2. Ineffective work methods.	3	12.5%
	B2. Lack of control.	3	12.5%
	A2. Poor project site layout.	3	12.5%
	A1. Poor design and specifications.	3	12.5%
1.13.6 Main cause category of waste.	Production	17	70.8%
1.14.1 Accidents.	Not significant	15	62.5%
	Moderately significant	1	4.2%
	Highly significant	5	20.8%
	Unknown	3	12.5%
1.14.2 Main causes of accidents.	A2. Poor project site layout.	7	29.2%
	C1. Poor qualification of team work.	6	25.0%
	C5. Lack of personal equipment.	4	16.7%
	C2. Ineffective work methods.	4	16.7%
1.14.6 Main cause category of waste.	Production	20	83.3%

Variables	Categories	Frequency	Percentage out of total
1.15.1 Clarifications.	Not significant	9	37.5%
	Moderately significant	6	25.0%
	Highly significant	4	16.7%
	Unknown	5	20.8%
1.15.2 Main causes of the clarifications.	E4. Lack of integration.	9	37.5%
	B3. Poor planning.	3	12.5%
	A1. Poor design and specifications.	3	12.5%
1.15.6 Main cause category of waste.	Information systems	15	62.5%
1.16.1 Other.	Not significant	9	37.5%
	Moderately significant	0	0.0%
	Highly significant	0	0.0%
	Unknown	15	62.5%
1.16.2 Main causes of other.	A1. Poor design and specifications.	3	12.5%
	C2. Ineffective work methods.	1	4.2%
	A2. Poor project site layout.	1	4.2%
1.16.6 Main cause category of waste.	Project	4	16.7%

Table 5.8: Descriptive statistics for questionnaire 3.

Variables	Categories	Frequency	Percentage out of total
1.2 Designation	Estimator	2	8.7%
	Site manager	9	39.1%
	Site engineer	4	17.4%
	Foreman	1	4.4%
	Other	7	20.4%
1.3 Are you permanent or temporary staff?	Permanent	22	95.6%
	Temporary	1	4.4%
Attitude of workforce			
1. Company performs well in the area of construction waste management.	Strongly agree	0	0.0%
	Agree	13	56.5%
	Undecided	0	0.0%
	Disagree	10	43.5%
	Strongly disagree	0	0.0%
2. Company has a waste management strategy.	Strongly agree	3	13.0%
	Agree	11	47.8%
	Undecided	1	4.4%
	Disagree	8	34.8%
	Strongly disagree	0	0.0%
3. Cost of waste does not have much effect on the project.	Strongly agree	0	0.0%
	Agree	3	13.0%
	Undecided	1	4.4%
	Disagree	13	56.5%
	Strongly disagree	6	26.1%
4. Waste management is as important as	Strongly agree	9	39.1%

Variables	Categories	Frequency	Percentage out of total
other functions of construction management.	Agree	10	43.5%
	Undecided	2	8.7%
	Disagree	1	4.4%
	Strongly disagree	1	4.4%
5. Attention of waste management in the actual practice is not sufficient.	Strongly agree	2	8.7%
	Agree	13	56.5%
	Undecided	2	8.7%
	Disagree	6	26.1%
	Strongly disagree	0	0.0%
6. Waste management is worthwhile irrespective of the cost gains.	Strongly agree	10	43.5%
	Agree	9	39.1%
	Undecided	3	13.0%
	Disagree	1	4.4%
	Strongly disagree	0	0.0%

Table 5.10: Descriptive statistics for questionnaire 4.

Variables	Categories	Frequency	Percentage out of total
1.2 Trade	Brick layer	3	14.3%
	Painter	2	9.5%
	Steel fixer	2	9.5%
	Plumber	3	14.3%
	Plasterer	2	9.5%
	Sutter hand	1	4.8%
	No trade stated	8	38.1%
1.3 Staff category.	Top management	5	23.8%
	Middle management	7	33.3%
	Supervisory	7	33.3%
	Labour	2	9.5%
Attitude of sub-contractors			
1. The industry should do more to reduce waste.	Strongly agree	5	23.8%
	Agree	16	76.2%
	Undecided	0	0.0%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
2. Site Management is the main factor affecting the levels of waste produced on site.	Strongly agree	5	23.8%
	Agree	7	33.3%
	Undecided	0	0.0%
	Disagree	9	42.9%
	Strongly disagree	0	0.0%
3. A waste level of 10% is an acceptable level for the construction process.	Strongly agree	1	4.8%
	Agree	4	19.0%
	Undecided	2	9.5%
	Disagree	14	66.7%

Variables	Categories	Frequency	Percentage out of total
	Strongly disagree	0	0.0%
4. It is the main contractors who are fully responsible to segregate waste on site.	Strongly agree	4	19.0%
	Agree	16	76.2%
	Undecided	0	0.0%
	Disagree	1	4.8%
	Strongly disagree	0	0.0%
5. Sub-contractors should segregate waste.	Strongly agree	5	23.8%
	Agree	13	61.9%
	Undecided	0	0.0%
	Disagree	3	14.3%
	Strongly disagree	0	0.0%
6. Waste minimisation will be a major issue for sub-contractors in future.	Strongly agree	5	23.8%
	Agree	13	61.9%
	Undecided	0	0.0%
	Disagree	3	14.3%
	Strongly disagree	0	0.0%
7. The Government should increase landfill tax to force waste reduction on site.	Strongly agree	1	4.8%
	Agree	1	4.8%
	Undecided	2	9.5%
	Disagree	16	76.2%
	Strongly disagree	1	4.8%
8. Sub-contractors should price for costs involved in waste reduction.	Strongly agree	4	19.0%
	Agree	10	47.6%
	Undecided	2	9.5%
	Disagree	5	23.8%
	Strongly disagree	0	0.0%
9. Sub-contractors should be penalised for waste produced on site.	Strongly agree	4	19.0%
	Agree	11	52.4%
	Undecided	2	9.5%
	Disagree	3	14.3%
	Strongly disagree	0	0.0%
	Unknown	1	4.8%
10. Poorly offloaded and incorrect stored materials are the major cause of wastage on site.	Strongly agree	2	9.5%
	Agree	13	61.9%
	Undecided	1	4.8%
	Disagree	5	23.8%
	Strongly disagree	0	0.0%
11. Lack of care by sub-contractors is the major cause of waste on site.	Strongly agree	4	19.0%
	Agree	13	61.9%
	Undecided	0	0.0%
	Disagree	4	19.0%
	Strongly disagree	0	0.0%
12. Main contractor should build in allowable waste percentages to sub-contractors packages.	Strongly agree	3	14.3%
	Agree	17	81.0%
	Undecided	1	4.8%

Variables	Categories	Frequency	Percentage out of total
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
13. Education of sub-contractors is the preferred method of reducing site wastage.	Strongly agree	5	23.8%
	Agree	15	71.4%
	Undecided	1	4.8%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
14. A financial incentive with financially benefits for sub-contractors will reduce waste.	Strongly agree	5	23.8%
	Agree	15	71.4%
	Undecided	1	4.8%
	Disagree	0	0.0%
	Strongly disagree	0	0.0%
15. The main contractor should employ operatives to sort and segregate waste on site.	Strongly agree	4	19.0%
	Agree	14	66.7%
	Undecided	1	4.8%
	Disagree	2	9.5%
	Strongly disagree	0	0.0%