A CASE STUDY OF THE COST AND CAUSES OF THE TONGAAT MALL ACCIDENT IN DURBAN

BY

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DECLARATION

I, Leonarda van Eeden, Student No. 214231682, hereby declare that this is my original work and that to the best of my knowledge this work has not been previously submitted in fulfilment of an equivalent qualification at any other recognised educational institution.

Name Leonarda van Eeden

Signed ……..

Date ……

DEDICATION

This study is dedicated to

God Almighty for making this possible.

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ABSTRACT

The literature shows that building collapses occur due to either management or operational failure. This dissertation presents the causes of building collapse linked to management and operational lapses. A case study research on the Tongaat mall collapse in November 2013 forms the basis for the research. Through data collection that entails content analysis of official inquiry into the collapse and subsequent semi-structured face-to-face interviews among the participants in the collapsed building, major failures were identified. Salient findings show that the regulatory functions on the building project were compromised, and the inability to ensure that the project fulfils all enforcement and compliance requirements significantly enhances the existence of a work environment that led to two fatalities and 29 injuries. This study corroborates past findings that have flagged implementation as the weak link of H&S management in terms of construction regulations in South Africa. In other words, the benefits of adequate policies on paper can only emerge through applications on construction sites

Key words: Accident, Building, Construction, Cost, Health and Safety, South Africa

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PREFACE

This research project examined the contributing factors and issues that lead to the building collapse in Tongaat, KwaZulu-Natal. The study investigated the cost of accident due to this collapse so as to explore whether the approach to construction health and safety (H&S) by project stakeholders was in line with what is required by legislation in South Africa. The rationale for the investigation stems from the view by scholars that construction industry stakeholders do not seem to consider the future in their actions and decisions. The study examined the remote and immediate causes of the accident, with specific focus on the construction H&S implications of decisions that manifest in the building collapse. Given the need for the lived experiences of the project participants, a single case study approach has been adopted. As opposed to the breadth of information, the single case study provides insights for the analysis of the direct and indirect cost of the accident. The premise of the study is that when the cost of accident (CoA) is known, the information would influence future actions that would mitigate the manifestation of fatalities and injuries on construction sites in South Africa.

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DEFINITIONS OF TERMS

Accident: an event arising out of and in the course of an employee's employment and resulting in a personal injury, illness or the death of the employee (Republic of South Africa, 1993, p. 3).

Employee: subject to the provisions of subsection (2), any person who is employed by or works for an employer and who receives or is entitled to receive any remuneration or works for an employer or any other person (Republic of South Africa, 1993, p. 3).

Employer: subject to the provisions of subsection (2), any person who employs or provides work for any person and remunerates that person or expressly or tacitly undertakes to remunerate him, but excludes a labour broker as defined in section 1 (1) of the Labour Regulations Act, 1956 (Act 28 of 1956) (Republic of South Africa, 1993, p. 3).

Direct costs: those costs directly related to or associated with injuries and any compensation awarded to workers as a result of being injured and are covered by workmen's compensation insurance premiums (Hinze, 1997, p. 64)

Hazard: a source of or exposure to danger (Republic of South Africa, 1993, p. 3).

Incident: an undesired event that takes place because the necessary SHE controls were not in place or failed (Hinze, 1997, p. 441).

Indirect costs: those costs which are hidden and for which no historical record is kept (Hinze, 1997, p. 66)

Lost workday injury: a work-related injury of an employee in which the employee experiences either days away from work (absence from the job for medical treatment or recuperation), days of restricted work activity, or both (Hinze, 1997, p. 441).

Near miss: incident involving no injury and no property damage, but high potential for such occurrence (Hinze, 1997, p. 442).

Occupational Safety and Health Administration (OSHA): agency created by the Occupational Safety and Health Act (OS11 Act) to promulgate safety and health standards, enforce compliance with the safety regulations, and monitor industry safety performance (Hinze, 1997, p. 442).

Risk: the probability that injury or damage will occur (Republic of South Africa, 1993, p. 5).

ABBREVIATIONS

ACPM	:	Association of Construction Project Managers
ASAQS	:	Association of South African Quantity Surveyors
CC	:	Compensation Commissioner
CESA	:	Consulting Engineers South Africa
CETA	:	Construction Education and Training Authority
CIB	:	International Council for Research and Innovation in Building and Construction
CIDB	:	Construction Industry Development Board
COA	:	Cost of Accident
COID	:	Compensation for Occupational Injuries and Disease Act
DIIR	:	Disabling Injury Incidence Rate
DoL	:	Department of Labour
FEMA	:	Federated Employers Mutual Assurance Company Limited
GCC	:	General Conditions Contract
GDP	:	Gross Domestic Product
H&S	:	Health and Safety
ILO	:	International Labour Organisation
JBCC	:	Joint Building Contracts Committee
MBASA	:	Master Builders Association South Africa
NEC3	:	Engineering and Construction Short Contract
OHSA	:	Occupational Health and Safety Act
SAIA	:	South African Institute of Architects
SFU	:	Standard of Uniformity in Construction and Procurement
SR	:	Severity Rate

CHAPTER ONE: BACKGROUND OF THE RESEARCH PROJECT

1.1 Introduction

Buildings through the ages have been a significant part of the socio-economic development of civilisation. In a civilised setting, shelter is ranked third in the hierarchy after food and clothing (Olusola, Ojambati, & Lawal, 2011, p. 462). Olusola et al. (2011, p. 462) record that the first documented building collapse was that of the Tower of Babel. In the modern age, it is not uncommon to hear of building collapse as an everyday issue in various countries around the world. At 7:05 pm on Friday, July 17, 1981, the atrium of the luxurious and most modern hotel in Kansas City, Missouri, United States of America (USA), the Hyatt Regency collapsed with a human life cost that totalled 144 fatalities with approximately 200 recorded injuries (Levy & Salvadori, 2002, p. 224). In this particular accident, it was decided that the responsibility for the collapse could mainly be attributed to the structural engineers. After further investigation, it was discovered that dangerous design suggestions had been made by the contractors, aimed at simplifying the construction of the walkways which later collapsed, proving fatal because these suggested changes had gone unnoticed by the design engineers. It must be noted that neither the quality of workmanship nor the materials used in the walkway system played a significant role in initiating the collapse (Levy & Salvadori, 2002, p. 230). In conclusion, the Missouri licensing board and the Missouri Court of Appeal found fault with the design engineers because they had not noticed the essential differences between their original design and the design suggested by the contractor that they acknowledged reviewing (Levy & Salvadori, 2002, p. 230).

Furthermore, on 11 May 2013, a four-storey building collapsed in Nigeria's commercial capital Lagos, killing at least four construction workers and leaving around 50 injured (News24, 2013: online). The incident occurred during the course of construction on the prestigious Victoria Island, in a lagoon set back from the Atlantic, home to some of Africa's most expensive real estate. This caused massive economic and social losses. In another tragedy, 13 bodies were pulled from the wreckage of a building under construction that collapsed in a coastal village in the popular Indian tourist state of Goa on Saturday, 4 January

2014 (News24, 2014: online). In relevant news reports, this type of catastrophes highlighted substandard construction of buildings. Collected studies by the British daily newspaper, *The Guardian* indicate that 2651 people were killed across India in 2012 due to collapse of 2737 structures, including houses and bridges. Real estate experts in the area note that many buildings collapse due to construction codes not being adhered to and poor attention to construction H&S (News24, 2014: online).

In specific terms, the frequency of building collapses in South Africa has been on the increase. On 18 August 2014, a building collapsed during renovation construction in the upmarket Meyersdal, Eco Estate, Johannesburg, South Africa (News24, 2014: online). A total of seven people died and nine were injured. In reports, the building collapsed from the roof down, entombing workers who were busy renovating the R9 million building. The focus of this research project is the Tongaat Mall building collapse, which occurred on 19 November 2013, in the town of Tongaat, KwaZulu-Natal. It was recorded that a concrete slab collapsed on top of workers that were busy with activities on the site. The incident killed two people and injured 29 others.

Windapo & Rotimi (2012, p. 284) state that the issue of building collapse during and after construction has failed to receive the attention it deserved from public and private clients and other construction sector stakeholders. As stated in the Construction Industry Development Board (CIDB) report (2009a), South Africa is not deficient in terms of OH&S (Occupational Health and Safety) legislation. It furthermore elucidates that the South African legislative framework addresses H&S at various levels. However, Windapo (2013, p. 69), citing the CIDB report (2009a), Geminiani and Smallwood (2008:p. 1) and MBSA (2013, p. 11), indicated that contractors in South Africa do not comply fully with H&S regulations amidst of all the efforts made by the Department of Labour (DoL) and stakeholders (Geminiani, Smallwood, 2008, p. 1). A marginal decrease in construction accidents and/or construction fatalities has been seen over the years. Therefore, while the statuary framework for designing and constructing buildings is well entrenched within a reasonably well defined authoritative control system, deficiencies within the system itself do exist, particularly as a result of changing technological and environmental circumstances. Government has invested in extensive legislative measures to counter these catastrophes (Olusola et al., 2011, p. 462).

Olusola et al. (2011, p. 463) see building codes as legal requirements, the purpose of which is to promote good practice in the design and construction of buildings in the interest of the health, safety and welfare of its occupants. However, control measures seem to be insufficient – in fact, seriously deficient if not non-existent, and mainly delegated to the individual entities assuming responsibility for their work, but with limited liability This situation is not limited to a single country, but certainly more pertinent in the developing world. Recent occurrences in South Africa opened concerns as to the efficiency of the South African system.

1.2 Statement of the problem

Construction H&S is the focus of many industry stakeholders and role players in South Africa. While it is acknowledged that many industry associations and professional societies have made significant efforts to improve H&S, the outcome is still not encouraging (CIDB, 2009, p. 5). Thus, the construction industry remains one of the largest contributors to the number of fatalities and injuries relative to other industrial sectors. This perception presents unique challenges. For the purpose of this research, the research problem under investigation was: *Building collapse has engendered increased construction accidents and the cost thereof in South Africa.*

1.2.1 Working Hypothesis

Based on the above mentioned problem statement, the working hypothesis for the study says: "Construction accident causations require structured analysis to prevent future accidents in South Africa".

1.3 Research questions

The research tackled the following questions:

- What are the contributing factors that led to the Tongaat mall accident?
- What is the non-monetary direct cost of the Tongaat mall accident?

- What are the non-monetary indirect costs of the Tongaat mall accident?
- What are the lessons to be learnt from the Tongaat mall accident?

1.4 Research aim and objectives

The aim of the study was to determine the socio-economic cost of the Tongaat mall accident. In order to realise this aim, the objectives pursued include:

- Determination of the contributing factors that lead to the Tongaat mall accident.
- Establishment of the direct cost of the Tongaat mall accident.
- Identification of the indirect cost of the Tongaat mall accident.
- Recommendations from the lessons learnt from this accident in order to mitigate future occurrences.

This study should contribute towards the development of preventative measures to prevent further loss of life, high insurance premiums and a rising cost of accident in South African construction.

1.5 Delimitations of the study

- The Tongaat mall building collapse forms the single case for the project.
- The relationship between building collapse and resulting cost of accident constitute the bulk of literature consulted.
- The perceptions collected and analysed pertain to only the Tongaat mall accident.
- The Tongaat mall accident is at the time of the study is "*sub judice",* which means that some construction project participants could not participate in the interviews.

1.6 Assumptions

- Accident is not a project requirement – accident prevention efforts required on constructions sites are different from those in manufacturing because the work

environment is in a constant state of change (Hinze, 1997, p. 9). Hinze (1997, p. 9) notes that accident prevention in the construction environment is more challenging, but it does not mean that safety objectives in a construction setting must be regarded any lower than manufacturing; therefore, an accident is not a project requirement.

- All injuries and accidents have cost implications - closer examination of the total cost of injuries reveals that they are quite high (Hinze, 1997, p. 83). Hinze pointed out that to disregard the costs of injuries is not sensible or financially pragmatic. The cost of injuries is high, even when they do not include the pain and suffering of the workers and their families. Once the magnitude of true costs of injuries is understood, it is easier to embrace a zero-accident philosophy.

1.7 Rationale for the study

According to Windapo and Rotimi (2012, p. 284), the issue of building collapse during and after construction has failed to receive the attention it deserves from public and private clients and other construction stakeholders. Research conducted by Soeiro, Silva and Barkokebas (2014, p. 193) establish that the construction sector stands out, with one in six fatalities occurring in labour accidents. It has been found that at least 60000 deaths occur per year on construction sites around the world, and this leads to a deadly accident every ten minutes (Soeiro, Silva, & Barkokebas, 2014, p. 192). Windapo (2013, p. 67-69) is of the opinion that the South African construction industry records show that work-related deaths, occupational diseases and injury claims absorb a significant proportion of the Gross National Product (GNP), this suggests that contractors in South Africa do not comply fully with H&S regulations despite efforts made by the DoL and other stakeholders.

The foremost motivation for choosing the topic is the necessity for improving H&S performance in the construction industry in South Africa to prevent more tragedies from occurring. Other reasons include the lack of in-depth analysis of accident causations in South African construction, especially in relation to building collapse. The lack hinders the creation and dissemination of preventive measures that could prevent future accidents and safe lives in the industry.

1.8 Summary

The research project was chosen in order to improve the understanding of cultivating a need for quality H&S performance in the construction industry in South Africa and to prevent more tragedies from occurring. From the limited research conducted on the cost of accident in relation to building collapse in South Africa and the phenomenal rise in building collapse cases across South Africa the researcher is of the opinion that this study was appropriately relevant.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter provides an overview of building collapses and discuss the principal reasons for such accidents. Olusola et al. (2011, p. 462) state in their research that when a building collapses, it fails to perform the function for which it was designed. It is crucially important to safeguard the lives of people who may be jeopardized in a catastrophic event such as building collapse during or after construction. The concern is not just about the increase of building collapse, but also the social and economic losses suffered due to loss of life, money and time, in addition to the psychological scars left by accidents.

2.2 Historic overview of building collapse

The frequency of building collapses in the recent past has become a major issue as this phenomenon has a detrimental effect on the socio-economic development of South Africa. These accidents have become a major cause for concern to government, construction professionals and stakeholders alike. Research by Yates and Lockley (2002, p. 8) found that trying to reduce the incidence of construction failures is a continuous process, and organizations such as the Occupational Safety and Health Administration (OSHA) and others are dedicated to this goal. To quote Ayedun, Durodola, and Akinjare (2012, p. 314), the proportion of buildings that collapse is significantly smaller compared with the vast majority in use, but the socio-economic impact of such accidents must be acutely noted. Ayedun et al. (2012, p. 314) also established that loss of life and monetary loss is most commonly associated with building collapse. Structural collapse is prevalent and occurs worldwide. Dyrud (2013, p. 2) and Ayedun et al. (2012, p. 314) contend that several causes of building failure can be attributed to either natural or man-made conditions. Natural phenomena may be attributable to seismic tremors and typhoons, such as the record snowfall in 2010 that collapsed the roof of Minneapolis Metrodome (Dyrud, 2013, p. 7). Often, though, artificial or man-made phenomena consist of accidents, which may be born from man's laxity in areas such as geo-technical investigations, building design and planning for superfluous live and

dead loads. Furthermore, inadequate foundation design, poor quality building materials to save money, derisory monitoring of craftsmen and meagre quality of workmanship could lead to the collapse of buildings.

Considering that the incidence of building collapse repudiates the principles of sustainable development, this would suggest that stakeholders do not consider the future of their current undertakings. Windapo (2012, p. 289), Dyrud (2013, p. 8), and Ayedun et al. (2012, p. 315) observe that the predominant reason for building collapse is structural failure, trailed by poor supervision and workmanship, the use of sub-standard materials, carelessness which could be linked to lack of competency in building techniques and supervision skills, and faulty design respectively. Other causes include excessive loading and adaptation and disdain for approved drawings. This suggests that the Tongaat mall building collapse is traceable to human activity or the lack thereof, given the non-occurrence of a natural phenomenon that led to the collapse.

2.3 Principal reasons for building collapse

2.3.1 Structural failure

Structural failure is defined by Yates and Lockley (2002, p. 9) as "the reduction of the capability of a structural system or component to such a degree that it cannot safely serve its intended purpose". Yates and Lockley (2002, p. 8), Barrister (2012, p. 40) and Wardhana and Hadipriono (2003, p. 151) are all of the opinion it is clear that much can be learnt through the failure of a structure rather than a study of structures which are successful. The proper appreciation of the causes of failure will assist professionals in refocusing their conceptual understanding of structural behaviour. Through research, it was established that the most prolific teachings in engineering judgments are obtained from studying case history failures, which point out without question, examples of bad judgment. The case studies provide guideposts for negotiating around pitfalls in conceptual design (Yates & Lockley, 2002, p. 8). They also provide invaluable insights into potential trip-wires that could lead to disastrous accidents such as building collapse. Yates and Lockley (2002, p. 9) show that structural failures could be due to:

- Poor communication between the various construction professionals.
- Lack of communication between fabricators and erectors.
- Poor workmanship.
- Compromises in professional ethics and failure to appreciate the responsibility of a profession.

Other mutual causes of structural failure are considered to be the lack of appropriate professional design and construction experience, especially when innovative structural designs are needed. Other reasons include the intricacy of codes and specifications leading to misinterpretation and misappropriation undeserved belief in calculations and in specified extreme loads and properties, the insufficient provision and evaluation of contract and shop drawings, and inadequate training of field inspectors, and limitations placed on design and construction time (Matthews & Saunders, 2009, p. 59).

2.3.2 Construction failure

Yates and Lockley (2002, p. 9) cite Janney (1986) in their statement that a construction failure is a failure that occurs during construction and they are considered to be either "a collapse, or distress, of a structural system to such a degree that it cannot safely serve its intended purpose". John (2009, p. 18) says when a component system or structure fails it may occur for many reasons, including changes in materials triggered by deterioration. Research has shown that unsuitable materials are one of the leading factors of failures. These failures may not lead to catastrophic structure collapse, but usually manifest as an unacceptable difference between expected and observed performance of a structural component in the building envelope. John (2009, p. 18) identified these changes as:

- Structural members becoming non-supportive, for example a moving component seizing
- Components becoming incapable of performing their intended function safely and reliably – loss of a loadbearing member could reduce the load-bearing capacity, which in turn leads to the loss of the factor of safety.

2.3.3 Inadequate construction supervision

Agwu (2014, p. 458) notes that many cases of poor construction supervision related to building failures have been reported. Poor construction supervision related building failures has also been observed to cut across different categories of buildings, namely: private, corporate or public. Agwu (2014, p. 459) sees the cause of building failures related to poor construction supervision is almost always unique to the particular building in question. A significant percentage of these failures are caused by carelessness and greed on the part of contractors (Windapo & Rotimi, 2012, p. 289). Poor construction supervision-related building failures might not be unconnected with the hasty and care free manner in which private clients handle their building projects with or without government approval (Agwu, 2014, p. 459). According to Agwu (2014, p. 459), 50% of poor construction supervision-related building failures in Nigeria is attributed to design failures, 40% to construction fault and 10% to product failures, also stating that poor construction supervision related building failures is no respecter of the size of a structure.

2.3.4 Inefficiencies related to institutional regulatory framework

The CIDB (2009, p. 10) notes that the poor H&S performance record of the construction industry globally has resulted in H&S regulations being subjected to major revisions. A range of regulations promulgated under the OH&S Act 85 of 1993 (Republic of South Africa, 1993) impact on construction H&S, in particular the construction regulations circulated in July 2003. A range of other legislation impact on the construction industry, some having direct or indirect reference to H&S: the Basic Conditions of Employment Act No. 75 of 1997 and Labour Relations Act N.6.103 of 1977. Smallwood and Geminiani (2008, p. 9) suggest that reduced budgets and the complexity of building design plan review have become an ever increasing burden for building departments. On-site inspection is intended to ensure that the construction is completed in accordance with the approved contract documents, but Smallwood and Geminiani (2008, p. 8) perceive that this is not the case. The CIDB (2009, p. 14) state that the primary construction H&S regulatory and enforcement structures in South Africa are the OH&S Inspectorate within the DoL and the Mine H&S Inspectorate within the Department of Minerals and Energy (DME). Compliance with building regulations falls

within the orbit of local authorities and the CIDB's Act also provides for the CIDB to play a regulatory role. Research conducted by Geminiani (2008, p. 9) in a study investigating the effectiveness of the DoL Inspectorate, showed that the Inspectorate was perceived to be more ineffective than effective.

2.3.5 Fast-track construction

Fast track projects are those in which construction begins before all of the architect's drawings and specifications are complete (Pawar, Attarde, Ayachit, & Kulkarni, 2014, p. 17). Also known as phased construction, the method is intended to save time by passing the traditional sequence of documentation, tendering and construction in order to allevaite the effects of inflation (Pawar, Attarde, Ayachit, & Kulkarni, 2014, p. 17). The use of fast-track methods of construction, design build approaches and other techniques to reduce the total elapsed time required from the decision to build to occupation, has had a damaging effect on the structural performance of buildings (CESA, 1996, p. 2). In structural components in terms of fast-track construction, the early removal of forms or the application of post-tensioning and the termination of curing in cold weather have safety implications if not applied appropriately (Barnett, Soutsos, Bumgey, & Millard, 2007, p. 388).

Likewise, the rapidly advancing increase in computational capability has provided mixed blessings, as in the Consulting Engineers South Africa (CESA) report (1996, p. 2). With a limited hands-on approach, obscuration of the building process can occur. This problem is most severe, state CESA, in the case of less experienced members of staff who lack the ability to umpire the reasonableness of the final result. The use of timesaving techniques requires greater team effort and co-ordination. In research conducted by CESA (1996, p. 2), it became clear, that confusion arises from these types of time-saving processes in terms of responsibility and accountability.

2.4 Consequences of building collapse

Apart from loss of life, many other people have been rendered disabled as a result of building collapse (Ayodeji, 2011, p. 41). Furthermore, building collapse has proven to have palpable consequences on the urban and socio-economic development of a country (Windapo & Rotimi, 2012, p. 284). Buildings that meet the desired performance requirements add value to the national asset stock and enhance its Gross Domestic Product (GDP) (Pillay & Haupt, 2008, p. 457). Windapo and Rotimi (2011, p. 284) suggest that there is only one alternative to sustainability: unsustainability which underperforming buildings bestow on the country's economy. In South Africa, occupational accidents and diseases account for approximately 3.5% of its GDP, which translates to about R30 billion (Pillay & Haupt, 2008, p. 457). Several productive lives and properties have been lost in the various incidents involving building collapse, and these losses have had negative impact on the socio-economic status of the country (Windapo & Rotimi, 2012, p. 284). Firms in construction fail to accurately accumulate the true costs associated with occupational accidents. There are aspects apart from the obvious financial and economic burden that cannot easily be quantified, namely the loss of a family member or even worse, the breadwinner. The DoL (2013, p. 38) announced that the construction industry has consistently been among those industries with high injury and fatality rates. Eliminating or reducing occupational injuries and disease will positively impact the mammoth amounts spent on compensation paid to workers that negatively affect the country's GDP (The Federated Mutual Assurance (FEM), 2012, p. 41).

2.5 Direct and Indirect costs

Hinze (1997, p. 64) states that cost of accidents (CoA) can be separated into two vital categories: direct and indirect costs. Direct costs are costs that are strictly linked to injuries; they are implicit and can be quantified with precision. Indirect costs also known as concealed costs of injuries with regards to construction workers and could be defined as costs of which no historical record or reclamation mechanism is in place. All these costs are determined by the severity of the accident (Pillay and Haupt, 2008, p. 457).

2.5.1 Direct costs

Direct costs can be defined as those costs that are insured, in other words costs covered by workers' compensation insurance policies. Examples of such costs include transport to a medical facility, medical and supplementary treatment, medication, hospitalization, disability benefits and lost wages incurred by the injured worker. These costs can be reviewed by analysing the historical data contributing to each injury incurred on site. It can therefore be summarized as direct costs being all the costs incurred directly relating to the treatment of the injury and any other compensation in providing relief to the injured worker (Hinze, 1997, p. 64).

2.5.2 Indirect costs

Indirect costs relate to the concealed costs, in such a way that they are not recognized in bookkeeping terms. When costs are accounted for, they habitually do not include the costs linked to schedule delays, administrative over-time costs, lower morale, increased absenteeism, and poor client relations. These hidden costs are not *prima facie*, so are not obvious. These indirect costs incurred can be much higher than the direct costs as initially estimated (Hinze, 1997, p. 66). Goetsch (2013, p. 14) and Pillay and Haupt (2008, p. 458), establish that indirect costs include:

- Sluggish productivity for both the injured worker upon returning to work and the workforce
- Clean-up costs
- Replacement costs
- Stand-by costs
- Cost of overtime
- Administrative costs
- Replacement worker orientation
- Costs resulting from delays

- Supervision costs
- Costs related to rescheduling
- Transportation
- Wages paid while injured is idle.

2.6 Health and Safety in relation to the cost of accident

The National Occupational Safety Association (NOSA) reports that incidents and disability rates are reduced through the implementation of H&S programmes. These reductions result in an overall improvement of quality of life. The financial benefits imply that employers and employees both reap rewards (NOSA, 2012, p. 15). The general morale and health status of the employee is improved. This provides the opportunity for improved production standards as well as improved employment opportunities, improved quality of products and an increased market share (NOSA, 2012, p. 15).

2.7 Summary

It is clear from the literature that there is a link between building collapse and CoA. Accidents in construction have multi-causal origins with catastrophic consequences. The CoA affects multiple stakeholders in the construction industry. Without a doubt, it is important to avoid accidents in the form of building collapse because of its socio-economic implications. It is clear from the literature that limited research has been conducted on cost of accident in relation to building collapse in South Africa. Despite legislation and regulation in South Africa with regards to H&S fatalities continue to occur in construction.

CHAPTER THREE: THE RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the design and methods adopted in the research. Two general approaches are widely recognised: quantitative research and qualitative research. Quantitative research is an investigation into an identified problem, based on testing a theory, measured with numbers, and analysed using statistical techniques (Kumar, 2014, p. 133). The goal of quantitative methods is to determine whether the prognostic generalisation of a theory hold true (Kumar, 2014, p. 133). By contrast, a study based upon a qualitative process of inquiry has the goal of understanding a social or human problem from multiple perspectives. Qualitative research is conducted in a natural setting and involves a process of building a complex and holistic picture of the phenomenon of interest (Kumar, 2014, p. 133).

Thomas (2011, p. 10) says that with qualitative data one can preserve chronological flow, see precisely which events led to which consequences, and derive fruitful explanations. In addition, good qualitative data are more likely to lead to serendipitous findings and to new integrations; they help the researcher to get beyond initial conceptions and to generate conceptual frameworks. Thus a qualitative research approach was adopted for this study.

The research study collected data from media reports, interviews, site visits and photo analysis. The variety of evidence covered in the study followed from the researcher having to study the Tongaat mall building collapse as a real-world setting and its participants. The research approach is premised on the need to evolve a comprehensive and logical means of data collection amongst various procedures and processes that must be followed for generating sound research results (Kothari, 2008, p. 8).

3.2 Research Design – Case Study

To cite Kumar (2014, p. 122), a research design is the road map that has to be followed during the research journey to discover the answers to the research questions as validly, objectively, accurately and economically as possible. It is a procedural-cum-operational plan

that details what and how different methods and procedures are to be applied in a research (Kumar, 2014, p. 122). From the explanations of Kumar (2014), research design is the means for achieving the goals of a research work (Flick, 2014, p. 116). Flick (2014, p. 116) feels it links theoretical frameworks, questions, generalization, and objectives with the methods used and resources available under the focus of goal achievement. In broad terms, the case study design was adopted for this study because there is a distinct desire to understand the complex social phenomena that occurred during the collapse of the Tongaat mall building collapse. The case study method allowed the researcher to retain the holistic and meaningful characteristics of the real-life events that transpired from the Tongaat mall collapse – such as individual life-cycles, organizational and managerial processes, social economic change and the maturation of the industry (Yin, 2014, p. 2).

Table 3.1 provides definitions and published examples of various types of case studies in the literature. Within this context, the most appropriate type of strategy for this research is the descriptive case study. As reported by Yin (2014, p. 64), a primary distinction in designing case studies is between single- and multiple-case designs. This means the need for a decision, prior to any data collection, on whether a single-case study or multiple cases are going to be used to address the research questions.

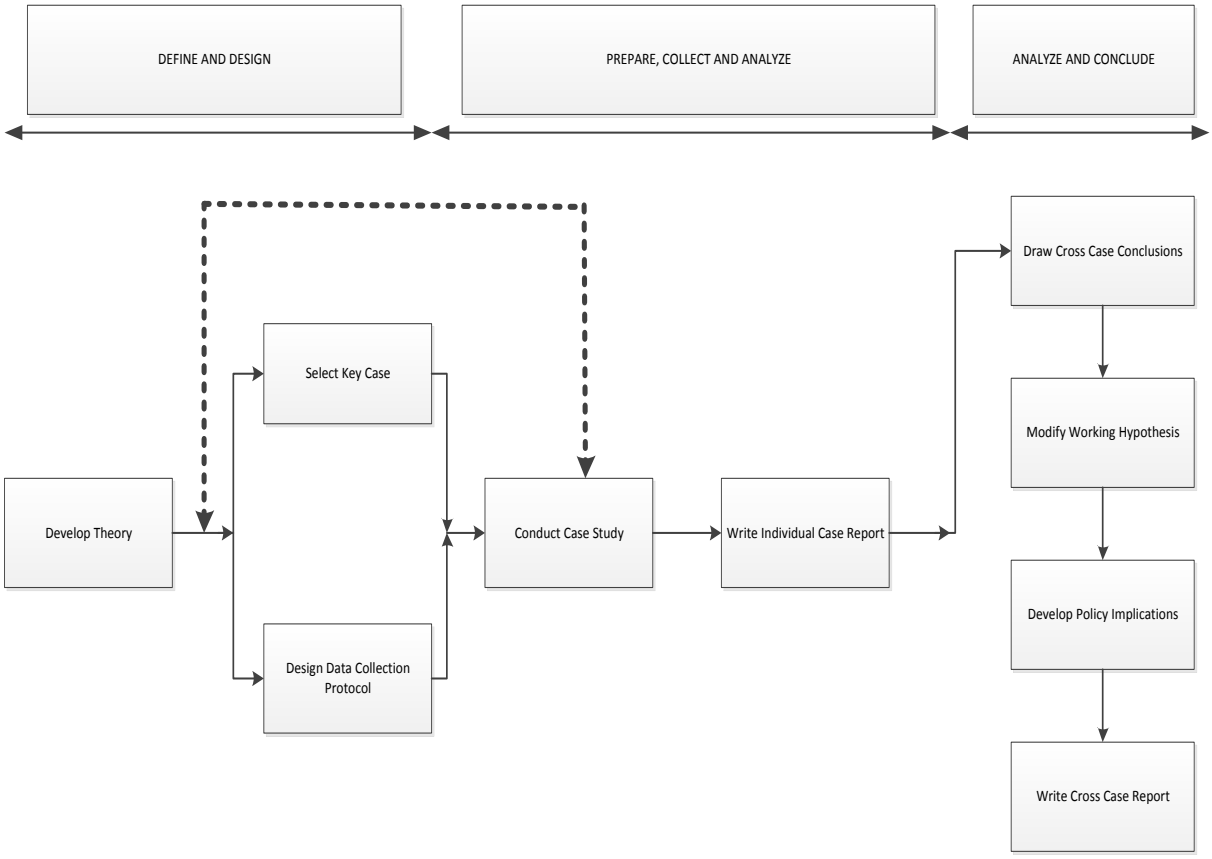

Figure 3.1: Case study method adopted for this research study (Yin, 2014, p. 60)

It was established that the research question will best be answered by using a qualitative case study. This implies that the case and its boundaries have been determined resulting in the selection of a specific type of case study design based on the work of several authoritative authors (Baxter & Jack, 2008, p. 547). The single-case study design is an appropriate design under several circumstances for this specific research study. Firstly, the Tongaat mall building collapse is analogous to a single experiment. Secondly, this single case can represent a significant contribution to knowledge within the construction H&S domain in South Africa. As such, the Tongaat mall collapse can be considered to be a complex functioning unit that has been investigated in its natural context through more than one method of data collection and it is certainly a contemporary case given its current status (Johansson, 2003, p. 2).

Table 3.1: Definitions and examples of different types of case studies

Type	Definition
Explanatory	This type of case study would be utilized if the researcher were seeking to answer a question that required illuminating the presumed instrumental links in real-life interventions that are too complex for the survey or experimental strategies. In evaluation language, the explanations would link program implementation with program effects.
Exploratory	This type of case study is used to explore those conditions in which the intervention being assessed has no clear, single set of outcomes.
Descriptive	This type of case study is used to define a phenomena and the real-life context in which it occurred.
Multiple-case studies	A multiple case study allows the researcher to explore differences within and between cases. The objective is to reproduce findings across cases. Because comparisons will be drawn, it is vital that the cases are chosen carefully so that the researcher can predict similar results across cases, or predict contrasting results based on a theory.
Intrinsic	Stake (1995) uses the term 'intrinsic' and suggests that researchers who have a candid interest in the case should use this approach when the intent is to enhance their understanding of the case. It is not undertaken primarily because the case represents other cases or because it illustrates a particular trait or problem, but because in all its particularity and ordinariness, the case itself is of interest. The purpose is NOT to come to understand some abstract construct or generic phenomenon. The purpose is NOT to build theory (although that is an option).
Instrumental	Is used to accomplish something other than understanding a particular situation. It provides insight into an issue or aids to cultivate a theory. The case is often looked at in depth, its conventional activities detailed, and it helps the researcher pursue the peripheral interest. The case may or may not be seen as a typical of other cases.
Collective	Collective case studies are analogous in nature and depiction to multiple case studies.

(Source: Baxter & Jack, 2008, p. 547)

A case study is about the explicit rather than the general (Thomas, 2011, p. 3) and in this case, the research study is to determine the consequences in terms of the social cost of the Tongaat mall accident in relation to construction H&S. The Tongaat mall building collapse is a particularly interesting key case by virtue of its size and the extraordinary amount of damage that it wreaked on the town of Tongaat and its environs (Thomas, 2011, p. 77). From the case study approach the subject matter has been scrutinized from several angles (Thomas, 2011, p. 4) to answer the research questions. From this type of approach a three-dimensional picture (Figure 3.2) has been sketched from which the focus area can be seen in its completeness. The case study approach is especially good for acquiring insightful research and gaining analytical comprehension from it (Thomas, 2011, p. 23). The key is to draw rich interconnected information from this singular focus and derive unique insights from the analysis that follows (Thomas, 2011, p. 44).

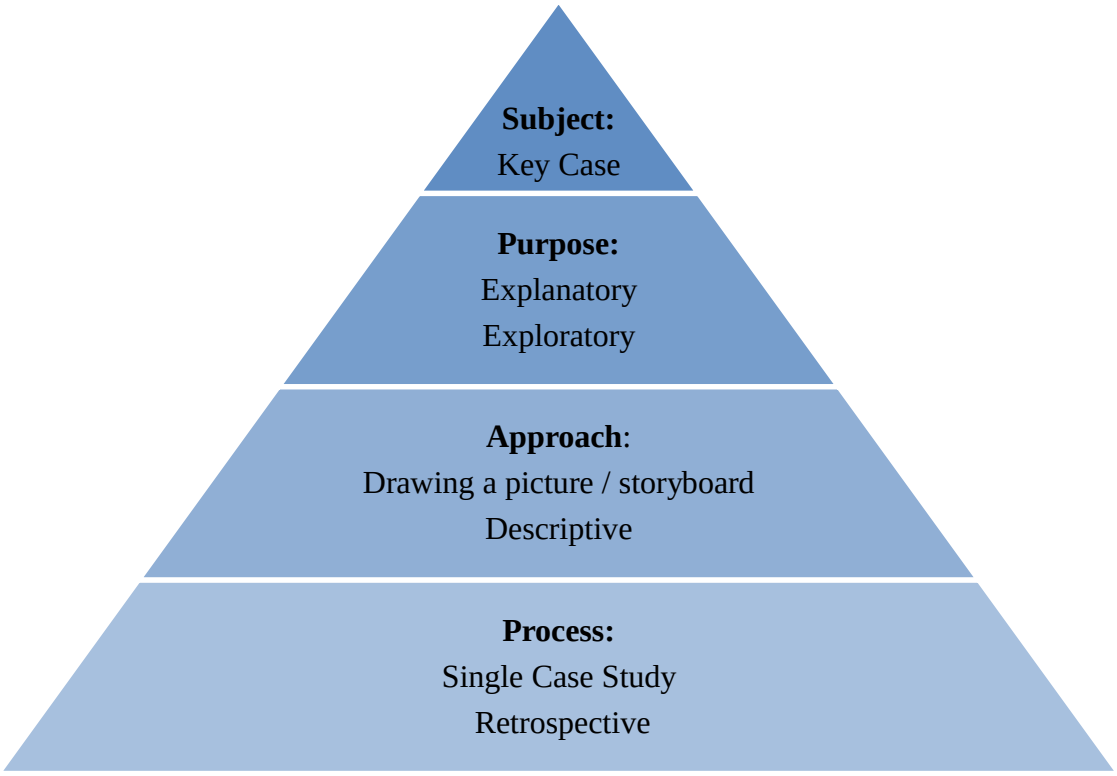

Figure 3.2: Mapping out of the design for the Tongaat mall accident case study (Adapted from Thomas, 2011, p. 95)

3.3 Research Area – Tongaat Mall

The research study analysed the 2013 Tongaat mall building collapse in KwaZulu-Natal. By investigating the various direct and indirect reasons that led to the building collapse, the direct and indirect cost of the accident had been evaluated to establish the effects of this catastrophic event. The town of Tongaat is known as a sugarcane-growing township in KwaZulu-Natal, South Africa. The town is situated on the banks of the Tongati River about 37 km north of Durban and 28 km south of Stanger (Stats SA:2011:online). It now forms part of the eThekwini, the Greater Durban metropolitan area (Figure 3.3). The population of the town is predominantly of Indian descent. Aesthetically English Colonial, but distinctly cosmopolitan in flavour, Tongaat, part of the Sugar Coast, now supports one of the largest sugar-producing districts in the world (Stats SA:2011: online). Tongaat has a population of 42 554 people and a density of 3 600 people per km².

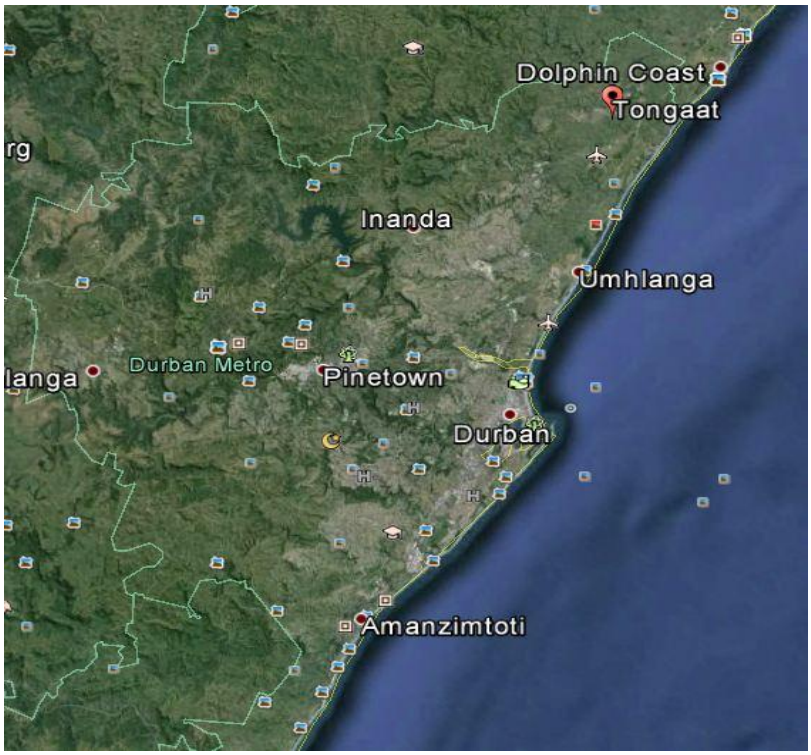

Figure 3.3: Map of the greater Durban Metropolitan Area (Source: Google Earth. 2013. Tongaat, KwaZulu-Natal, South Africa.)

The Tongaat mall building project was a multi-storey shopping complex 37km north of Durban situated in the town of Tongaat. Construction of the 16000 m², R220-million shopping mall began in March 2013 and was scheduled for completion in April 2014. The

shopping mall was situated on the corner of Gopallal Hurbans Road and Ganie Street, north-east (Figure 3.4) and within 10 metres of the railway line on the west side (Figure 3.5 and Figure 3.6).

Figure 3.4: Arial view of the Tongaat mall location (Source: Google Earth. 2013. Tongaat, KwaZulu-Natal, South Africa. Earthview landscapes)

Figure 3.5: Mall boundary on the west side indicating the railway line (Source: Van Eeden, 2015)

Figure 3.6: Mall boundary on the west side indicting the railway line (Source: Van Eeden, 2015)

3.4 Research Process

Similar studies on the collapse of buildings at the construction stage in which fatalities and injuries were recorded have used a case study approach to gain insights so as to evolve interpretations of the events (Aini, Fakhru'l-Razi, Daud, & Adam, 2005, p.). The study of the Tongaat mall collapse is also aimed at insights and interpretations that can inform policy and practice. In other words, the case study approach has been adopted for this study in order to acquire insights and gain analytical comprehension of the events (Thomas, 2011, p. 23). The findings presented in the next chapter are based on the analysis of content – official inquiry of the collapse, observations on sites and interviews of participants in the project.

The subject of the study was chosen because of its inherent interest. Another motivation for choosing this topic is the necessity for improving H&S performance in the construction industry in South Africa to prevent more tragedies from occurring. The case was contrasted with what transpired from other cases around the world.

The gathering of qualitative data was divided into two stages. Stage 1 focuses on analysing public records in the form of media reports in conjunction with reports received from the DoL. From this document analysis, project participants were identified. The analysis of documents led to the compilation of questions for the interviews – the interview guide. The interview guide was made up of open-ended questions that interrogated the perceptions of the project participants. Stage 2 of the data collection thus focuses on interviews. The principle of voluntary participation was upheld in the interviews. This suggests that people were not coerced into participating in the research. Confidentiality was enhanced by keeping participants anonymous throughout the study. After the interview guide was developed and tested, study participants were selected from regional and local administrators of OHSA, area directors of OHSA, approved occupational safety and health programmes, and members of the Department of Labour and the eThekwini municipality. Many of these interview requests were denied due to the matter being *sub judice*. The interview participants thus included only construction workers that were actively involved in the construction of the Tongaat mall.

Recorded interviews were transcribed and organised into a data management system. When dealing with the data, tables were constructed to facilitate cross-case analysis that enabled the researcher to generate reoccurring concepts, ideas or phrases. This is then followed by interpretation: how the researcher understands and explains what the coding has revealed about the views in the field, the links between each other, their ties to context conditions, and the like (Flick, 2014, p. 373).

A visual mind map was used to assist in formulating the concepts as connections were made (Figure 3.7). During each of these stages, especially as data were being visually displayed, the researcher checked for consistency. In addition, the central and guiding questions were always displayed to reiterate the focus of the study and prevent the analysis from straying.

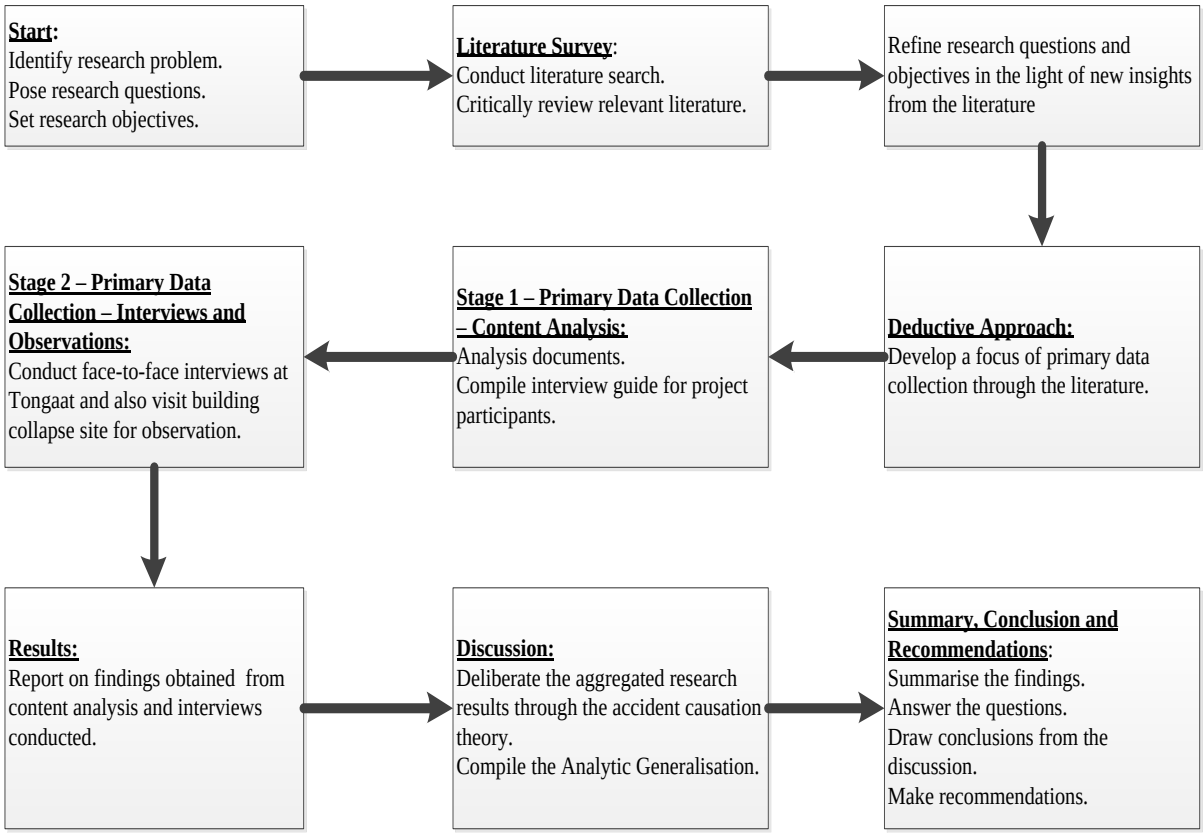

Figure 3.7: Schematic illustration of the research strategy adopted in this study

3.5 Sampling

A purposive sampling method was adopted in this research (Yin, 2014, p. 42). This enabled the researcher to exercise judgement in selecting participants that served best in enabling the researcher to answer the research question and meet the objectives (Yin, 2014, p. 44). This form of sample is often used when working with very small samples such as with case studies (Yin, 2014, p. 42).

3.5.1 Content Analysis

The primary data consisted of gathering data about the case study by means of a synopsis of the highlights of the accident in the media. A compilation of graphic records were reviewed

and analysed as indicated in the Table 3.2. A total of 80 clippings were analysed for their content. These clipping were analysed and a mind map was formulated.

Table 3.2 Overview of the various documents analysed during the study

Name of Document	**Time – Line**	**Amount of Articles**
Department of Labour Republic of South Africa website	20 November 2013 – 17 November 2015	40
News24 website	24 November 2013 – 25 August 2014	29
IOL news website	21 November 2013 30 March 2015	1
FSPBusiness website	13 February 2014	1
Klass Looch Associates website	30 March 2015	1
Politicsweb website	20 November 2013	1
Construction Review Online website	11 September 2014	1
Infrastructurene.ws and service delivery website	10 April 2014	1
Sowetan website	20 November 2013	1
SAcommercialprop – News website	25 November 2013	1
Timelive website	24 November 2013	1
Mail and Gaurdian website	13 December 2013	1
Manase Report eThekwini Municipality website	23 July 2013	1
Total		**80**

3.5.2 Semi – structured Interviews

The sample population was made up of nine construction workers that were directly involved in the Tongaat mall project. At the beginning of the study, 13 candidates were identified because of their direct involvement with the Tongaat mall project. However, most of the government officials, consultants and even the general contractor declined to be interviewed

on record due to the case being *sub judice*. Potential participants were contacted telephonically. Upon acceptance the participants were requested to meet the researcher and the same request letter were presented. This request was presented by making use of a covering letter (Annexure A). This was done in order to authenticate the request. The participants were also reassured about the contents of the study and clarification of any question that the participants had regarding the interview. Most of the candidate participants accepted the request made on the first telephone contact. Other candidate participants were eliminated because they failed the preliminary screening done during the first telephonic contact. Candidate participants had to been working on the Tongaat mall building site. A total of nine construction workers were interviewed for the study. All the participants for the fieldwork that agreed to the interviews belong in the category of historically disadvantaged group. Their education ranged from primary to secondary school certificates.

3.6 Data collection

In content analysis, counting the frequency with which certain terms appear is a core aim of the analytic process (Ritchie, Lewis, & Nicolls, 2014, p. 273). The content and context relative to the Tongaat mall collapse were analysed to identify issues dominating the media coverage of the event. The media coverage refers to both online and printed news materials that were systematically evaluated in terms of text (words) and images recorded without the interference of the researchers. Online materials were accessed through the press releases of the DoL in South Africa, whereas printed materials mainly focused on newspaper clippings of the DoL inquiry. The analysis was then linked to the role of actors in the collapsed building. The analysis utilized the textual data to elicit meaning, gain understanding, and develop empirical knowledge on the collapsed mall (Flick, 2014, p. 96). Prior to the content analysis, building collapse literature was reviewed to provide background information relative to the problem.

The reviewed literature aided the identification of themes. The analytical procedure that follows the literature review entails locating, selecting, making sense of, and synthesising the textual data. The iterative process involves superficial assessment of the reports, in-depth reading of the reports and eventual interpretation (Thomas, 2011, p. 171). The data collection consisted of interviewing the participants. The interviews focused on the project participants

that were directly involved with the development to reflect on the actual situation. This enabled the researcher to make proper and accurate findings.

The client, contractor and various members of the professional team of the collapsed building were not willing to participate in the interviews. Interview participants of the Tongaat mall building construction thus covered various construction site workers that were in the employment of Gralio Precast. Informed discussions with regards to the Tongaat mall collapse were conducted with the following professionals: members of the inquiry, local municipality building inspectors and subcontractors. The sources of evidence as discussed below were the most commonly used during this research study. A useful overview of the six major sources considers their comparative strengths and weaknesses (Table 3.3).

Table 3.3: Six sources of evidence and their associated strengths and weaknesses

Source of Evidence	Strengths	Weaknesses
Documentation	• Stable – can be reviewed repeatedly. • Unobtrusive – not created as a result of the case study. • Exact – contains exact names, references, and details of an event. • Broad coverage – long span of time, many events, and many settings.	• Retrievability – can be low. • Biased selectively, if collection is complete • Reporting bias – reflects (unknown) bias author. • Access – may be deliberately blocked
Archival Records	• Same as above for documentation • Precise and quantitative	• Same as above for documentation • Accessibility due to privacy reasons
Interviews	• Targeted – focused directly on case study topic. • Insightful – provided perceived causal inferences	• Bias due to poorly constructed questions • Response bias • Inaccuracies due to poor recall • Reflexivity – interviewee

		gives what interviewer want to hear
Direct Observations	• Reality – covers events in real time. • Contextual – covers context of events.	• Time consuming. • Selectivity – unless broad coverage. • Reflexivity – event may proceed differently because it is being observed. • Cost – hours needed by observers.
Participant Observation	• Same as above for direct observations. • Insightful into interpersonal behaviour and motives	• Same as above for direct observations • Bias due to investigator's manipulation of events
Physical Artefacts	• Insightful into cultural features • Insightful into technical operations	• Selectivity • Availability

Source: Yin (2014, p. 106)

Thus, the sources of evidence consulted for this research study were newspaper clippings and other articles appearing in the mass media or in community letters including website reports by the DoL, photographs and field visits in addition to the interviews. Yin (2014, p. 107) states that newspaper accounts are excellent sources for covering certain topics such as combining personal participation with extensive newspaper documentation and using documentary sources to reconstruct reality. Furthermore, the interviews that were conducted serve as one of the most important sources of case study information (Yin, 2014, p. 110). In Yin (2014, p. 110), the interviews would appear to be guided conversations rather than structured queries. In other words, although the researcher pursued a consistent line of inquiry, the actual stream of questions in the case study interviews was fluid rather than rigid. The rationality behind choosing these sources was merely to corroborate and augment evidence from the other documents.

Data triangulation encourages the researcher to collect information from multiple sources but is aimed at corroborating the same fact or phenomenon (Yin, 2014, p. 120). In pursuing such corroboratory strategies, Figure 3.8 distinguishes between two conditions: 1) when the researcher has really triangulated the data; and 2) when the researcher has multiple sources as part of the same study, but they nevertheless address different facts.

The benefits from using these various sources of evidence for this specific research study were maximized by following three principles (Yin, 2014, p. 118). These principles assured validity and reliability of the case study evidence. Making use of the newspaper clippings, DoL reports, photographs and field visits and interviews allowed the researcher to address a broader range of historical, attitudinal, and behavioural issues (Yin, 2014, p. 120). However, the most important advantage presented by using the various sources was the development of converging lines of inquiry, a process of triangulation. The second principle was by creating a case study database by means of case study notes, case study documents and tabular materials (Yin, 2014, p. 123). The third and last principle applied by the researcher was to maintain a chain of evidence. This principle allows the external observer – in this situation, the reader of the case study – to follow the derivation of any evidence, ranging from the initial research questions to the ultimate case study conclusion (Yin, 2014, p. 127). Yin (2014, p. 119) found that case studies using multiple sources of evidence were rated more highly, in terms of their overall quality, than those that relied on one single source of information.

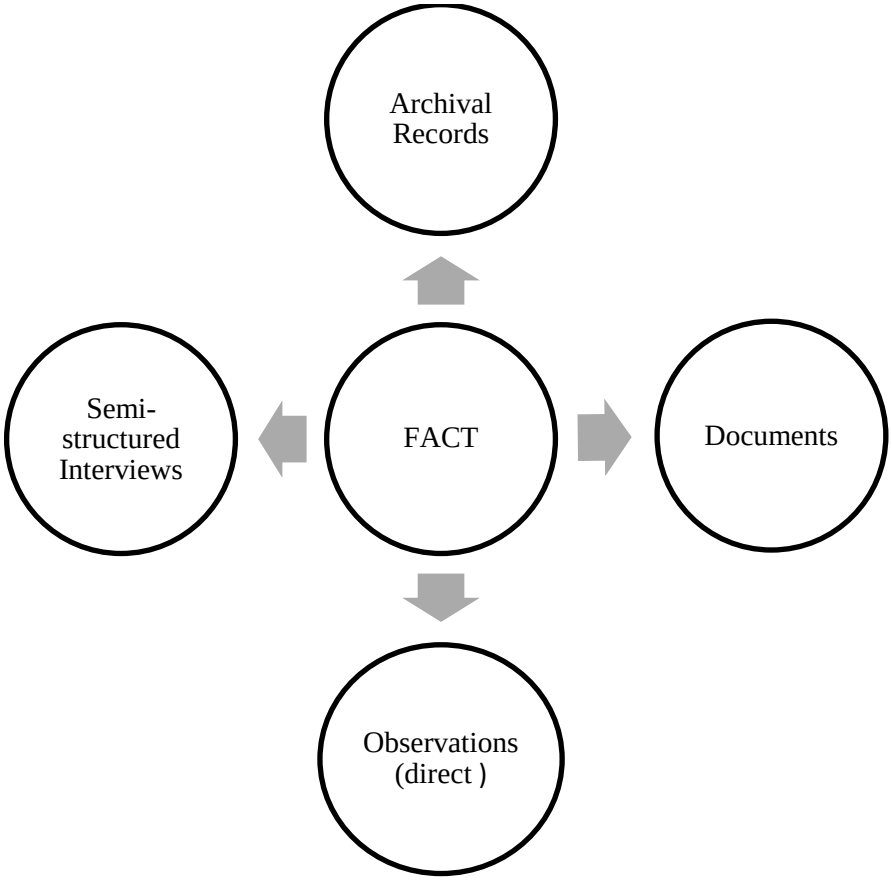

Figure 3.8: Convergence of multiple sources of evidence. (Source: Yin, 2014, p. 121)

3.7 Data Analysis

Textual data consist of words and observations, not numbers. As with all data, analysis and interpretation are required to bring order and understanding. This requires creativity, discipline and a systematic approach. The information gathered from the literature, newspaper articles and interviews were systematically analysed.

The purpose of the research study was reviewed prior to the formulation of interview questions. The data were then organised in order to identify consistencies and differences. All the data that were gathered for each question were put together and analysed. From this, connections and relationships were explored. The gathered data were then categorized by means of coding. This was achieved by identifying themes and patterns in terms of behaviours, interactions, incidents, terminology, or phrases used. These were then organized into intelligible categories that summarized and brought meaning to the text.

A number of themes were identified in advance by studying the literature; the researcher then searched the data for these themes, which provided direction for what was needed from the data. By matching the data to the themes, categories and sub-categories were found to emerge. Reading through the field notes and newspaper clippings showed themes or issues recurring in the data. These led to the establishment of new categories or sub-categories. This approach allowed categories to emerge from the data, which were defined after working with the data confirming the identified themes. This was an iterative process (Powell & Renner, 2003, p. 3). Several categories were used to reflect the nuances in the data and to interpret the data clearly (Powell & Renner, 2003, p. 3).

3.8 Summary

This chapter introduced the research methodology that was chosen to achieve the aims and objectives of the study. The case study research design decisions guided the researcher in effectively addressing the research problem. A qualitative approach is the most appropriate method for data collection and data analysis for this particular project. Interviews and observations were used to collect the primary data for the case project.

CHAPTER FOUR: THE RESEARCH FINDINGS

4.1 Introduction

This chapter reports on the findings obtained from the data gathered from the newspaper clippings, DoL reports, interviews and observations. The data analysis and the interpretation of the results are illustrated with tables and figures.

4.2 Findings of Analysed Documents

The following subsections illustrate the findings of the official inquiry into the Tongaat mall accident.

4.2.1 Regulatory Control

The construction regulations set out the legal requirements for construction operations. Figure 1 by means of a timeline indicates the course of action that was taken by the DoL and the local authority to prevent the events that transpired before the Tongaat Mall collapse. The figure shows that the local authority took all the necessary steps to stop any further continuation of construction on the site. Despite all the regulatory steps, the developer continued with construction until the mall collapsed. Shown in a timeline format, the evidence of the apparent failure of the developer to comply with legal terms is illustrated as follows:

- The developer ignored summons issued six days prior to the tragedy to cease work on the site. Construction continued unabated.
- In court papers the municipality alleged that Gralio Precast the principal contractor disregarded an interim order and a final order granted against the company to stop construction of the Mall.

- The contractor's previous housing developments have been cited in investigations by the Manase forensic audit report on fraud and mismanagement in the eThekwini municipality, for "shoddy" construction work.
- The general foreman (GF) was given instruction by the general contractor (GC) to continue work knowing that a stop order has been issued.
- No H&S audits were carried out in the four months preceding the collapse.
- The safety agent appointed by the GC reported that there was no signing off on any scaffolding or supports to be removed at any stage during the time (four months) he was appointed by Gralio Precast.
- The H&S agent said that no consent had been given to remove formwork, props or scaffolding on the day of the accident.
- The Safety folder disappeared on the day of the accident.
- GF had been assigned six safety posts – law allows a person to hold a maximum of two such posts.
- The post-tensioning sub-contractor was aware that a court order had been issued but was told the situation was sorted out and work continued.
- Earthworks plans were rejected four times for issues that could be rectified by the architect.
- Earthworks plans were approved in principle by the municipal Land Use department due to the fact that consent was given by Transnet as the building was within 10 metres of the railway line.
- The required consent from Transnet was never obtained.
- To date no plans have been submitted to the municipality's Development, Applications and Approvals department.
- The developer failed to obtain permission to demolish the existing building before construction began.
- The municipality's law enforcement officer visited the site on 8 May 2013 and informed the GF that construction was illegal. The officer showed him the contravention notice and ordered the GF to stop construction.
- A fine was issued to the amount of R2500 – R1000 for failing to comply with a notice to cease building and R1500 for building without approved plans.

- On 9 May the law enforcement officer returned and found construction had continued. The officer issued another fine to the amount of R2500 to the GF and waited for the construction workers to vacate the site.
- The last fine was paid, indicating admission of guilt.
- When construction continued unabated the matter was referred to the municipality's legal department. Photos were taken and a letter from the city's legal department was sent to the developers.
- Mr Singh, director of Rectangle Property Investments and owner of Gralio Precast's other company, Woodglaze, was accused of fraudulently obtaining R236 million from the Social Housing Regulatory Authority by setting up a social housing company, Moko Rental Housing Project, to obtain funds to buy flats from itself.
- GC was unable to indicate what qualifications the GC staff had.
- In a media statement made by GC, the mall was always going to collapse, even if the concrete had the required strength and steel bars. This is contradictory considering the GC believed the poor design by the structural engineer contributed to the collapse of the mall.
- The contractor reassured the structural engineer during the project's weekly meetings that there was nothing to be worried about. During one meeting the structural engineer was told that the drawings were approved.
- The GC reported that, in hiring a qualified and competent professional team the GC is absolved of all responsibilities.

Figure 4.1 shows an infographic representation of the timeline of the events as they transpired at the Tongaat mall project.

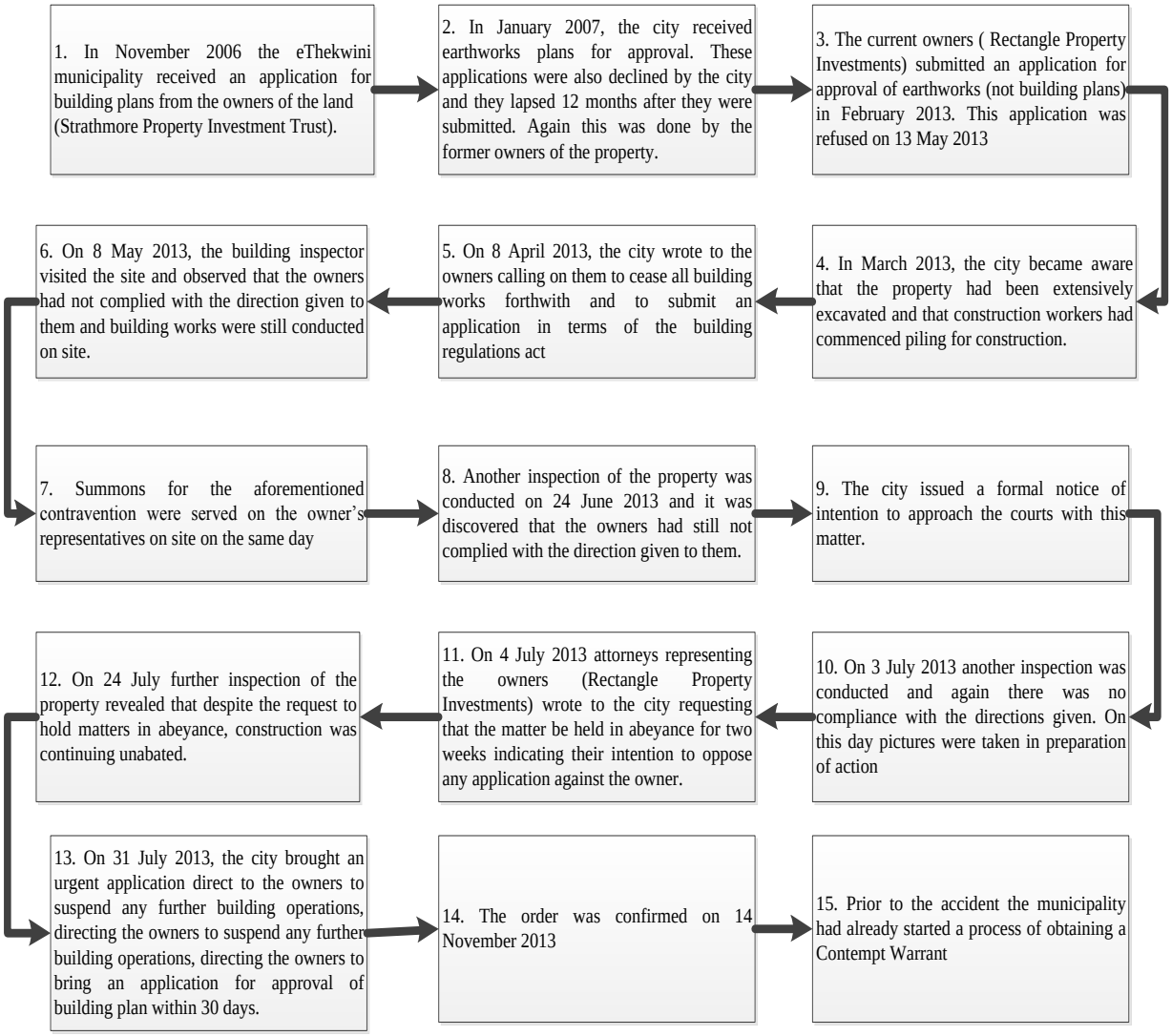

Figure 4.1: Timeline of the events as they transpired at the Tongaat mall project

The information above indicates that despite the promulgation and implications of the construction regulations it is notable that the client, general contractor, general foreman and H&S agent lacked the sufficient knowledge stated in the regulations (Republic of South Africa, 2003; 2014).

Figure 4.2 is a summary of the regulatory failures detected in the findings while reviewing the documents related to the Tongaat mall collapse. From Figure 4.2 it is noted that the developer failed to adhere to the construction regulations. For instance, construction of the mall continued unchanged although plans were unapproved by the local authority. Various

transgressions by the developer were noted during analyses of the documentation. Figure 4.3 indicates the Tongaat mall boundary on the west side. This photo clearly indicates the close proximity of the boundary wall to the railway line. Figure 4.4 similarly indicates the close proximity of the project to the railway line for which approval had to be granted by Transnet. This was, however, not obtained before the collapse according to the analysed document.

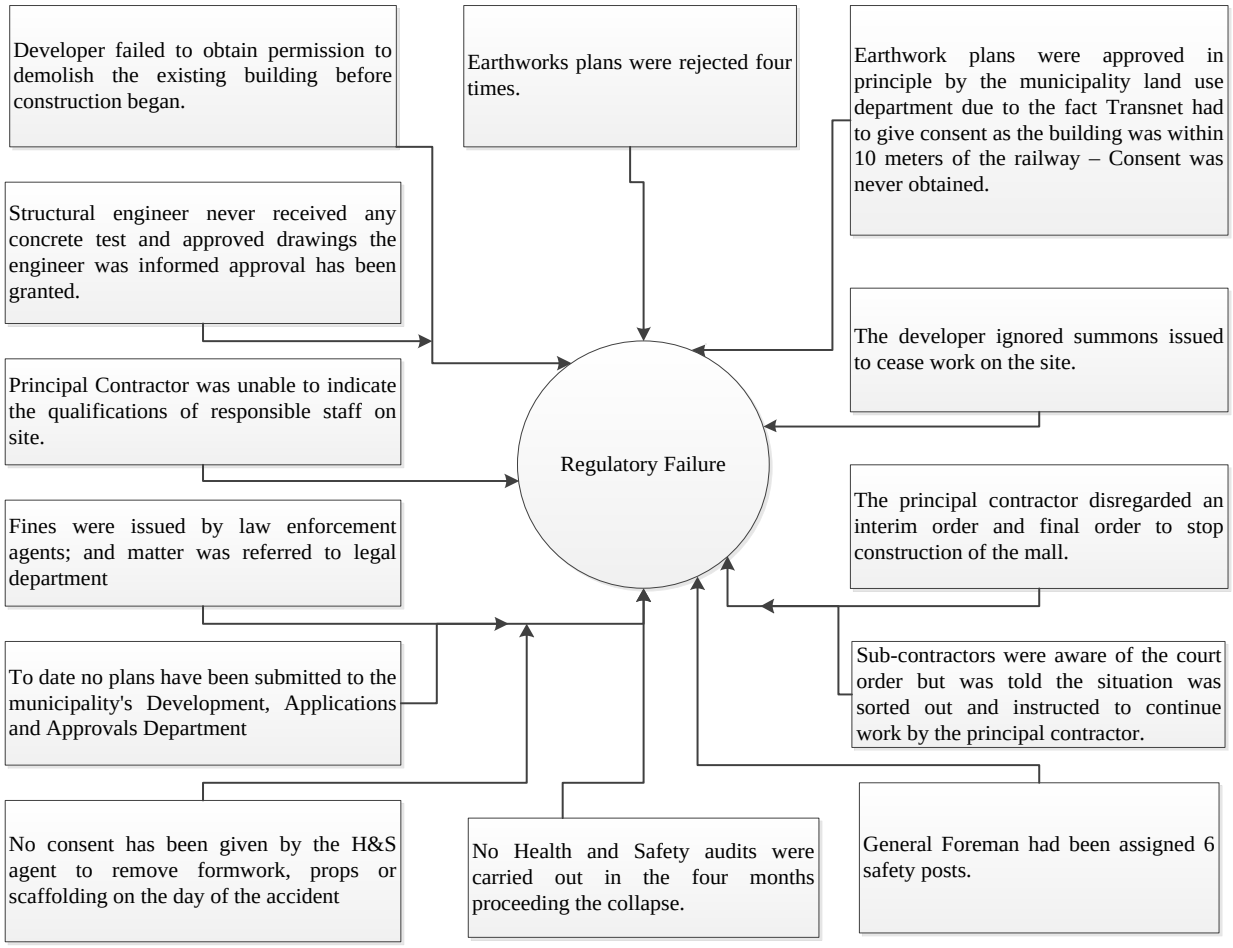

Figure 4.2: Insights into regulatory failure experienced on the Tongaat mall project

Figure 4.3: Tongaat mall boundary on the west side indicating the railway line (Source: van Eeden, 2015)

Figure 4.4: Tongaat mall boundary on the west side indicating the railway line (Source: van Eeden, 2015)

4.2.2 Structural Failure

The information in this section indicates the structural failures that were identified in the document analysis regarding the Tongaat mall collapse.

- A slab of concrete sagged by 7cm.
- Concerns over the lift shaft design were raised. These plans were altered.
- Concerns over 10m walls without any support were raised. These plans were altered to include support.
- The brickworks supervisor reported that 10 plan revisions were done in a space of three months.
- Concerns about the thickness of the columns were raised by the GF.
- There were three points of weakness close to each other, with one of the weakest links being one of the beams.
- The foundation of one of the columns that supported the beam in question was inadequate as there was only one pile although three piles were required.
- Various engineers involved in the inquiry had reached an agreement that the triggers for the collapse involved beam number 7 and columns 243 and 319.
- Column 243, a critical column required to support a lot of work and was close to its load-carrying capacity.
- Column 243 failed along with beam 7.
- Engineers suggested that if load-carrying capacity was reached, the column should have been made bigger.
- Engineers suggested in the event of an inadequate foundation in column 319, measures to compensate should have been carried out as well as underpinning.
- Negligence was found in relation to the design load of column 243 but the structural engineer's calculations were not interrogated by consulting engineers.
- Negligence on behalf of the structural engineer depended on whether the structure was braced or not. The structural engineer reported that column 243 was braced, thus adequate to take the load.
- Design Specifications: Column 243 was in the upper limits of 'slender', it was inadequately designed for its purpose.

- Design Specifications: Under design of this column resulted in it collapsing.
- Construction Load: Column 319 with single piling would have failed.
- The steel that had been used did not fail, but was insufficient to handle the stresses caused by the 150 tons. This was evidenced by the fact that the steel did not break but "the steel was pulled straight out of the concrete".
- As the collapse started it put pressure on beam 7, which collapsed. This put pressure on a neighbouring concrete slab that swung around. This slab collapsed as the columns under it could not handle the swinging motion.
- According to the structural engineer, various changes were made to the design which affected the integrity of the structure, and he was never appointed to perform any construction monitoring services.
- Mr Singh the principal contractor relied on the structural engineer for quality control, reinforcing inspection and certifying structural stability compliance during his ad hoc inspections.

From the information above, it is apparent that two supporting columns and a beam affected the structural integrity of the collapsed slab. In Figure 4.5, the most significant findings in terms of columns failures are highlighted. Figure 4.5 shows various concerns in terms of the concrete strength and foundation design of columns. Figure 4.6 indicates the partly collapsed slab and dismembered columns. Column joints can also be seen, which indicates that columns were not poured in one continuous operation. Figure 4.7 indicates shoddy construction work in terms of column construction that was notable throughout the construction site. Figure 4.8 indicates deflection of columns that was notable throughout the site. Figure 4.9 indicates columns that were notably crooked throughout the site. These figures provide photographic evidence of the extent of the shoddy construction work interims of column construction that was experienced on site before the collapse occurred.

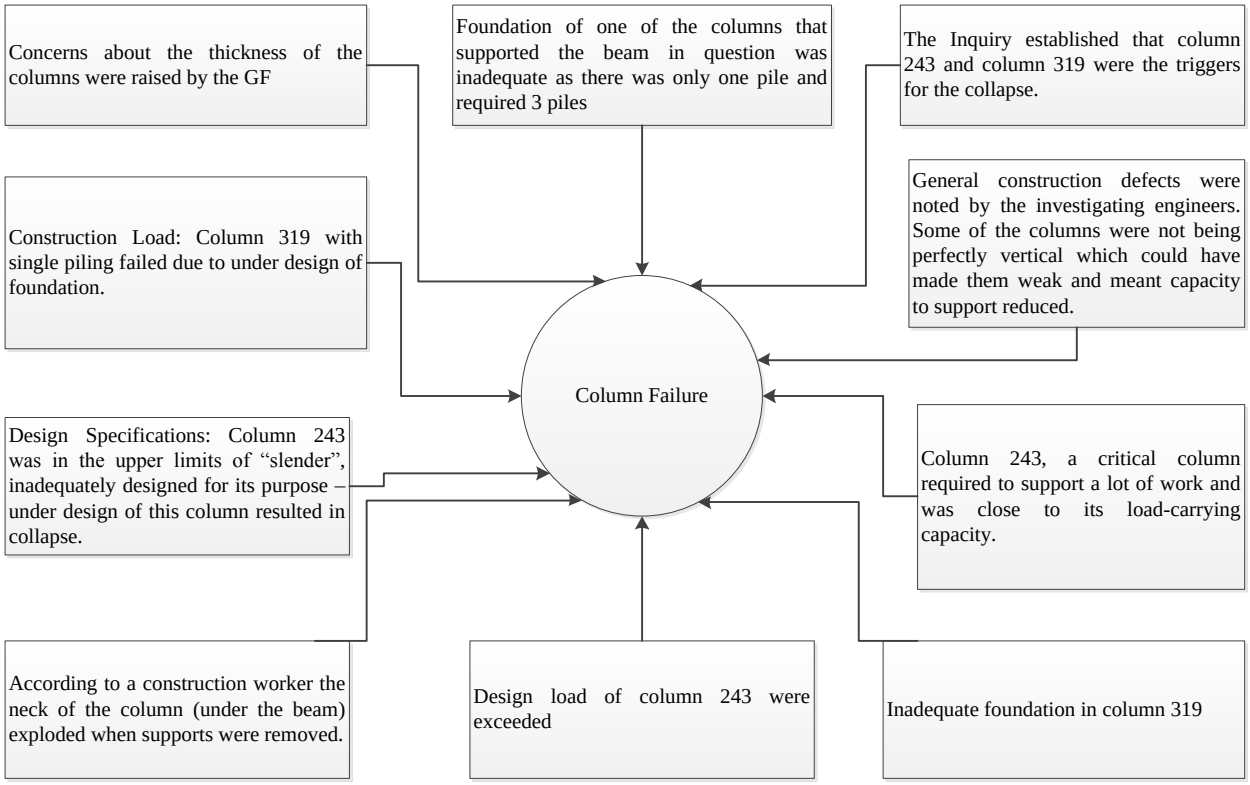

Figure 4.5: Insights into the lack of structural integrity that led to column failure on the project

Figure 4.6: Collapsed slab and dismembered columns (Source: Van Eeden, 2015)

Figure 4.7: Shoddy construction work in terms of column construction that was notable throughout the site (Source: Van Eeden, 2015)

Figure 4.8: Deflection of columns that was notable throughout the site (Source: Van Eeden, 2015)

Figure 4.9: Columns that were notably cockeyed throughout the site (Source: Van Eeden, 2015)

4.2.3 Construction Failure

The information in this section indicates the construction failure-related events that were identified in the document analysis regarding the Tongaat mall collapse:

- To quote the GF, the GC ordered two beams to be built under the sagging slab.
- The GF said that the supporting columns should have been bigger to avert the collapse. These concerns were raised with the GC.
- The GF also said that slabs had been poured at least 21 days before scaffolding was removed.
- Formworks were removed on the day the slab collapsed.
- On 7 October 2013 during an inspection of a slab, the post-tensioning sub-contractor noticed that five cables were missing and that some bars had been incorrectly laid.

- Construction workers said the scaffolding supporting the beams on which the concrete slab rested was removed too soon due to it being needed elsewhere.
- According to the construction worker the neck of the column (under the beam) exploded when the supports were removed.
- The strength of the concrete was in places less than a third of what was specified by the contractor. The concrete failed to reach even half of the required strength. The weak concrete was used in the portion that collapsed.
- The concrete failed to reach the 30 megapascals (MPa) after 28 days.
- The Concrete Testing Laboratory reported that when the test results were sent to the GC it was assumed the person receiving the results would take action.
- The GC mixed the concrete on site.
- The Concrete Testing Laboratory indicated that there was nothing wrong with the type of cement used.
- The laboratory reported that, the concrete could be weak because of insufficient cement used, or too much water was added.
- The laboratory indicated that there were substantial variances in the strength of concrete.
- Concrete was tested at three days, seven days and 28 days. Design by the structural engineer required all concrete to have a strength of 30 MPa after 28 days.
- Concrete tests of concrete slabs carried out by the Concrete Testing Lab prior to the mall's collapse showed that of 64 samples taken from the concrete that the GC mixed on site, only 14 met the 30 MPa requirements.
- 36 concrete samples were tested on cement supplied by the ready-mixed cement company NPC. It was found that only three of these samples missed the 30MPa requirement at 29MPa.
- The GC provided only the concrete test results from the slabs that research the required 30MPa.
- The inquiry revealed some test results came back as low as 9MPa – only strong enough to be plaster on internal walls.
- Concrete test samples or 'cores' were taken from supporting columns and beams of the mall's debris.
- General construction defects were noted by the engineers. Some of the columns were not perfectly vertical which could have made them weak and meant capacity to support was reduced.

- Beam 7 had only seven steel bars of which six were cast in the concrete. The concrete making up the beam was not poured in one session. One portion of the beam had been allowed to dry for two weeks before the rest of the beam was poured, creating a cold joint.
- No bonding of the cold joint described as 'bond failure'.
- Strength tests were never carried out on the concrete used in the columns supporting the mall.
- GF was not aware of the results of any tests carried out on concrete that was poured at the construction site.
- No reasons were given by the GF why no concrete tests were conducted on the columns.
- GF indicated that he did not know that the tests carried out at the time of construction on the concrete strength of the slabs and beams were below the required 30MPa.
- According to the GF, the fact that the concrete was not the required strength was never brought to his attention.
- Concrete tests were carried out by a laboratory but only on slabs and beams.
- GF said he was not aware that the weakest concrete from the tests carried out after the accident came from concrete that had been mixed by the GC.
- GF indicated that there had never been any written permission given for pouring concrete after the steelwork had been put in place.
- GF admitted that on one occasion permission for the pouring of the concrete had not even been received from the structural engineer.
- Permission to pour concrete was given by the foreman doing the steelworks.
- The GC may have been using old drawings while building the mall. The GC indicated he had newer drawings but because, he said, there had been no changes to the columns, the old drawings were used for the columns.
- A beam holding a concrete slab was missing reinforcing bars.
- The steel subcontractor indicated that 19 steel bars were fitted in the beam. This was done in accordance with the engineer's plans.
- The beams were to be fitted with 19 Y32 reinforcing bars, but it was found that there were only 7 beams, indicating 12 bars were missing.
- 36 samples taken by the structural engineer and tested by the laboratory were taken from one beam and six columns. Only the concrete from two columns met the minimum required strength of 24 MPa.

- The beam had not been cast in a single pouring. It had a joint and broke at this point of weakness.
- There were also seven reinforcing rods in the beam instead of the required 19, although only six were cast in concrete.
- Design specifications: the consulting engineers had no criticism of the design of the beam, but it had not been constructed in accordance with the construction drawing.
- Column 243 had not been constructed to the design specifications in terms of strength.
- Beam 7 failed when form scaffolding that was supporting the beam and concrete slab was removed
- When scaffolding was removed the beam was required to support a weight of 150 tons – a weight it could not carry because of the weakness of the beam.
- Concerns were raised about the accuracy of the structure.
- Only one of the seven metal bars reinforcing beam 7 had the required length and strength.
- It was indicated that the metal bars reinforcing in beam 7 were too short.
- The company that supplied the scaffolding and formwork indicated that scaffolding and design drawings on how it was to be installed were provided.
- Scaffolding designs were based on engineer's drawings received from the GF.
- It was indicated that the collapse occurred when scaffolding and formwork were being removed.
- It was indicated that design drawings for the scaffolding and formwork had been done but no scaffolding design drawings were requested for the section that collapsed. The scaffolding material used was the property of the identified subcontractor. At no stage was the sub-contractor asked to provide drawings in connection with the collapsed section.
- According to the structural engineer, concrete tests were never forwarded to him. The contractor communicated to him that the concrete strength was in accordance with the structural engineering designs.
- The structural engineer never authorized the casting of beams.
- The structural engineer had not authorized the pouring of beam 7, indicating there was no request to inspect it when reinforcing was made.

The information above indicates attributes that relates directly to the literature. The data analysis showed that non-compliance with specifications/standards by developer/contractor;

inadequate supervision or inspecting and monitoring, economic pressure, incompetent conversion, change of use of buildings and the employment of an incompetent contractor were the prominent findings that came to light. In Figure 4.10, the most significant findings in terms of beam failures are highlighted. The documents reveal that a slab known as Slab 7 sagged by 70mm. There were also various construction method deviations that were in stark contrast with what is stipulated in the construction regulations of 2003 and 2014. Figure 4.11 and Figure 4.12 point to the extent of the damage caused by the collapse. Figure 4.13 is an example of the "shoddy construction" found in the Tongaat mall project. Figure 4.14 indicates the poor concrete work that was apparent in the Tongaat mall project.

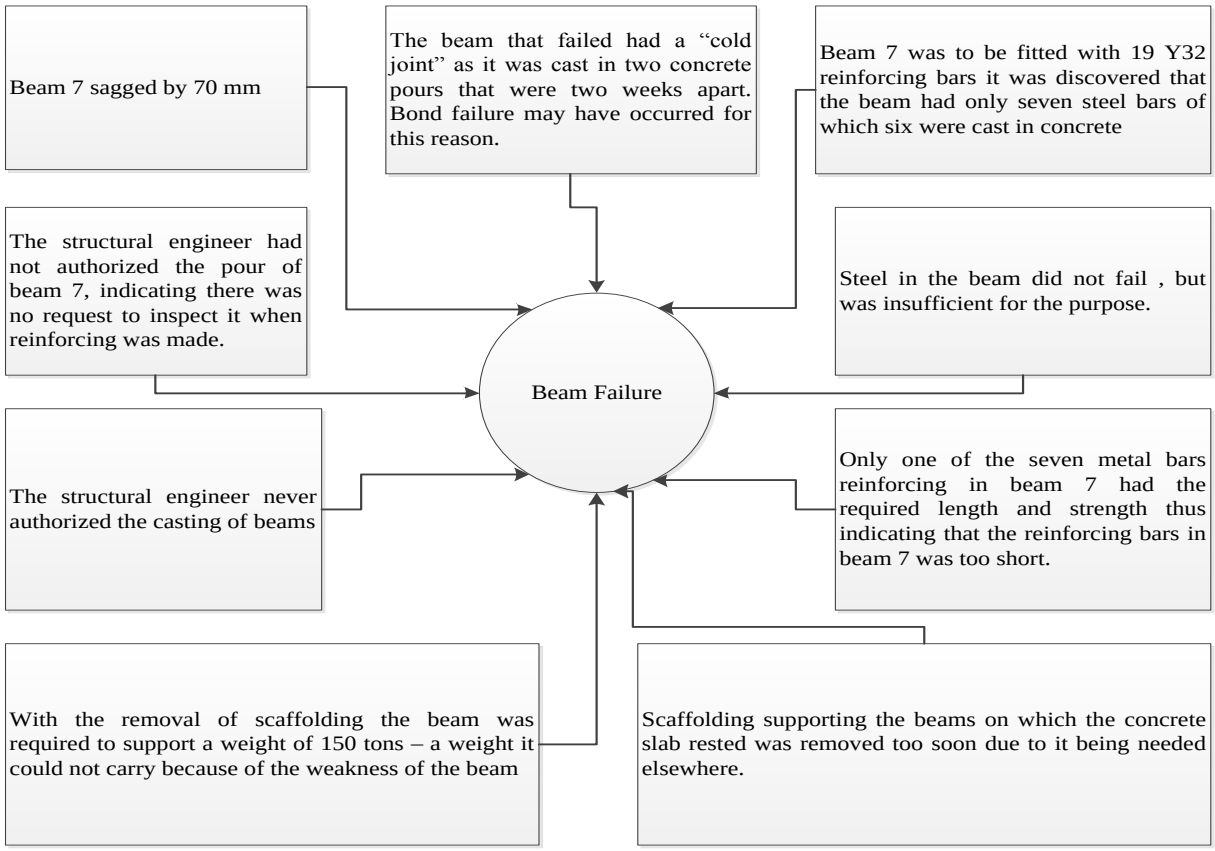

Figure 4.10: Insights into the lack of structural integrity that lead to beam failure on the Tongaat mall project

Figure 4.11: Extent of the Tongaat mall collapse – slab view (Source: Van Eeden, 2015)

Figure 4.12: Extent of the Tongaat mall collapse – centre view (Source: Van Eeden, 2015)

Figure 4.13: Example of poor construction found in the Tongaat mall (Source: Van Eeden, 2015)

Figure 4.14: Example of poor concrete work evident in Tongaat mall (Source: Van Eeden, 2015)

These traits are notable and correspond with the literature, as indicated in Figure 4.15. The poor concrete strength in the portion that collapsed is noteworthy. The GF indicated that no tests were carried out on the columns. It is also significant that the weakest concrete came from concrete mixed by the GC on site.

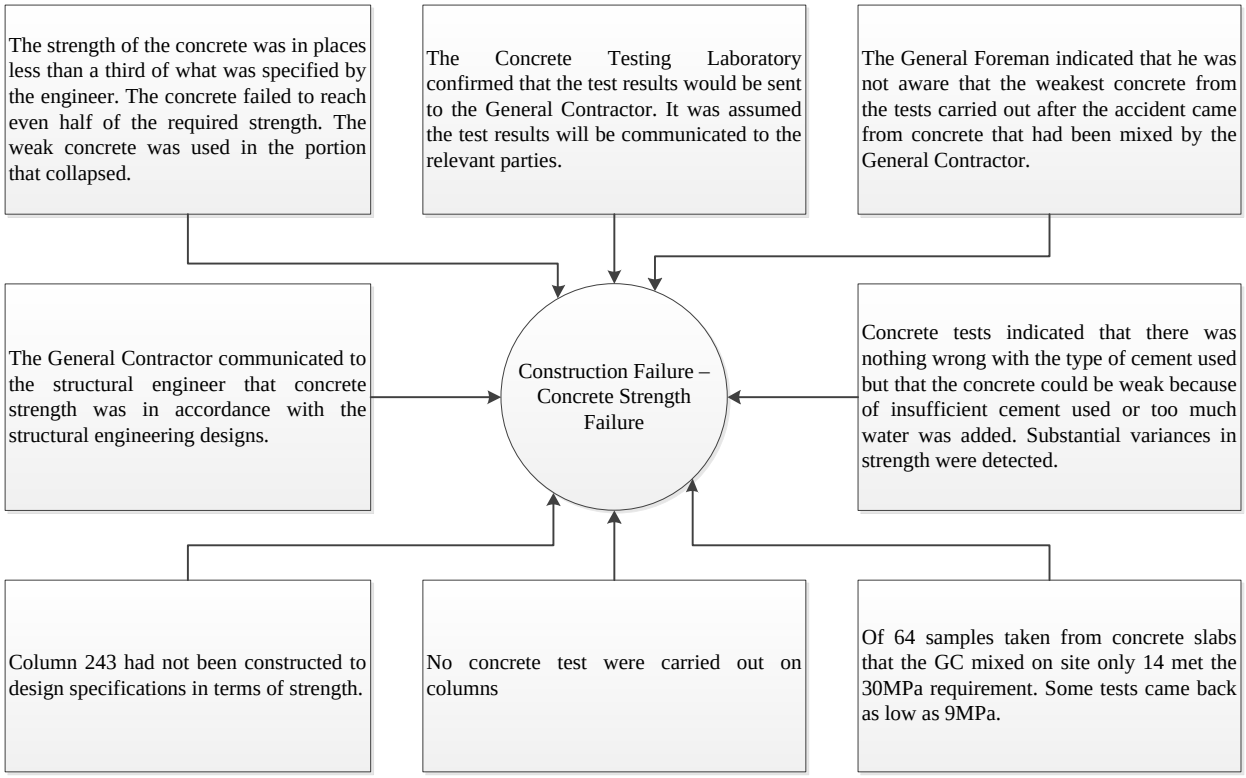

Figure 4.15: A summary of concrete strength failure narrative in Tongaat mall project

4.2.4 Construction Supervision

The information in this sub-section indicates the construction supervision failures that were identified in the document analysis regarding the Tongaat mall collapse:

- Construction defects (deflection) of a slab were noted by the General Foreman (GF) and construction was halted.
- GF admitted to not having any formal qualifications.

- GF had been assigned six safety posts – regulation allows a person to hold a maximum of two such posts.
- The post-tensioning subcontractor averred the structural engineer had been present at only two of the 10 inspections to check post-tensioning cables of the concrete slabs.
- Reports stated that the structural engineer was responsible for the structural design and should have exercised a greater role in checking that work followed designs – reports indicate that he did not meet his professional obligations.
- GF could not explain the test results as he was not responsible for the mixing of the concrete.
- GF was not aware that he had to ask for the results of strength tests carried out on concrete poured at the site.
- General contractor (GC) was unable to indicate what qualifications the staff had.
- Personnel of other companies contracted by GC were the only individuals who appeared to have any formal qualifications.
- The GC indicated that he had trusted his GF, backed up by inspections by the structural engineer to ensure the job was completed properly.
- The GC said he relied on the structural engineer for quality control, reinforcing inspection and certifying structural stability compliance on completion.

These attributes are notable and correspond with the literature as indicated in Figure 4.16.

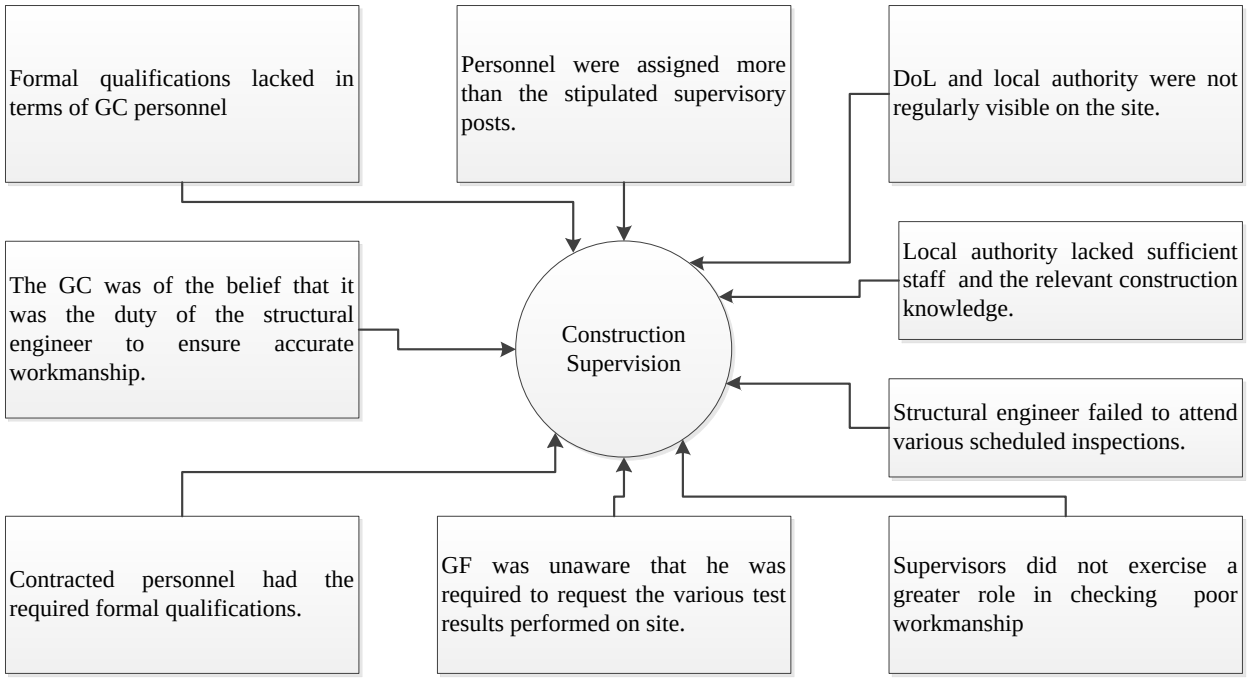

Figure 4.16: A summary of construction supervision narrative in Tongaat mall project

4.2.5 Non – monetary cost of accident

This sub-section indicates the attributes uncovered while analysing documents in terms of the costs of the Tongaat mall accident:

- The Durban High Court was requested to impose a fine on Rectangle Property Investments for the collapse of the mall or they should be jailed for contempt of court.
- Legal representatives were acquired for inquiry and impending investigation.
- An unidentified member of the public died in the accident.
- The partly built Mall was to have been demolished following a High Court order made days before the collapse.
- Investigation fees by an expert engineer for the insurers after the collapse.
- Medical costs of various injured workers.
- Workmen's compensation required.
- Lost sales opportunities.
- Lost social benefits such as secondary income due to the mall in the area.

- Price of site closure due to the collapse.
- Loss of future work by the contractor due to bad reputation incurred by collapse and media coverage of the event.
- If convicted, jail time could lead to termination of the business entity for owners of organizations involved in the project.
- Damage to equipment, plant, tools, or other property.
- Idle plant and equipment.
- Nearby property prices influenced negatively by the carcass of the collapsed structure.
- Negative social activities being conducted in the collapsed structure.

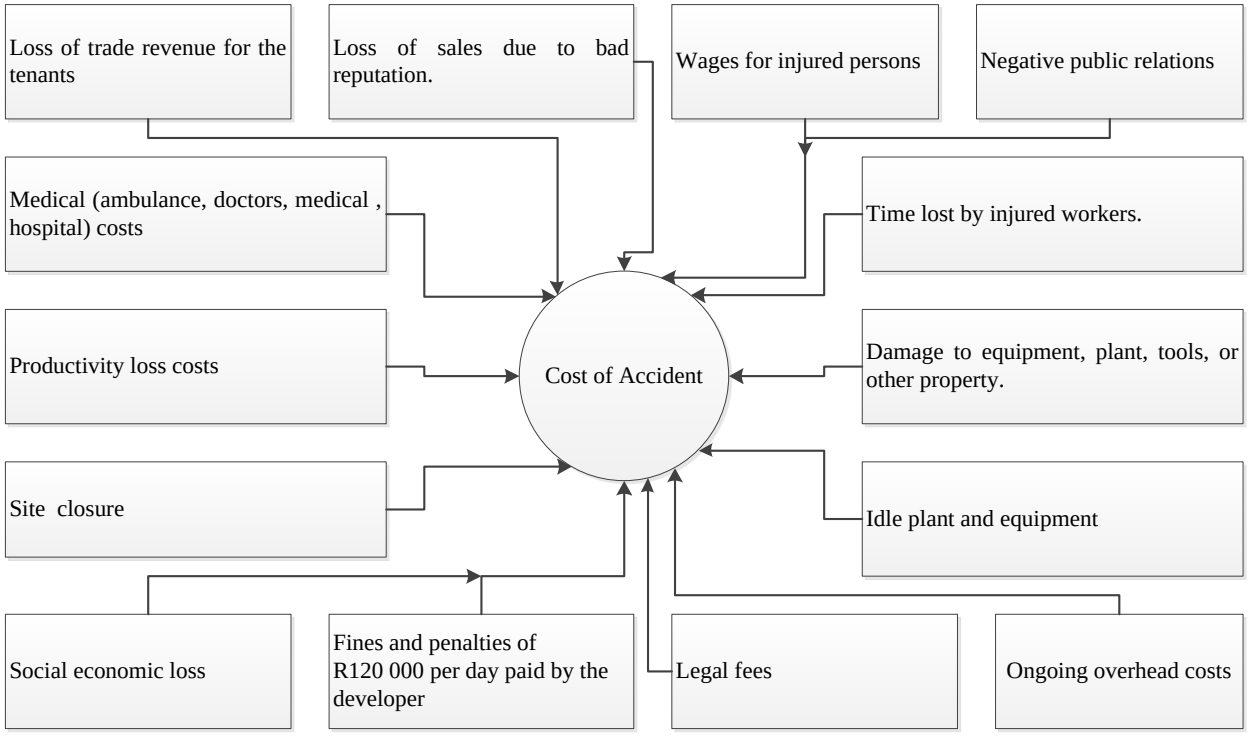

Figure 4.17: A summary of the socio-economic cost of accident of the Tongaat mall project

4.3 Findings of Face-to-Face Interviews at Tongaat, Durban

The interview guide comprise of open-ended questions that interrogated the perceptions of the project participants. When dealing with the textual data, tables were constructed to facilitate cross-case analysis that enabled the researcher to generate reoccurring concepts, ideas or phrases, as shown in the following sub- sections.

4.3.1 Demographic Information of Interviewees

The following questions were asked to determine job description, level of involvement in the construction industry as well as the knowledge in terms of the construction regulations of the interviewees. Thus responses were sought to:

- Question 1: Please introduce yourself in terms of your profession, employer, and position.
- Question 2: Please indicate your level/extent of involvement in the construction industry.
- Question 3. Based on your working experience in the industry, how would you rate your familiarity with the Construction Regulations (2003 or 2014)?

From the responses to Question 1, it was observed that most interviewees were general workers that were involved in the Tongaat mall project. These interviewees saw Mr. Ronnie Pillay, the appointed foreman of Gralio Precast, as their employer. The interviews also pointed out that the majority of workers participated in concrete work activities. The responses to Question 2 indicate that majority of the interviewees had extensive experience in the industry, although they failed to specialize in a specific trade. In response to Question 3, the interviewees appeared to have a superficial knowledge/familiarity with the South African construction regulations as they were unable to engage in conversations that shows extensive understanding of the regulations.

Figure 4.18 provides a summary of the responses related to background information of the interviewees.

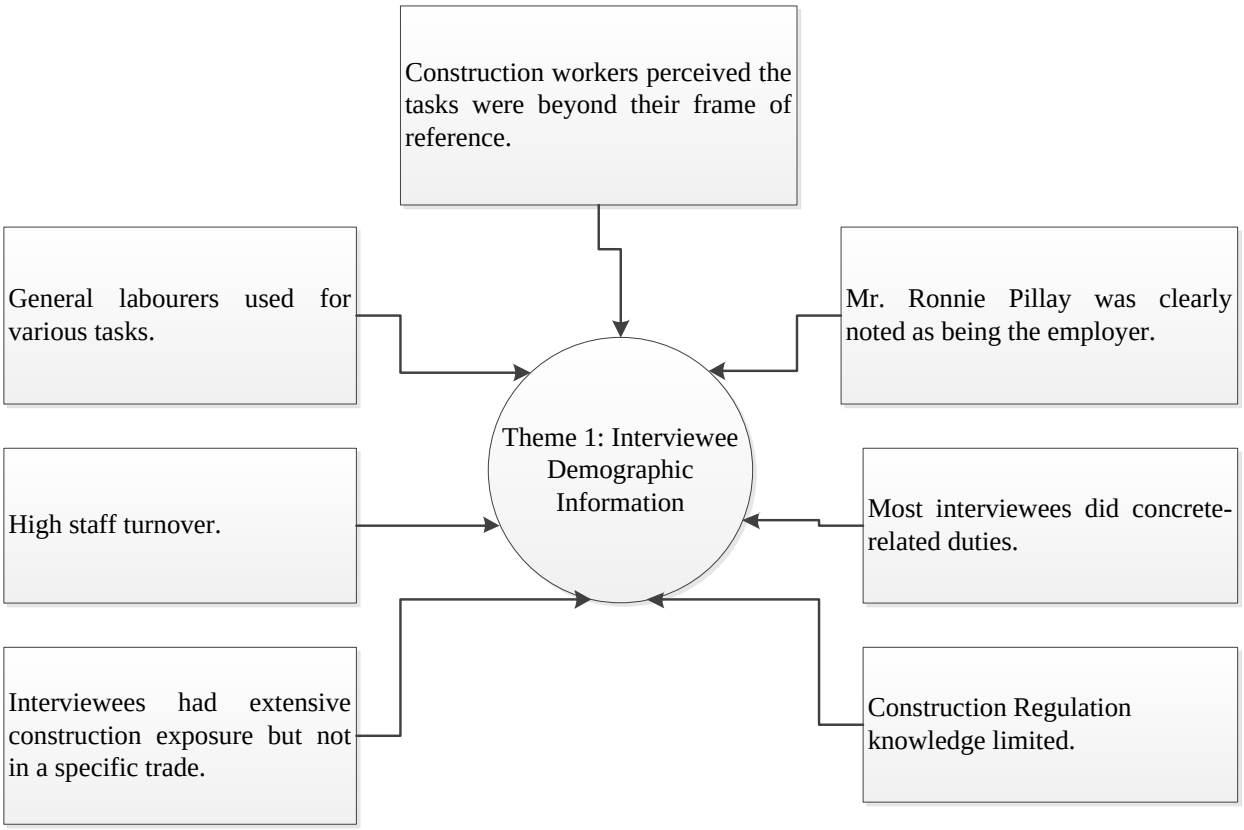

Figure 4.18: Demographic information of interviewees.

4.3.2 Theme 1: Structural Integrity

Based on the analysed inquiry documents, questions related to the structural integrity of the collapsed mall were asked in the interviews. In essence, the aim was to see if the contractor complied with design specifications in executing the work. These questions also assess quality of supervision and monitoring of work by client-appointed design engineers. The specific interview questions include:

- Question 1: In your opinion, how would you rate (if any), the implementation gaps relative to design and specifications on the Tongaat mall project?
- Question 2: What is your perspective on the adequacy of design supervision and monitoring in the Tongaat mall project?
- Question 3: What are your views on the inspection of material in terms of the Tongaat mall?

- Question 4: What is your view on the structural elements of the Tongaat mall project?
- Question 5: What is your view on the influence of the structural elements on the collapsed sections of the project?

When the responses to these questions were transcribed and analysed, the general sentiments of the interviewees became apparent. 1) The interviewees perceived that enough emphasis was not put on quality of workmanship since the work was seen to be rather rushed so as to increase productivity and reduce lagging deadlines. For instance, the interviewees cited the premature removal of formwork without regard to the curing of concrete as signs of hurried processes. 2) The interviewees also noted that the GF on the project focused on sporadic instead of adequate inspection and monitoring of works. 3) The interviewees noted minimal guidance in terms of induction or 'toolbox talks'. Various interviewees indicated that they could use their own discretion in completing tasks as long as the work was completed before the due date and should be of seemingly good quality without major visible defects. Also, they reiterated that supervision as pertaining to material and concrete batch testing was apparently absent. 4) The interviewees were of the opinion that the cast columns on the project were of low standard and the fact that formworks were removed 'too soon' did not help matters. This scenario is exacerbated by the reported lack of control in terms of concrete mixing on the site. The responsible party for the concrete mixing is Gralio Precast. 5) The interviewees also suggested that the collapsed section was as a result of the poor quality concrete in terms of strength due to variations in the MPa. This was further induced by the premature removal of formwork and props as mentioned earlier. The illustration of the perceptions of the interviewees is shown in Figure 4.19.

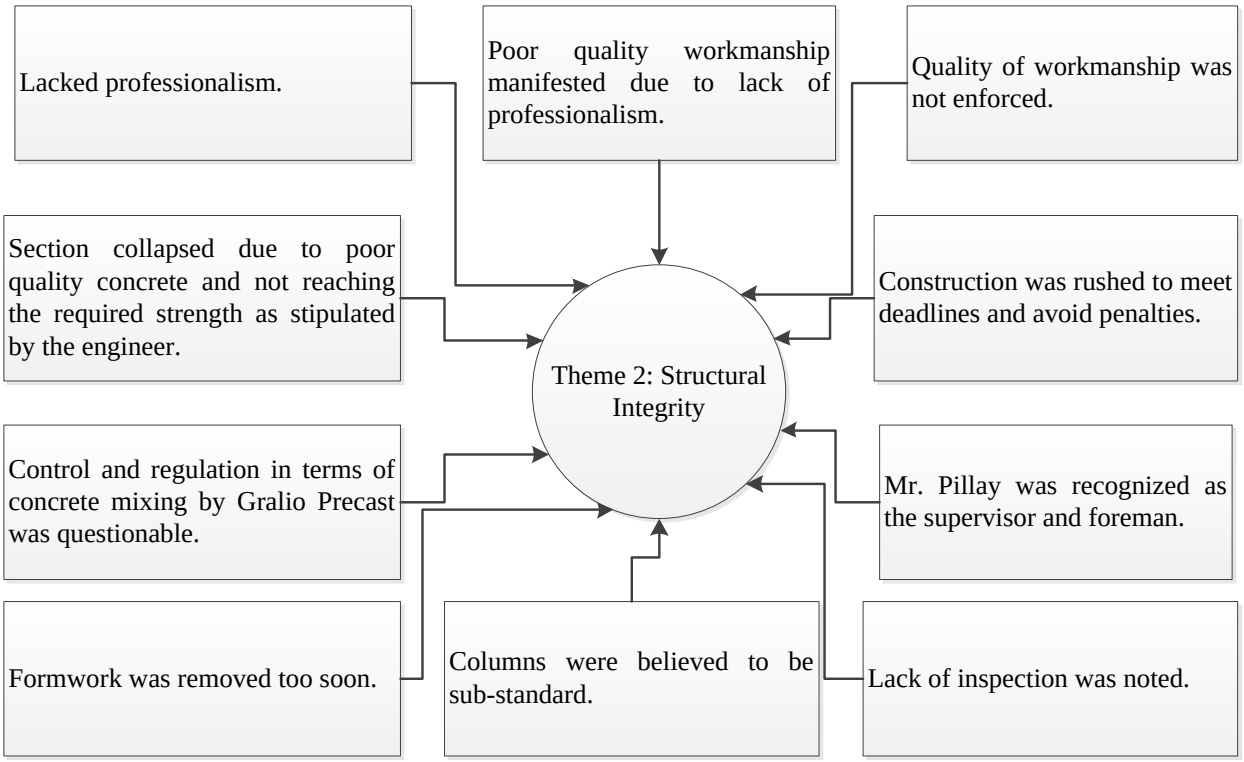

Figure 4.19: Summary of responses to structural integrity related questions

4.3.3. Theme 2: Construction Work Performance

The abovementioned theme is about the quality of supervision by the contractor and his team in terms of capacity of site management on the project. The questions assess whether the GC conceded on the schedule to improve productivity and if so, what were the challenges experienced due to these spontaneous schedule alterations. The questions were aimed at determining what type of failures were detected that might or might not have influenced the collapse. These questions include:

- Question 1: What are the process and coordination gaps that may have influenced the collapse of the Tongaat mall project?
- Question 2: What are the challenges encountered with project implementation on the Tongaat mall project?
- Question 3: Are you familiar with construction failure modes that may have influenced the collapse of the project?

- Question 4: What are the notable deviations in Tongaat mall project work processes, which can be found in terms of the Construction Regulations (2003 or 2014)?

In answering these questions, the interviewees report that the supervision as a crucial process in construction was below expectations and help from supervisors was even non-existent in certain instances despite consistent demand for production improvement. For example, the supervisors often overlooked poor workmanship unless a defect was obvious. When defects were obvious, rework directives would be given. A clear instance was the demolition of columns that had clear deflections.

In addition, the interviewees recalled that they were pressured to perform tasks they did not feel comfortable with. The interviewees clearly saw these incidents as intimidating. The interviewees were equally of the opinion that scheduling and work sequencing were not properly done on the project. They perceived the absence of a clear sense of direction and that production was just chased for the sake of completing on time. Chasing the completion of the project on time led to obvious mistakes and construction flaws in the structural elements the interviewees constructed as evidence in the deflection in the columns, beams, slabs and walls. The interviewees went on to note that the procedure and methods used for correcting mistakes and defects that deviated from the norm. Although instances of objections were recorded, in general, directives from site management were obeyed. As earlier observed, limited know-how concerning the construction regulations among the interviewees was observed. If this was the case, the ability to comply with the regulations would appear to be truly limited.

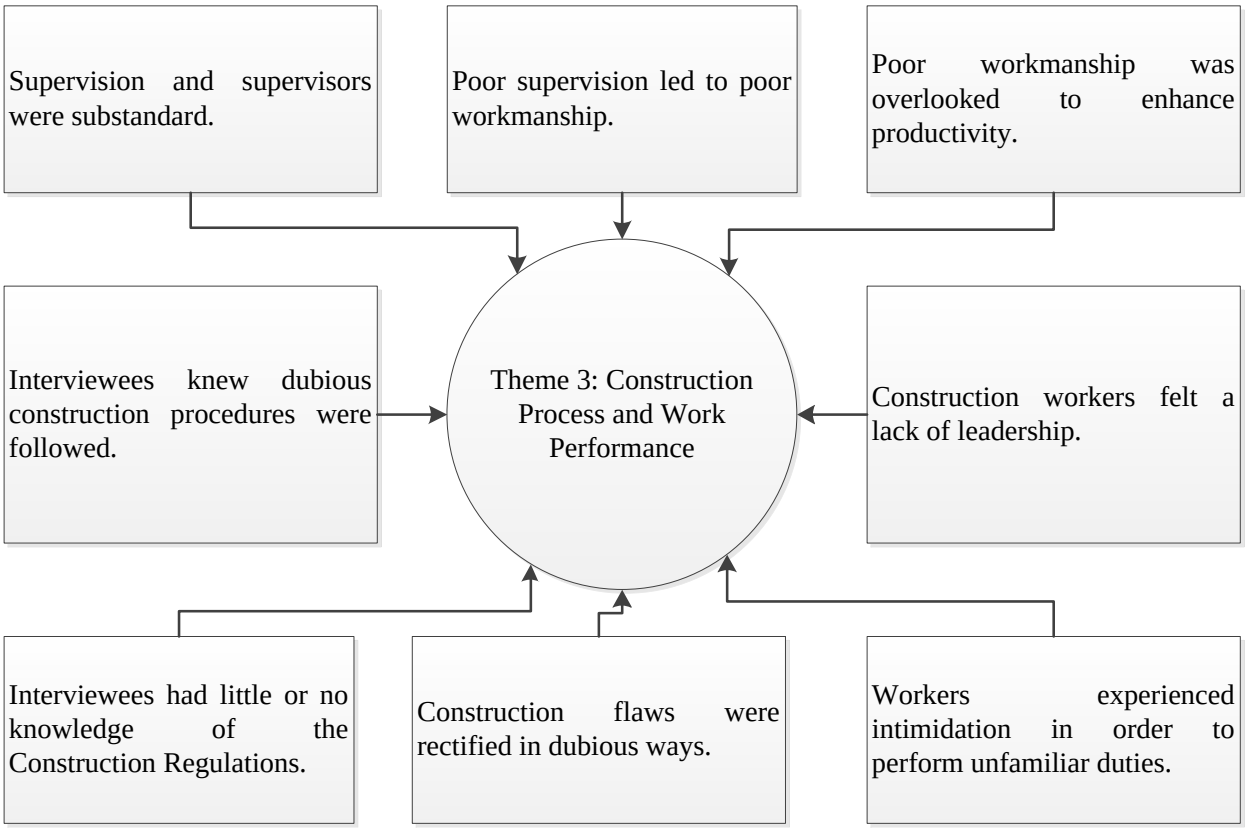

Figure 4.20: Summary of responses to construction work performance related questions

4.3.4 Theme 3: Construction Supervision

This particular theme emerged through the connection between poor construction supervision and practices recognized on the Tongaat mall project. These questions address the magnitude of the involvement of the H&S officer appointed and the magnitude of the involvement of the client and contractor in safeguarding the work environment for all involved on the Tongaat mall project. Six questions were used to derive this theme, and they include:

- Question 1: Did you experience any significant relationship between poor construction supervision and building construction practices in terms of the use of substandard designs, materials, manpower and procedures on the project?
- Question 2: What are the consequences of the problems observed in the supervision of the construction works?

- Question 3: Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the safety officer appointed for the Tongaat mall?
- Question 4: Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the client?
- Question 5: Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the contractor on the project?
- Question 6: What are the notable deviations in Tongaat mall project supervision processes, which can be found in terms of the Construction Regulations (2003 or 2014)?

Figure 4.21 illustrates the responses to these questions. In brief, the interviewees were of the opinion that supervision was inadequate as they also indicated that they did not have confidence in the leadership of the GF and even questioned his qualifications and knowledge of the construction process. The interviewees also noted that the effects of poor leadership from the GF contributed significantly to the poor supervision quality on the project. For instance, the interviewees observed that the GF also doubled as the H&S officer on the project. The GF had reprimanded the workers on the use of correct personal protective equipment (PPE) on the site on several occasions and there was not a distinct professional seen as the H&S officer on the project. In fact, the usage of the correct PPE on the site was low despite the reprimand by the GF. Further, events on the project show that thorough compliance to H&S practices was lacking on the site and the contractor failed to uphold sound H&S practices on the project. However, it was affirmed by one of the interviewees that his supervisor saw PPE of utmost significance to H&S on site.

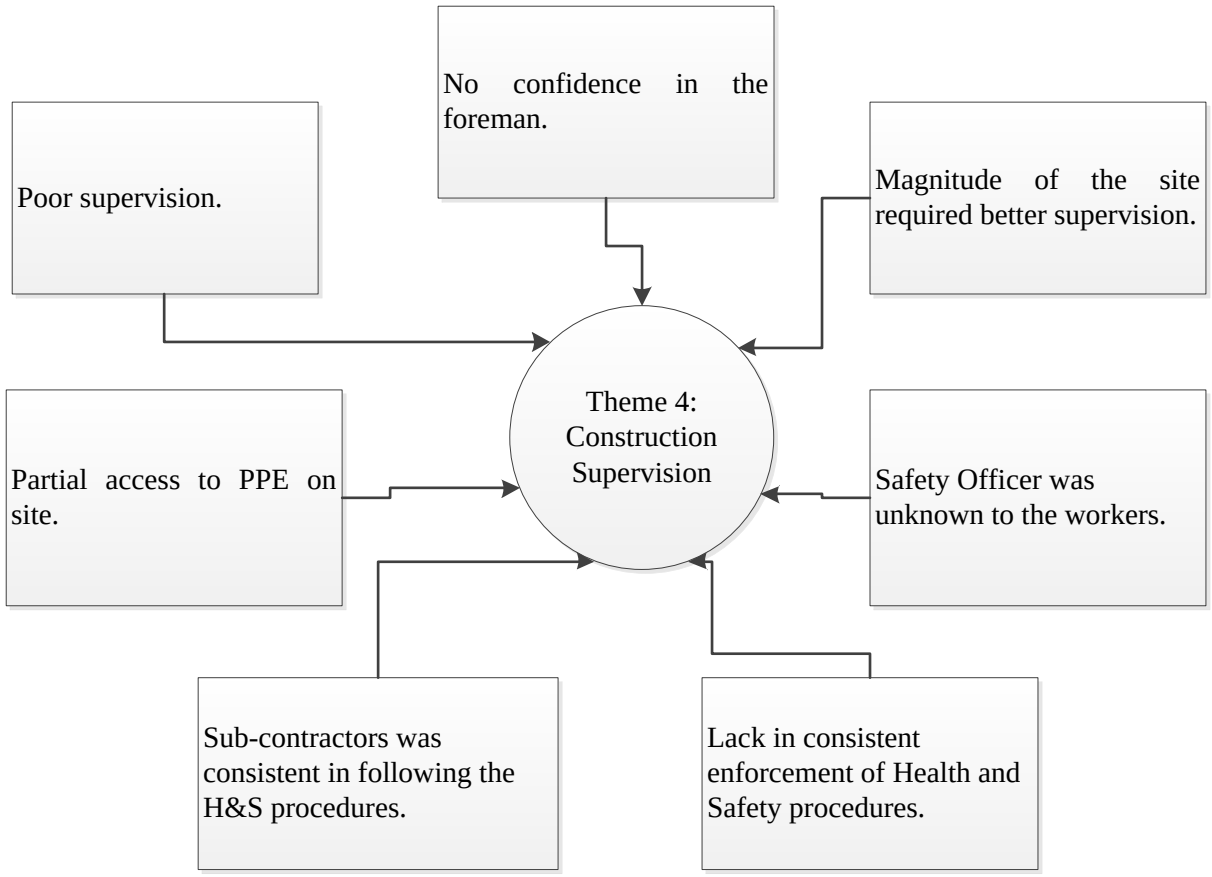

Figure 4.21: Summary of responses to construction supervision-related questions

4.3.5 Theme 4: Institutional Regulatory Environment

For this theme to evolve, the study elicited responses to "*Based on your opinion, how did you experience the on-site inspection of the Tongaat mall project; what is your perception on the enforcement of compliance with Construction Regulations (2003) by the local authority / municipality during the Tongaat mall design phase; and what is your perception on compliance enforcement on the Tongaat mall project?*"

These questions investigated the involvement of the local and governmental authority in the Tongaat mall project in terms of the on-site inspection as well as the enforcement of the regulations. They also assess the enforcement of these regulations by associated governmental authority. The analysis of the data indicates that the interviewees were not really aware of any inspections performed on site. This suggests that the interviewees were

not notified when such persons arrived on site or that they did not recognize such persons on the site. The lack of clear responses to Question 2 signified that the local authority had no significant presence on the site. The response to Question 3 signified that the interviewees perceived a significant lack of leadership in terms of enforcing regulations on the project. For example, the interviewees could not identify the responsible personnel that represented the local or governmental authorities on the project.

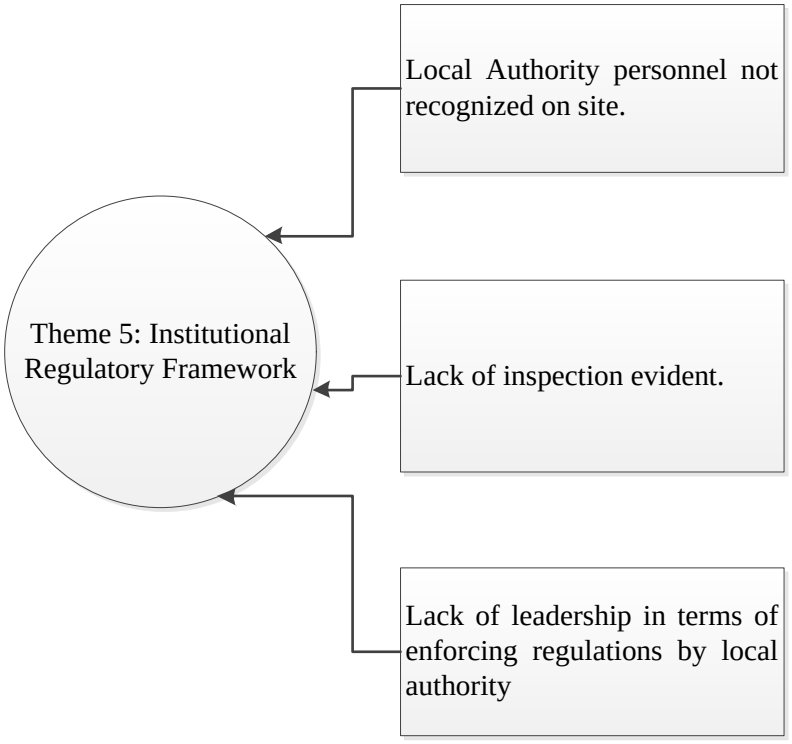

Figure 4.22: Summary of responses to institutional regulatory environment-related questions

4.3.6 Theme 5: Lessons learnt from the Tongaat mall accident

These open-ended questions were aimed at permitting the interviewee to express his/her own personal views in terms of the construction operations as experienced on the Tongaat mall project. It also allowed the interviewer to probe responses or ideas that were indicated earlier in the interview. The questions were aimed at allowing the interviewee to indicate the socio-economic impact of the Tongaat mall accident. The questions asked include:

- Question 1: Please indicate your experiences in the Tongaat mall collapse.
- Question 2: Please discuss your ideas concerning the construction operations of the project.

- Question 3: Please discuss the implications of the building collapse for the client, contractor, designer, and municipality.
- Question 4: Please indicate how you perceived the status of health and safety with regards to the Tongaat mall project.
- Question 5: Please provide your perspective on the outcomes of the Tongaat mall collapse in terms of monetary loss.

Responses to the questions show that the interviewees would decline ever working on a site where PPE is not accessible. They would also be hesitant to work on a site where the required supervision is lacking and where construction regulations are lacking. The interviewees also note that the rate of production was forced on them to the detriment of quality workmanship. They cited the fact that walls were constructed too fast without the necessary reinforcement or bracing, while formwork and props were also removed too soon. The interviewees recognized that the procedures were incorrect, and when they attempted to object, they were reprimanded. The interviewees pointed out that as work is scare they were in dire need of employment so much so that this placed them in a position where compliance to the directives given to them had to be obeyed. In brief, most of the interviewees were unhappy about the lack of PPE on site; they were also upset about the fact that their H&S and wellbeing were compromised on the project. The analysed data show that the rate of unemployment among the interviewees was high and that they needed the remuneration – hence their inability to challenge poor work processes. The interviewees reiterated that if they did not comply with the directives given to them their employment would be terminated. Some of the interviewees indicated that they did not want to be associated with the construction of the mall to guard their own safety and wellbeing.

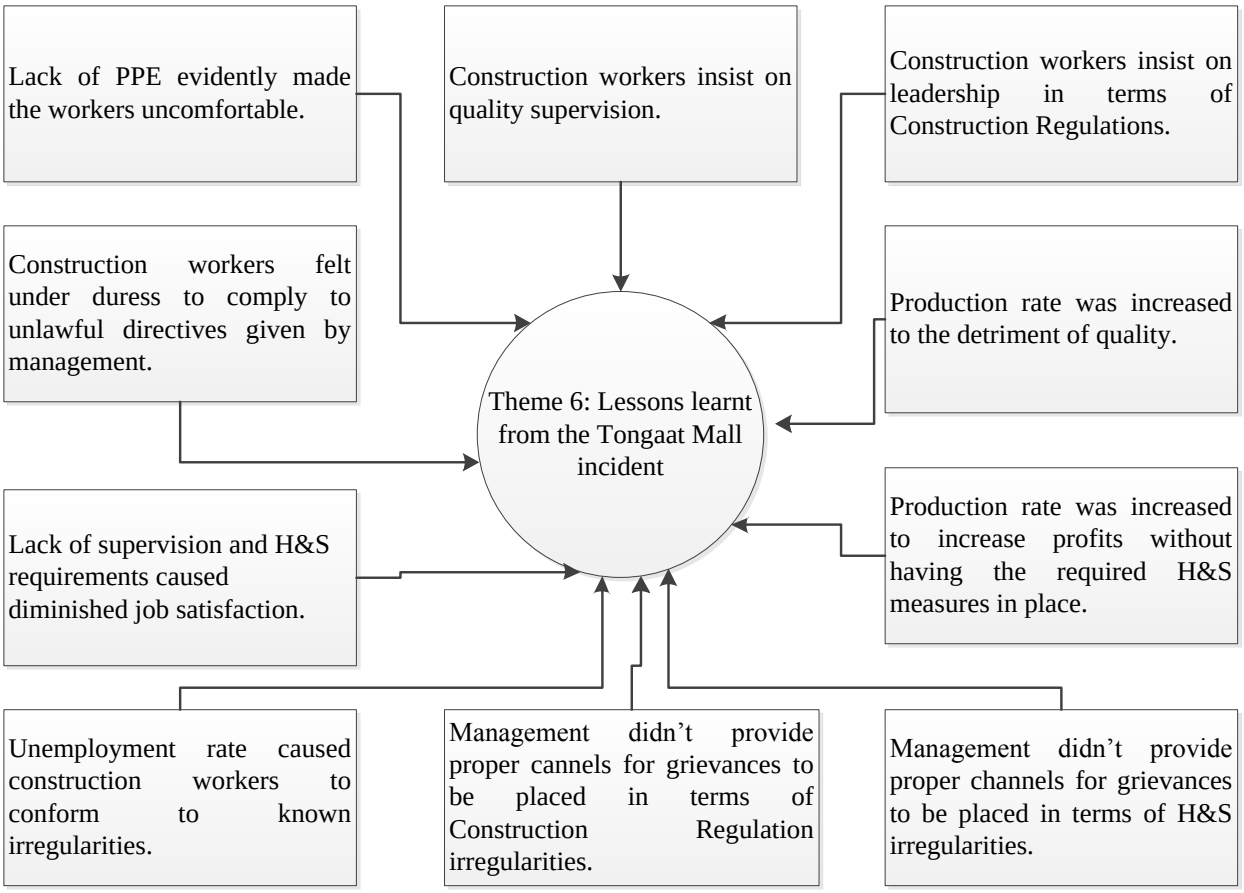

Figure 4.23: Lessons learnt in the Tongaat mall accident

4.4 Cross Analysis Data Presentation

After the data were collected, the researcher needed to see whether the expectations regarding data characteristics had been met. Choice amongst possible analyses should be based partly on the nature of the data. The method used in exploring the relationships amongst qualitative data was tabling the occurrences of categories and examining their connections (cross-tabulation). Table 4.1 reveals the relationship between the analysed documents and interviews.

Table 4.1: Cross tabulation of Tongaat mall accident findings

Research Question	**Document Analysis of Inquiry**	**Interview Analysis of Inquiry**	**Outcome**
1. What are the contributing factors that led to the collapse of the Tongaat mall?	Poor supervision by the management team.	Poor quality workmanship due to lack of supervision by professional team. Lack of inspection by the professional team. Supervisors were not qualified and lacked leadership. Poor supervision overlooked to enhance productivity.	Confirmed
	Poor quality control by the management team.	Quality workmanship was not enforced. Poor quality workmanship due to lack of supervision by professional team. Lack of inspection by the professional team. Material testing done intermittently. Poor quality overlooked to enhance productivity	Confirmed
	Lack of regulatory control by local and governmental authority.	Lack of inspection by regulatory bodies and professional team.	Confirmed
	Failure of structural elements such as beam and columns.	Column construction believed to be sub-standard. Formwork was	Confirmed

		removed too soon.	
	Failure to abide by Construction Regulations 2003 & 2014.	Construction procedures were questionable in order to meet deadlines and to avoid penalties. Formwork was removed to soon. Control and regulation of concrete mixing questionable. Construction flaws were rectified in dubious ways. Construction workers had little or no knowledge of the Construction Regulations. Supervisors were substandard and lacked leadership. Lack of inspection by regulatory bodies and professional team.	Confirmed
	Failure to acknowledge Health and Safety Act.	Appointed safety officer was unknown to construction workers. Lack of consistent health and safety protocol. Lack of sufficient PPE on site.	Confirmed
	Failure by management team to provide safe working environment.	Appointed safety officer was unknown to construction workers. Lack of consistent	Confirmed

		health and safety protocol. Lack of sufficient PPE on site. Various site accidents reported before collapse.	
	Failure to ensure proper material testing.	Material testing done intermittently. Control and regulation of concrete mixing questionable.	Confirmed
	Inadequate/under qualified staff placed in management positions.	Supervisors were substandard and lacked leadership.	Confirmed
	Management staff had to perform various supervisory and H&S roles.	GF had to perform various H&S and supervisory tasks.	Confirmed
	Inadequate foundation and column design by the structural engineer.		Unconfirmed
	Inadequate design alterations to accommodate variation orders.		Unconfirmed
	Failure to perform proper construction procedures by the principal contractor.	Poor quality workmanship due to lack of supervision by professional team. Construction procedures were questionable and forced to meet deadlines and avoid penalties. Column construction believed to be sub-standard.	Confirmed

		Construction flaws were rectified in dubious ways.	
	Failure to perform induction meetings with staff to acknowledge the various Construction Regulations of the various trades and tasks performed on the site.	Inadequate training provided. General labourers were used for skilled tasks without proper training. Construction workers had little or no knowledge of the Construction Regulations.	Confirmed
2. What is the direct cost of the Tongaat mall accident?	Medical costs	Medical costs incurred by previous accidents that were pointed out by the interviewees on the site.	Confirmed
	Cost reimbursed by Workmen's Compensation Insurance		Unconfirmed
	Net insurance premium.		Unconfirmed
3. What are the indirect costs of the Tongaat mall accident?	Loss of sales due to bad reputation	Interviewees indicated that the construction industry is in their opinion not trustworthy and has a poor reputation.	Unconfirmed
	Wages for injured workers.	Some of the workers that were injured before the collapse had to pay for medical aid from their own funds.	Unconfirmed
	Negative public relations.	Negative reputation when applying for work on other sites.	Unconfirmed

	Time lost by injured workers.		Unconfirmed
	Idle plant and equipment.		Unconfirmed
	On-going overhead costs.		Unconfirmed
	Legal fees		Unconfirmed
	Fines and Penalties		Unconfirmed
	Socio-economic losses.	The Mall would have brought money to an already high unemployment-stricken town. The Mall would have increased property prices in the area. Families suffer because of the loss of income.	Confirmed
	Site closure and demolition.	Material damage and loss.	Confirmed
	Productivity loss costs.	Some of the interviewees lost their equipment during the collapse.	Unconfirmed
	Loss of trade revenue for the tenants.		Unconfirmed
	Opportunity costs	Some of the interviewees lost their equipment during the collapse.	Confirmed
	Losses due to Stop Work Orders (SWO) issued to the project (disruption of schedules)		Unconfirmed

4. What are the lessons to be learnt from the Tongaat mall accident?	Proper incident reporting system must be in place.	Construction workers performed unlawful duties under duress; they were threatened with termination of employment if they did not conform.	Confirmed
	Implement corrective and preventative measures to avoid accidents.	Lack of quality supervision.	Confirmed
	Adequately qualified and competent supervisors must be present on site.	Lack of leadership in terms of explaining the relevant Construction Regulations. Lack of supervision and leadership caused loss of job satisfaction.	Confirmed
	A competent H&S officer or agent must be appointed to oversee construction work.	Lack of supervision and leadership caused loss of job satisfaction.	Confirmed
	All H&S practitioners must be registered with the South African Council for the Project and Construction Management Professions (SACPCMP)		Unconfirmed
	Fines and Penalties must be adequate to justify the size of the project in monetary value.		Unconfirmed
	The CIDB should review the current contractor grading system in terms of questionable reputations of construction		Unconfirmed

	companies.		
	Compliance and monitoring of compliance to Construction Regulations requires sufficient competencies and personnel to be effective.	Inadequate channels provided to report Construction Regulation irregularities. Construction workers performed unlawful duties under duress; they were threatened with termination of employment if they did not conform.	Confirmed
	Health and Safety in construction should be better defined in terms of liability.	Production levels increased to the detriment of quality and adequate H&S measures. Inadequate channels provided to report H&S irregularities.	Confirmed
	Stakeholders benefitted financially whilst carrying out unlawful activity which makes them liable to face civil claims and possible prosecution.	Production was increased while quality was lagging behind. High unemployment caused construction workers to perform known unlawful construction procedures. Construction workers performed unlawful duties under duress; they were threatened with termination of employment if they did not conform.	Confirmed
	In terms of the OHSA Act the categories of employers must	Production levels increased to the detriment of quality	Confirmed

	prepare a written policy concerning "the protection of the health and safety of their employees at work", including a description of their organisation and the arrangements for carrying out and reviewing that policy.	and adequate H&S measures.	
	Once construction of the mall is completed the owner of the mall remains responsible for the continued safe use thereof.		Unconfirmed

4.5 Summary

This chapter examined the results found in the document analysis and interview analysis. A mind map and various figures were designed to highlight important aspects that came to light through the investigation. The cross case analysis reported on the interview elements and document elements that proved to be significant in the specific case study. The next chapter, Chapter 5, provides the implications of the cross-tabulated findings through the lens of accident causation theory.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

This chapter discusses the aggregated research results through the accident causation theory. The narrative in the chapter therefore focuses on the adapted accident causation theory model, the summary of the aggregated results, and their analytic generalization.

5.2 Accident Causation Theory Model

Understanding accident causation is intrinsic to successful prevention (Toft, Dell, Klockner, & Hutton, 2012, p. 1). To shed light on the accident phenomenon, over the years authors have developed a plethora of models. Closer scrutiny of these models reveals that there are some common themes. Accident prevention is the most basic of all safety management paradigms (Toft, Dell, Klockner, & Hutton, 2012, p. 1). If safety management is effective, there should be an absence of accidents, and if accidents are occurring, then effective safety management could be missing. Hovden, Albrechtsen and Herrera (2010, p. 855) state that accident models affect the way people think about safety, how they identify and analyse risk factors and how they measure performance. They can be used in both reactive and proactive safety management and many models are based on an idea of causality. Accidents are thus the result of technical failures, human errors or organizational problems (Toft, Dell, Klockner, & Hutton, 2012, p. 1).

A simple linear model has been adapted for this study. The model assumes that accidents are the culmination of a series of events or circumstances, which interact sequentially with each other in a linear fashion, and thus accidents are preventable by eliminating one of the causes in the linear sequence (Toft, Dell, Klockner, & Hutton, 2012, p. 3).

5.2.1 Bird and Germain's Loss Causation Model

The above-mentioned model recognizes the need for management to prevent and control accidents. Bird and Germain (1985) developed an updated domino model which they considered reflected the direct management relationship with the causes and effects of accident loss and incorporated arrows to show the multi-linear interactions of the cause and effect sequence. This model became known as the Loss Causation Model (LCM) and was represented by a line of five dominos, linked to each other in a linear sequence (Figure 5.1).

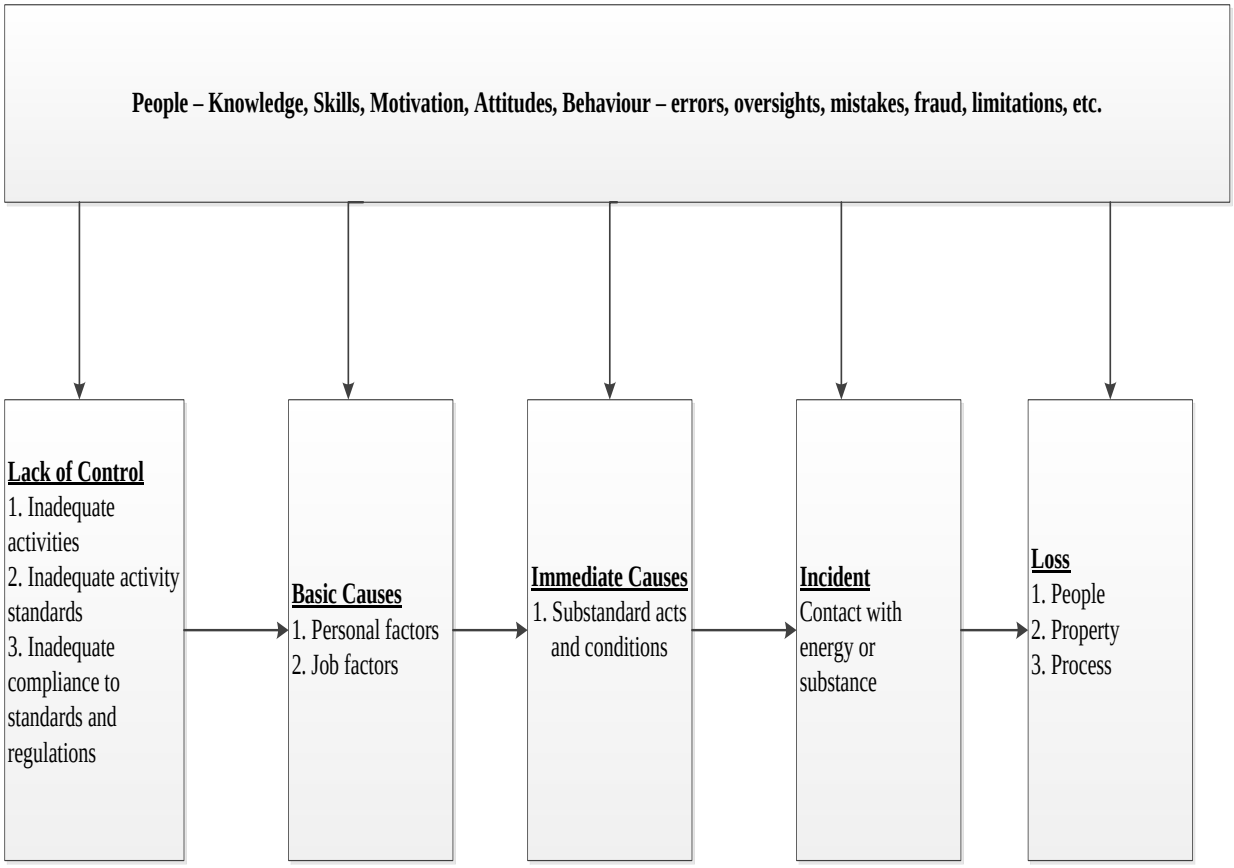

Figure 5.1: Loss causation model (Toft, Dell, Klockner, & Hutton, 2012, p. 7)

This model allows a structured method of identifying and categorizing the events that caused the Tongaat mall collapse. For instance, the loss that occurred can be described in the following terms:

- Injuries and fatalities involved in the accident
- Damage to property on-site and in the surrounding area, and
- Damage to the process and/or equipment involved, taking into account revenue lost due to inactive operation of the process.

In addition, the incident that occurred could be described in detail, in terms of the events that transpired and that resulted in physiological and or/or structural threshold limits being exceeded (Amyotte & Oehmen, 2002, p. 55). Substandard practices relate to the failure to use PPE, removing safety devices (early striking of formwork, for example), and the failure to follow procedures. Substandard conditions include inadequate access to personal protective equipment.

According to Amyotte & Oehmen (2002, p. 55), the immediate causes of the accident are analyzed, and the basic causes are investigated. Some personal factors that could bear responsibility are inadequate employee capability, lack of knowledge by the employees about possible dangers, a high stress level in the work environment, and improper job motivation imposed by management. Job-related factors could also be responsible, such as inadequate leadership, inadequate maintenance, inadequate work standards, and the abuse or misuse of equipment. An inadequate loss management programme can lead to potential accidents and shows a fundamental lack of management control. Inadequate programme standards or inadequate compliance with existing standards also illustrate a need for changes that should be incorporated by management (Amyotte & Oehmen, 2002, p. 55). The basic premises of the domino loss causation model are one of multiple causes – accidents are seldom, if ever, the result of a single event. On the contrary, there are typically several layers of causation.

By applying the LCM for the Tongaat mall collapse that killed two construction workers and injured 29, it could be seen that many factors contributed to the poor work conditions that continually existed on the Tongaat mall construction site and made it an accident waiting to happen. All of the substandard conditions and practices could be attributed to the lack of concern that management had towards H&S issues on the site, which was one of the primary root causes of the problem at the Tongaat mall project. The analysis that follows relies exclusively upon public domain references and personal interviews.

Significant contributing factors are given for each level of causation, with the objective of avoiding such costly incidents in the future. Again, this is the primary purpose of case studies of industrial accidents.

5.3 Loss Causation Model and the Tongaat mall Accident

Owing to the need for the researcher to achieve analytic generalization through literal and theoretical replication, hitherto exhibited by the selection criteria for the case study, there is an imperative need for the researcher to explore patterns across the case. It is important to note that it is not the intent of the LCM to place blame on individuals for committing substandard acts or for allowing substandard conditions to exist, but rather to encourage managers to evaluate the management system that influence human behaviour (Storbakken, 2002, p. 19). By punishing the employee, attention is shifted away from the management system that allowed the loss to occur in the first place. The following questions may be asked to maintain focus on the management system to identify where the breakdown occurred that led to the loss (Storbakken, 2002, p. 19):

- Why did that substandard practice occur?
- Why did that substandard condition exist?
- What failure in the supervisory/management system permitted that practice or condition?

Loss causation models are useful tools that aid in the identification of root causes of specific incidents as illustrated in the next sub-sections.

5.3.1 Loss

Loss is the result of an accident. Loss can be direct or indirect, both of which must be considered to fully impact an organisation. Both direct and indirect costs of injury or death are deducted directly from profits (Storbakken, 2002, p. 15). Losses resulting from the

Tongaat mall building collapse include the death of two people plus 29 injured. The losses also include extensive damage to construction equipment and the construction site itself. Potential bankruptcy of the contractors is equally possible due to lack of income and the litigations that are unfolding. The site had to be closed because it was rendered inoperable, thus removing a source of additional revenue for the company. Cost of demolition to the partly collapsed structure is a loss, and payments, which include severance, worker's compensation and unemployment insurance payments constitute monetary losses. Cost of running an extensive criminal investigation and trial involving the developer, principal contractor and professional team form part of the losses, apart from loss of future lease and rental income. Loss in revenue due to negative public relations for the project parties has both social and economic implications. Some direct losses that arose from the accident include:

- Loss in revenue due to idle plant, idle equipment, fines, penalties, and 'Stop Work Orders'
- Personal losses faced by the two construction workers' families and friends, on which it is impossible to put a price tag
- Expenses related to first-aid materials during the collapse, and the cost of transporting injured workers to the medical care centres, and
- Cost of investigation and associated efforts required to close the site.

5.3.2 Incident

The incident reported upon in this research is the Tongaat mall building collapse of 19 November 2013. The incident occurred in Tongaat, South Africa. It was recorded that a concrete slab collapsed on top of workers that were busy with activities beneath the slab. The incident killed two workers and injured 29 others.

5.3.3 Basic Causes

Basic causes are the underlying or root causes for the existence of immediate causes. As with the immediate level of causation (substandard practices and conditions), it is helpful to separate basic causes into personal factors and job factors (Amyotte & Oehmen, 2002, p. 58).

Personal factors that contributed to the Tongaat mall collapse include the lack of construction experience of personnel working on the site and the apparent lack of proper application of safe construction work practices. In addition, the study points to possible physiological stress caused by fear of reprisal for reporting safety concerns about work conditions.

Job factors that contributed to the Tongaat mall collapse pertain to the lack of proper orientation and training for new employees. The adequacy of toolbox talks is not certain and the clear disregard of safe work practices and procedures constitutes a major problem. The poor state of H&S audits and the missing H&S file of the project that would have revealed job-related issues are noteworthy.

5.3.4 Immediate Causes

Substandard practices are behaviours that could permit the occurrence of an accident (Amyotte & Oehmen, 2002, p. 57). The term 'substandard' acknowledges that organisations have standards of performance that are to be followed by all employees. Substandard practices that contributed to the Tongaat mall collapse include the continuation of construction activities in spite of 'Stop Work Orders'. This was a major contributor that was closely followed by inadequate construction procedures followed on the site. Inadequate H&S procedures and poor workmanship are all manifestations of poor management. For instance, it was observed that on the Tongaat mall project testing of materials was done haphazardly, formwork for columns and beams was removed too soon, and worst of all, no one could be recognized as H&S officer of the project – in other words, substandard conditions that could permit the occurrence of an accident existed in the project (Amyotte & Oehmen, 2002, p. 57).

5.3.5 Management Control

Lack of control in managing loss is generally due to deficiencies in one or more of three areas – the loss management programme or system itself, the standards identified and set for the

loss management programme, and the degree of compliance with such standards (Amyotte & Oehmen, 2002, p. 58).

In the case of the Tongaat mall collapse, management commitment to safe working conditions is suspect and the fact that compliance and accountability recorded low priorities shows a poor management control environment. As an illustration, compliance issues plagued the Tongaat mall project and if a stop order had been obeyed, perhaps the tragedy would have been averted.

5.4 Analytic Generalizations of Tongaat mall Case Study

It was observed that the causes of the Tongaat mall building collapse were inappropriate management of construction activities, poor regulatory control, structural failure, followed by poor supervision and workmanship, carelessness which could be linked to lack of competency in building techniques and supervision skills, and faulty designs. These issues were also flagged in past building collapses (Windapo & Rotimi, 2012, p. 288). Other causes included excessive loading and conversion and disregard for engineering drawings. The data suggested that the Tongaat building collapse was traceable to human activity (or inactivity).

The increase in building collapse incidents in South Africa highlights the H&S issues facing the construction industry, particularly in project implementation. In general, the analysis shows that constant revision of design was rampant on the project as designs were altered to make room for support on several occasions. The gaps in practice that led to the building collapse are multiple in that the client, the GC and the design engineer through various actions and inactions failed to stop the collapse. The design of a slender column that was unable to carry the dead weight of the collapsed slab is a case in point. This example supports the arguments that opportunities to reduce H&S risks are highest at the pre-construction stage and become less as the project progresses through implementation (Toole, 2007, p. 129). Designers, especially structural engineers, should respond to H&S situations at the pre-construction stage more strongly (Toole, 2007, p. 129). In Behm (2005, p. 591), these arguments corroborate the import of the time-safety influence curve, which describes the relationship between the progression of a project through its phases (initiation, design, procurement, implementation, etc.) and the ability to influence H&S as the project passes

through the classical stages of product realisation. In other words, at the commencement of a construction project site work, the ability to influence H&S is expected to be very low. This is evident in the reported quality of work and supervision that occurred on the Tongaat mall project.

Clients have key roles to play in providing and achieving optimum standards in H&S. This is particularly important when compliance is required. As shown in the findings of this building collapse, the client may have averted loss of lives in the site if compliance was adhered to as required. The Health and Safety Executive (HSE) (2002) confirms that clients have overall control of contracts and how projects are undertaken. The disappearance of the H&S file, which should contain documented H&S plan and specifications for the project, is another area where the construction regulations (2003) flagged the contributions of client/developer. In fact, the CIDB report of 2009 noted that in an August 2007 'Blitz' in which over a thousand construction sites were inspected by the DoL in South Africa, 52.5% of the sites failed to comply with one requirement or the other.

Following the client is the role that the design engineer has played on the project. It is not clear the extent to which the design engineer complied with section 9 of the construction regulations (2003), which states that "the designer of a structure shall inform the contractor in writing of any known or anticipated dangers or hazards relating to the construction work, and make available all relevant information required for the safe execution of the work upon being designed or when the design is subsequently altered". This clause is relevant to the roles of the design engineer in terms of addressing the mentioned triggers of the collapse – beam and columns. The need for design to consider H&S has been highlighted in the literature. The link between design and fatalities has been observed by researchers (Behm, 2005, p. 590; Cooke & Lingard, 2011, p. 7). For instance, a review of over 200 fatalities in the construction industry in the United States of America (USA) by Behm (2005, p. 596) suggests that 94 cases can be linked to design. Among the 258 construction fatalities assessed by Cooke and Lingard (2011, p. 7), 40% were linked to the design of the work place. These statistics underscore the importance of design influence on H&S performance.

Compliance matters are also heightened when the roles of the GC are examined. Given that the H&S performance of the GC is influenced by management commitment, communication and feedback, supervisory environment, H&S rules and procedures, training and competence levels, and work pressure (Teo, Haupt, & Feng, 2008, p. 491), the construction work and

supervision-related issues discussed earlier could be linked to the GC on site. For instance, the lack of the GF's relevant qualification may have contributed to his responses to issues on the site. In addition, the perception that H&S is the responsibility of everyone on site is contrary to what happened when the GF asked the workers to continue to work despite a notice to stop. Among others, section 5 of the construction regulations (2003) mandate a principal contractor to "stop any contractor from executing construction work which is not in accordance with the principal contractor's and/or contractor's health and safety plan for the site or which poses a threat to the health and safety of persons". The interpretation of this clause and its compliance is important and it requires the GF, assuming he is in the know, to take steps to mitigate possible failures on the project site.

The regulatory failures experienced on the Tongaat mall collapse involve multiple parties to the project. The failures mirror the causes of the collapse of a four-storey building close to its completion in Kuala Lumpur, Malaysia (Aini et al., 2005, p. 59). The collapse of this building recorded seven fatalities and 11 injuries. The inquiry into the causes of the collapse mentioned under-design of the building [column-related problems], and the poor quality of reinforced concrete work. Concerning the second cause of collapse, the inquiry flagged (1) improper curing of concrete, (2) premature striking of key formwork, (3) inadequate supervision in terms of compliance of used materials to specifications, and (4) deviations from structural design details. It is noteworthy that inferences can be drawn between this collapse that occurred in 1968 and the Tongaat mall collapse that occurred in 2013. Similar causes of the two collapses show that the industry in developing countries needs to address H&S behaviours of project actors.

5.5 Summary

LCM starts with a lack of control, which is within the four essential functions of management – plan, lead, control and organise. Taking this into consideration, it may be summarized that the losses recorded in Tongaat are indicative of a failure on management's part to perform one of its essential functions. By asking the right questions, the lack of control in the management system may be identified and addressed to prevent the sequence of events from occurring that leads to the eventual loss.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

In this chapter, the findings of the study are summarized, objectives evaluated, conclusions are drawn, and recommendations are made. Accidents in construction, as with accidents elsewhere, are the outcome of a sequence of events. In recognition of this complex sequence of events, this research followed these steps:

- Collected detailed data on the Tongaat mall collapse to determine the full range of contributing factors that led to the catastrophe.
- Used collected information to describe the processes of accident causation, including the contribution of management, project site and individual factors in the Tongaat mall accident.
- Established the non-monetary direct cost of accident of the Tongaat mall.
- Identified the various non-monetary indirect costs of the accident of the Tongaat mall.
- Highlighted lessons learnt from this accident to prevent future occurrences.

The gathering of qualitative data was divided into two stages. Stage 1 focused on analysing public records in the form of media reports in conjunction with reports received from the DoL. From this document analysis, project participants were identified. Stage 2 of the data collection focused on interviews. The interviewees construction workers that were actively involved in the construction of the Tongaat mall.

6.2 Summary of the Salient Findings

Not all tragedies can be avoided, but in the case of construction, experience, regulations and legislation should, in theory, minimize its occurrence. In South Africa, all employers are subjected to regulations, starting with the DoL Occupation Health and Safety Act in general

and more specifically, the construction regulations of 2014. In practice, the compliance and monitoring of compliance to these regulations present complex scenarios, and require sufficient competencies and personnel to be effective.

This research has demonstrated how the Tongaat mall construction accident arose from a failure in the interaction between management, regulatory authority, construction workers, their workplace and the materials and equipment they were using. Each of these elements was affected by various shaping factors, varying in the extent to which risks may be present and controlled in the work activity. In turn, originating influences include the permanent works design, construction processes and safety culture that bear upon these shaping factors.

The research has found that problems arose from workers' capabilities. This points to inadequate supervision, education and training, and poor information sharing. Shortcomings with equipment, specifically PPE, were identified. Originating influences, especially inadequacies with mindfulness, were considered to be present during the collapse. Frequently, no H&S audits or risk assessments had been undertaken covering circumstances that led to the Tongaat mall collapse. It appears that PPE was relied upon habitually as a substitute for risk elimination or reduction at source. It was judged that the accident could have been mitigated through design changes and it was found that despite the construction regulations (2003: 2014) and the Health and Safety Act 85 of 1993 (Republic of South Africa, 1993), many designers are still failing to address the safety implications of their designs and specifications. The influence from the client on safety appeared to be limited. This was again despite the responsibilities on clients imposed by the construction regulations. So severe are the possible infractions in the case of the Tongaat mall tragedy, that a Section 32 hearing was appointed by the DoL to investigate probable negligence on the part of several stakeholders.

6.3 General Conclusions

Achieving a significant and sustained reduction in accidents will require attention at all levels of the hierarchy of causation described in this dissertation. Important points include:

- There is a significant relationship between poor construction supervision and construction practices.
- There is a significant relationship between poor construction supervision and the building collapse.
- Responsibility for H&S needs to be owned across the project team from designers and engineers through to skilled trades' personnel and operatives.
- Other research has shown how the lead given by front-line supervisors has a strong influence on H&S performance. Worker participation in managing H&S is important, to generate ideas and to build ownership and responsibility.
- Where H&S depends on communication and coordination, it is important that a robust safe system of work is established by management.
- There needs to be greater sophistication with the use of PPE.
- It is important that H&S be disassociated from 'bureaucracy'.

6.4 Lessons Learnt

Because of the numbers of fatalities and injuries that accompany building collapse, both project actors and the public should be concerned when it occurs. The headlines that usually accompany such collapse do more harm to the image of the construction industry, which is a major employer of labour in most countries. The collapse of the Tongaat mall in South Africa is not different. The experiences detected from the analysed inquiry-related documents show that the event may have been prevented through adherence to the tenets of construction regulations by the developer, engineer, and GC of the project. The trigger for the mall collapse – a beam and two columns – emerged from poor H&S management that was on-going on the project in contrast to responsible designs that pose zero harm to persons, supervision of construction work, and the quality of the final product (elements of the building collapse such as the failed slab).

The roles of the major project actors have been observed through the reports and their implication for practice is profound, in the sense that several deviations from acceptable H&S behaviour could be decoded in the reports. The findings of the study suggest that the quality

of construction work and supervision as well as the recorded compliance with regulations are the factors that contributed to the collapse.

Several important lessons can be learnt from this costly tragedy. When viewed in a proactive manner, it is obvious that the domino model shown in Figure 5.1 offers multiple opportunities for loss control. These opportunities occur at the pre-contact (lack of management control, basic causes and immediate causes) stages, contact (incident) stage, and post-contact (loss) stage. In pre-contact control, the main objective is to reduce risk and prevent accidents from happening in the first place. If an incident were to occur, pre-contact control also involves planning ways to reduce the severity of the loss. The second level of control (contact control) involves measures taken to reduce the degree of damage at the time of the incident. Post-contact control seeks to contain the extent of loss after the accident occurs.

In the field of loss management, it is ultimately desired to eliminate risks, hazards and accidents altogether; therefore pre-contact control should be emphasized. This requires attention to both system and attitude perspectives. A loss management system – implemented, supported and enforced by management personnel – is absolutely critical.

6.5 Specific Conclusions

In Chapter 1 the working hypothesis was presented relative to the problem statement. Construction failures that eventuate in injuries and accidents are pervasive in the industry. Their pervasiveness requires stakeholders to improve all the triggers (remote and immediate) of failure. Lessons learnt from the case study can obviate the reoccurrence of construction failures. Improving the analysis of accident causation in South Africa would produce results that could provide a better understanding of construction failures. Meaningful investigation about the cause of failures would enhance the H&S of both man and machine in construction. The study has shown that it is truly crucial to engender structured analysis of accident causation in South Africa because of multiple pathways of the causation. The working hypothesis shows that the study is not exhaustive, but insightful.

Based on the document and the interview findings, the specific conclusions of the research include:

1. Determination of the contributing factors that led to the Tongaat mall accident.

It was observed that the prevalent cause of the Tongaat building collapse was inappropriate planning and management of construction activities, poor regulatory control, structural failure, followed by poor supervision and workmanship, carelessness which could be linked to lack of competency in building techniques and supervision skills, and faulty design. Other causes included excessive loading and conversion and disregard for engineering drawings. The data suggested that the Tongaat building collapse was traceable to human activity (or inactivity).

2. Establishment of the non-monetary direct cost of the Tongaat mall accident.

The non-monetary direct accident costs are those actual cash flows that can be directly attributable to or associated with injuries and fatalities. The insured accident costs to contractors are typically the costs covered by work injury compensation insurance policies. These costs may be measured by the insurance premium paid by the contractor. It was confirmed that various medical costs were incurred by the principal contractor on the Tongaat mall project for accidents that occurred in the months leading to the building collapse.

3. Identification of the non-monetary indirect cost of the Tongaat mall accident.

The uninsured cost items incurred by the Tongaat mall collapse were examined. The results show that there was loss in productivity due to the fatality and injuries resulting from the collapse, cost of supervisory and/or staff effort to manage the loss, and the cost of transporting the injured workers. Furthermore, the financial losses the client and contractor had to absorb due to other ancillary costs arising from the accident were difficult to quantify, such as damage to company reputation and morale of employees, on-going overhead costs, legal fees, fines and penalties and the socio-economic losses of such a disaster.

4. Recommendations from the accident in order to mitigate future occurrences.

The following recommendations were compiled after the various research objectives were reached. Mall developers as in the case of the Tongaat mall need to set quality standards for the populaces to be engaged. Set design standards based on tenant profiles and occupant needs to be established before construction commences to avoid numerous variation orders. During the study it was found that various variation orders were produced during the construction of the Tongaat mall that may have potentially affected the quality of work.

Moreover, variation order occurrence can lead to revision of H&S considerations. Furthermore, a system must be developed to conduct regular performance guarantees and verification tests. These hold points should be critical stops in the construction process where verification checks should be performed to ensure adherence to the construction regulations in the presence of the resident engineer who should sign off on the hold point, verifying satisfactory completion. From the study it is clear that a monitoring team whereby at least one member from each professional body must be represented to perform quality assurance.

The study exposed the need for effective monitoring of building projects by government bodies in charge of development and control needs to be carried out to ensure compliance. The study also established the need for stiffer penalties for non-compliances. The South African government should review the penalties for contravening the national building code and make them stiffer to discourage non-compliance.

6.6 Recommendations for Further Research

- It is recommended that a study be conducted to establish the monetary cost of accident of the Tongaat mall building collapse.
- Future studies could be conducted in terms of ascertaining the indirect or ancillary costs, such as damage to company reputation, damage to the relationship with the clients, damage to the morale and job satisfaction of workers, all of which is difficult to quantify.
- A Web-based repository of failed buildings that may serve as a means to reduce recurrence of future failures should be created and maintained.

6.7 Concluding Remarks

Accidents such as the Tongaat mall collapse can be prevented with proper H&S leadership. Loss causation models are useful tools that aid in the identification of root causes of specific incidents. Pre-contact accident causation levels afford the greatest opportunities for preventing repeat occurrences in the same industry.

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ANNEXURE A: COVER LETTER

• PO Box 77000 • Nelson Mandela Métropolitain University

• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University

for tomorrow

12-03-2015

To Whom It May Concern

Dear Sir / Madam,

Re: A CASE STUDY ANALYSIS OF THE COST OF TONGAAT MALL ACCIDENT IN TONGAAT, DURBAN, KWAZULU – NATAL, SOUTH AFRICA

An Interview is a significant part of an on-going research project at the Nelson Mandela Metropolitan University, which is aimed at meeting the requirements for M. Tech (Construction Management) qualification. Through the health and safety perspective, this research aims to document the leading factors, costs involved, challenges faced and lessons learned from the collapse of the Tongaat Mall building project.

I will like to invite you to participate in this study. Your consent is required for an interview session with your esteemed organization. The interview is expected to take not more than one hour. Please note that the interview proceedings will be treated as strictly confidential, and a confidentiality agreement will be entered with you or your organization should you wish so. Should you require a transcribed version of the interview for verification purposes, it shall be forwarded to you.

Thank you very much for your assistance.

Sincerely,

Leonarda van Eeden
Researcher

Fidelis Emuze PhD Pr. CM GMICE AMSAICE ICIOB

ANNEXURE B: INTERVIEW QUESTIONS

Note: This is not the copy that will be seen by participants. They will receive Possible Interview Questions, framed to suit the status of the participant.

Statement of the Problem	**Objectives**	**Possible Interview Questions**
Building collapse has engendered increased construction accidents and its cost in South Africa	1. Determination of the contributing factors that lead to the collapse of the Tongaat Mall.	**1.1 <u>Structural Failure</u>** 1. Explore the respondent's perspectives on building codes and specifications and how these could lead to a misinterpretation and misappropriation of design drawings and design materials. 2. Explore the respondent's perspectives on adequacy or inadequacy of field inspectors 3. Explore the respondents view on the design team's in-depth knowledge of the potential sources of risks and how this influenced the identification of risks during the design phase of the project. 4. Explore the respondents view on the inspection of material; did the inspection include sampling? 5. To what degree were the design deficiencies responsible for the collapse? 6. Did the failure occur in the physical aspects of the construction project; is this failure associated with the incident, and is it linked to the design? 7. Explore the respondents view on the physical aspect of the construction project associated with the incident and is it linked to the design? 8. Explore the respondents view is there a design suggestion from the existing literature which, if implemented during the design process, would have reduced the risk associated with the incident? 9. Explore the respondents view on any other design suggestions which, if implemented during the

		design process, would have reduced the risk associated with the incident? **1.2 <u>Construction Failure</u>** 1. Explore the respondents view on possible risks with regards to construction finance, construction time and construction design; and were these risks addressed in light of the different contractual relationships existing among the functional entities involved in the design, development and construction of the project? 2. Explore the respondent's opinion on why this safety accident occurred; was it due to a lack of project management, negligence of the construction safety policy or confliction of unparalleled construction programming? **1.3 <u>Construction Supervision</u>** 1. Did the respondent experience any significant relationship between poor construction supervision and unsustainable building construction practices (use of substandard designs, materials, manpower and procedures) that lead to the building collapse? 2. Did the respondent experience poor construction supervision in the execution of the building project? Does poor construction supervision account for the use of substandard designs in the building project execution? 3. In the respondents opinion, does poor construction supervision account for the use of substandard procedures in building execution? 4. Explore the respondent's opinion to establish which mechanisms were in place to heed warning signs during erection and construction? 5. Explore the respondents view on how the physical aspects of the construction project

		prohibited the contractor from implementing a temporary safety measure? **1.4 <u>Institutional Regulatory Framework</u>** 1. Explore the respondent's perspectives on on-site inspection. 2. Explore the respondent's perspectives on contract documents and the construction completed as the approved plans suggest. 3. Explore the respondent's perspectives on the regulatory role of the OH&S Inspectorate within the DOL. 4. Explore the respondent's perspectives on the enforcement of compliance with building regulations by the local authority / municipality. 5. Explore the respondent's perspectives on the effectiveness of the DoL Inspectorate. **1.5 <u>Fast Track Construction</u>** 1. Did the respondent experience any significant relationship between the selected procurement system and the effect it had on the performance of the Tongaat Mall construction product? 2. Explore the respondent's perspectives on communication between the various construction professionals. 3. Explore the respondent's perspectives on the level of communication between the design team and the contractors involved in executing the design decisions. 4. Explore the respondent's perspectives on professional ethics and which profession is responsible for design failures. 5. Explore the respondents view on the extent of hazard identification, risk assessment and risk control according to the risk management

		procedures ahead of the collapse? 6. Explore the respondents view on the cost of the design changes requested by the building envelope engineer; has the design changes been used on other projects and has it performed? 7. Explore the respondents view on if these design changes were allowable by Building Regulations and the Code of Conduct? **2. <u>Explore the respondent's perspective on the Health and Safety programme that was implemented during the construction of the Tongaat Mall.</u>** 1. Explore the respondent's perspective on how the Health and Safety programme was maintained and enforced by the safety officer. 2. Explore the respondent's perspective on how the Health and Safety programme was maintained and enforced by the local government. 3. Explore the respondent's perspective on how the Health and Safety programme was maintained and enforced by the client. 4. Explore the respondent's perspective on how the Health and Safety programme was maintained and enforced by the contractor .
	2. Establishment of the direct cost of accident of the Tongaat Mall	1. Explore the respondents view on the hierarchy of consequences in terms of direct cost of accident of the Tongaat Mall building collapse? 2. Ask the participants to identify the components of insured accident costs that arose from the collapse to the client and contractor? 3. Ask the participants to identify the components of direct accident costs that arose from the collapse to the client and contractor? 4. Ask participants to identify the factors influencing the insured cost of accident of the building collapse?

		5. Ask participants to identify the factors influencing the direct cost of accident of the building collapse? 6. Explore respondents view on the benefits of investment in health and safety with regards to direct cost of accident? 7. Explore the respondent view on the extent of cost of compensation offered to workers as a consequence of being injured during the Tongaat Mall collapse; and which remaining costs had to be covered by the client himself?
	3. Identification of the indirect cost of the accident of the Tongaat Mall	1. Explore the respondents view on the hierarchy of consequences in terms of the indirect cost of accident of the Tongaat Mall building collapse? 2. Ask participants to identify the components of uninsured accident costs that arose from the collapse to the client and contractors? 3. Ask participants to identify the factors influencing the uninsured cost of accident of the building collapse? 4. Explore the respondent's perspectives on other ancillary costs that arose from the accident which are difficult to quantify? 5. Explore respondents view on the benefits of investment in health and safety with regards to indirect cost of accident? 6. Explore the respondents view on the indirect costs related to costs of clean-up after the accident? 7. Explore respondents view on indirect costs associated with the administrative costs in terms of paperwork related to claims and reports after the accident? 8. Explore the respondents view on indirect costs that may have been overlooked but were found to be detrimental to the client and contractor as a result of the accident? 9. Explore the respondents view on the

		incongruence between the average insurance premiums and combined uninsured costs associated with the accident?
	4. Recommendations from the lessons learnt from this accident in order to mitigate future occurrences.	1. Ask participants about their experiences and expectations related to the Tongaat Mall collapse and its aftermath. 2. Explore the respondent's thoughts concerning construction programme operations. 3. Explore the respondent's perspectives on programme processes. 4. Explore the respondents view on the significant impact of the "tight project schedule"? 5. Explore the respondent's perspectives on accountability of the government bodies with regards to the collapse? 6. Explore the respondents view on the accountability of the client and professional team with regards to the collapse. 7. Explore respondents view on in-depth investigations being carried out with regards to site conditions, client's needs and collaborative work to minimize design and cost variations. 8. Explore respondents view on the benefits of investment in health and safety? 9. Explore the respondent's perspectives on the outcomes of the Tongaat Mall collapse in terms of monetary loss? 10. Explore the respondent's perspectives on any changes they perceive in themselves as a result of their involvement in the catastrophe.

ANNEXURE C: INTERVIEW PROTOCOL

A. Interviewee Demographic Information

1. Please introduce yourself in terms of your profession, employer, and position?
2. Please indicate your level / extent of involvement in the construction industry?
3. Based on your working experience in the industry, how would you rate your familiarity with the Construction Regulations (2003 or 2014)?

B. Structural Integrity

1. In your opinion, how would you rate (if any), the implementation gaps relative to design and specifications on the Tongaat Mall project?
2. What is your perspective on the adequacy of design supervision and monitoring in the Tongaat Mall project?

   What are your views on the inspection of material in terms of the Tongaat Mall?
3. What is your view on the structural elements of the Tongaat Mall project?
4. What is your view on the influence of the structural elements on the collapsed sections of the project?

C. Construction Process and Work Performance

1. What are the process and coordination gaps that may have influence on the collapse of the Tongaat Mall project?
2. What are the challenges encountered with project implementation on the Tongaat Mall project?

   Are you familiar with construction failure modes that may have influenced the collapse of the project?
3. What are the notable deviations in Tongaat Mall project work processes, which can be found in terms of the Construction Regulations (2003 or 2014)?

D. Construction Supervision

1. Did you experience any significant relationship between poor construction supervision and building construction practices in terms of the use of substandard designs, materials, manpower and procedures on the project?

2. What are the consequences of the problems observed in the supervision of the construction works?
3. Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the safety officer appointed for the Tongaat Mall?
4. Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the client?
5. Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the contractor on the project?
6. What are the notable deviations in Tongaat Mall project supervision processes, which can be found in terms of the Construction Regulations (2003 or 2014)?

E. Institutional Regulatory Framework

1. Based on your opinion, how did you experience the on-site inspection of the Tongaat Mall project?
2. What is your perception on the enforcement of compliance with Construction Regulations (2003) by the local authority / municipality during the Tongaat Mall design phase?
3. What is your perception on compliance enforcement on the Tongaat Mall project?

F. Direct Cost of Accident

1. Please discuss the components of insured costs that arose from the Tongaat Mall building collapse?
2. Please discuss the factors that influenced the direct cost of the Tongaat Mall building collapse?
3. What in your opinion is the extent of the cost of compensation offered to workers as a consequence of being injured during the Tongaat Mall collapse?
4. Based on your experience, which direct costs had to be covered by the client due to the Tongaat Mall building collapse?
5. In your opinion, what are the direct costs related to costs of clean-up after the Tongaat Mall accident?

G. Indirect cost of the accident

1. Please discuss the components of uninsured accident costs that arose from the Tongaat Mall building collapse to the client and contractors?
2. Please discuss the factors influencing the uninsured cost of the Tongaat Mall building collapse?
3. What is your perspective on other supplementary costs that arose from the Tongaat Mall accident?
4. In your opinion what are the indirect costs associated with the paperwork related to claims and reports after the Tongaat Mall accident?

H. Lessons learnt from the Tongaat Mall accident.

1. Please indicate your experiences in the Tongaat Mall collapse?
2. Please discuss your ideas concerning the construction operations of the project?
3. Please discuss the implications of the building collapse for the client, contractor, designer, and municipality?
4. Please indicate how you perceived the status of health and safety with regards to the Tongaat Mall project?
5. Please provide your perspective on the outcomes of the Tongaat Mall collapse in terms of monetary loss?

Thank you for agreeing to participate in my study. Your inputs will be very valuable in my effort to complete my research. As a respondent, the results of the interview questions will surely be beneficial to all stakeholders involved.

Thank you for your participation.

Yours sincerely

Leonarda van Eeden

ANNEXURE D: INTERVIEW TRANSCRIPTS

Interview transcript
A. Interviewee Demographic Information
Interviewer: 1. Please introduce yourself in terms of your profession, employer, and position?
Interviewee 1: My name is Siniko Nondalane. I am 25 years old and my telephone number is 0832414851. I was a general labourer but because Ronnie could see that I am a clever guy (can I say clever guy?) they gave me the concrete power machine to operate. My employer was Ronnie Pillay Interviewee 2: My name is Douglas Dube (ZULU). On the site there I was a labourer but as a labourer there I had to do all other kind of jobs. My employer was Ronnie, he was the foreman and the project manager of the site. I was on the site for 3 months. Interviewee 3: My name is Themba. I am a steel erector by boss was the Pholobwa steelworks. Steel works foreman name was Donovan. Interviewee 4: My name is Freedom Chamane, my telephone number is 074 049 8438. I am a general labourer. Ronnie Pillay was my employer. On site I did the concrete work and columns and decks. Interviewee 5: My name is Sandile Smgonjya. My telephone number is 071 922 9950. I am a plasterer and carpenter. Ronnie Pillay from Gralio was my employer. I made the columns the beam and the decks. Interviewee 6: My name is Jacob Mthumbu my number is 0730163566. I am a plasterer my employer was Gralio. Interviewee 7: My name is Spamandla my telephone number: 061195955170. I am not currently working. I was mixing concrete and all those cleaning ups. Ok so you were a concrete mixer and doing house-keeping. Yes. I am 22 years old.

Interviewee 8:

My name is Sibongise my telephone number: 0833447268. I worked on the construction site as a general worker for 1 month. I was not there during the collapse.

Interviewee 9:

My name is Zamekile and my telephone is 0765877902. I am a general worker and a builder. I worked at the Tongaat mall for 2 months. I did not see the collapse I was gone that time.

Interviewer: 2. Please indicate your level / extent of involvement in the construction industry?

Interviewee 1:

I worked on the Tongaat project for +- 6 months before it collapsed. I have been in the construction industry for 8 years. I have been working for Grinnaker, Stefanuti Stocks Group 5. We started working at Tongaat because there was nothing available at the time. The councilor Michael Abrahams of the ANC sent us there

Interviewee 2:

I have been in the construction industry for maybe 8 years. I am a labourer but can also do concrete work.

Interviewee 3:

Erector of the steel for the top.

Interviewee 4;

I have been working in the construction -+3 years.

Interviewee 5:

I have been working in the construction for 9 months.

Interviewee 6:

Too many years.

Interviewee 7:

I don't have any experience in the construction industry. I work on the Tongaat Site for about 30 days. I was not there on the day of the collapse I was absent.

Interviewee 8:

I have previous construction experience as a general worker I don't know how many years.

Interviewee 9:

I am a general worker and a builder. I work in the construction many years

Interviewer: 3. Based on your working experience in the industry, how would you rate your familiarity with the Construction Regulations (2003 or 2014)?

Interviewee 1:

I am familiar with the construction regulations. I can say on that site it is the first time I have seen such poor service because things were done there that was not professional. The engineers were not professional. Ronnie was a supervisor, he was a foreman, he was a safety guy, he was a quantity surveyor he did like 5 positions himself.

Interviewee 2:

We didn't sign any contract at the site. We didn't get the pay slips. We just get the money. We had the PPE we had boots, overalls, safety vests and helmets but we didn't have any gloves.

Interviewee 3:

Yes I know about the regulations. I don't know the regulations.

Interviewee 4:

Yes I know about the regulations.

Interviewee 5:

No I don't know the regulations.

Interviewee 6:

I do not know the regulations.

Interviewee 7:

I know about the regulations but I don't have enough knowledge about it.

Interviewee 8:

I do not know the regulations.

Interviewee 9:

I know the regulations

B. Structural Integrity

Interviewer: 1. In your opinion, how would you rate (if any), the implementation gaps relative to design and specifications on the Tongaat Mall project?

Interviewee 1:

The contractor did not follow the plans he did things his own way. If you look at the columns you will see the columns are upside down I mean they are not straight. The carpenters were not professional carpenters they will just pick somebody from the road or something. Basically most of the guys that worked there were from Mozambique then it would be the first time they would do this type of job.

Interviewee 2:

The only thing we couldn't see what was happening on their own job because we were just informed we would do this that day. For example they should come and tell us now today you and you will do these things. We had the site meeting in the morning and we were told what to do by Ronnie Pillay.

Interviewee 3:

Yes my contractor was right everything my contractor did was right. The concrete and brick contractor was not right. If you do the concrete the stripping must be done 7 to 15 days. Now this contractor maybe he put the concrete today and tomorrow they take out the stripping now the concrete is not strong it is weak. Then they put machines at the top that is why the slab fell.

Interviewee 4:

Firstly the columns were wrong. They putting concrete 7pm in the night time and at approximately 8am the formwork was removed and more would be built. The beams were erected at 12 o'clock and after 7 or 8 days the formwork was removed. The problem was that the columns were bending and not straight. The cement was weak it was mixed on site.

Interviewee 5:

Yes he come to check.

Interviewee 6.:

I see Ronnie on the site. Ronnie check all the plastering. The inspector and the engineer he is coming there it was the white man and an Indian man. Everybody he cried the columns he said the columns were small there. Everybody cried for the column. Me as a black man I cannot tell him it is wrong.

Interviewee 7:

I can say no, some of the things he just let us do it without seeing if there would be a danger in it or not. We had to improvise on the job. If we were 20 construction workers maybe 3 knew had to do the job. Ronnie would just let us go on with work our own.

Interviewee 8:

Yes some walls were cracking and then the columns were too small you could see they were too small for the structure

Interviewee 9: NA

Interviewer: 2. What is your perspective on the adequacy of design supervision and monitoring in the Tongaat Mall project?

Interviewee 1:

No, what I would say the engineer himself hardly came on site. I believe in my opinion that guy was paid off. The engineer was an Indian guy. I know there are many engineers but the one that came to site which we saw was an Indian guy. I don't know the structural engineer.

Interview 2:

I think it wasn't good for us as the workers. You were asked to do something and you were scared. If you climb the scaffold you must have those safety belts that you use to make sure you do not fall we didn't have those belt. So we climb those scaffolds and the scaffold is shaking. Even the person who had done the scaffold he didn't have the erecting certificates. We would climb high without those belts. We told the foreman to organize some belts for us but came with about 3 belts. Some would use the belts some would not have belts we would share the belts. If you come to site earlier you would have a belt. First come first serve.

Interviewee 3:

For me when the building fall it was chaila time I had to go home it was about 3:30. Yes my supervisor was always there if the steel job was done every time he was there. My engineer he was there every time. I never see the engineer for the concrete.

Interviewee 4:

Yes they checked but they never told us that anything was wrong or to remove or re-do anything.

Interviewee 5:

Yes there was an inspector I do not know his name. I think it was Ronnie the foreman. Yes, when we were still coming and going to the site there were people who would come for inspection to check the concrete and steel

Interviewee 7:

When concrete was to be poured someone did come before and after to look at the concrete and reinforcing. This man was a white man I do not know if he was the engineer. I was absent many days so the engineer might have been there but I cannot say for all the days.

Interviewee 8:

I saw the GF Ronnie Pillay he did not do much supervision. There was nobody helping Ronnie it was only him.

Interviewee 9:NA

Interviewer: 3. What are your views on the inspection of material in terms of the Tongaat Mall?

Interviewee 1:

No, the reason why I am saying this is because we worked after hours. The normal time was 7:00 to 3:30 but almost every day will work until 23:00. There were no engineers on site during that time at night so we did our own thing do you understand. During the day he maybe come once off but we will be pouring concrete in the night so there was no engineer to inspect the concrete work and stuff and the concrete was made on site. We normally work from 7:00 – 3:30 but then you will work overtime they never paid us for the overtime. Then we will work from 4:00 -23:00 pouring concrete and mixing on site. We were just used like slave labor. There were only a few electricity lights on site for us to work during the night.

Interviewee 2:

There was one guy from the municipality he used to come there with the municipality car. I am not sure for what but it looked like inspection with and all those things he did that with Ronnie. We didn't know what we were doing was right or not. Like the steel was it good steel or not. We thought they bring the mall here so everything must be right according to our ways and the worst thing it is not our jobs to see were they good concrete or good steel our aim is just to graft and push the work that all. You were never sure if anything was right. Those people would use to do the columns they didn't have the certificates to do the job too they were just normal guys like me. I also do not have

certificates to do columns but I did the columns if it is "kokai" I would know I didn't have information about that thing. I just do what I was told. You would be there for 3 days without a guy who knows a thing then one day they would come and say you are right without checking all those things and the second thing the columns must set for 3 days to be dry but what we used to do we would pour the column the one day the next day we would take off the formwork and pour the next column while the column is still wet. We had no choice if they tell us we should do that thing if did not they would chase you of the site. We wouldn't say a thing about this is not right.

Interviewee 3:
The steel at the top was right. There was no problem with the top steel.

Interviewee 4:
They were rushing, telling us that the job must be done.

Interviewee 5:
Yes, when we were still coming and going to the site there were people who would come for inspection to check the concrete and steel. He would come maybe one day in the week.

Interviewee 6:

Interviewee 7:
No because as I know when concrete is mixed there must be too much of cement sand and stones we used to put into four wheelbarrows / barrels 1 bag of cement and it would be weak. I know it was weak it depends on what you will use the concrete if it is the cement for plastering then you mix 4 barrels with 1 packets of cement for concrete it needs to be stronger so for 2 barrels you need to mix 1 bag of cement.

Interviewee 8:
I did not see the inspection.

Interviewer: 4. What is your view on the structural elements of the Tongaat Mall project?

Interviewee 1:
My view is the carpenters were rushed to do the work. The concrete was weak. Everything was on time frame there we will pour concrete today in 2 days' time the formwork must be out and used elsewhere. The concrete was very weak if it should be 25 MPa maybe we were pouring 15MPa. This was just my estimation because I saw the mix and they used cheap cement as well.

Interviewee 2:

I do not think the columns were done correctly in my way. The way we did them they did not give enough time for concrete to dry. Column laborers didn't have any certificates. Any laborer would pour columns. The concrete was mixed on site Gralio got their own mixers. They mixed it and we would pour it.

Interviewee 3:

The column was weak the columns was small maybe 300 maybe the column for the mall should be 450 – 600. The reinforcing for the slab was small. The time the slab fall all the reinforcing for the slab was cut. The reinforcing was too small (short).

Interviewee 4:NA

Interviewee 5:

The time we put the concrete so sometime the rain is coming so we put the concrete down. Now we vibrate with the rain so it mix more so the mix is more loose and weak.

Interviewee 6:

You would never be able to see bending or sagging because the engineers, inspectors arrived and its them who were supposed to notice that, not someone who is a worker like me. I saw that the columns were bad.

Interviewee 7:

The beams and columns were not given enough time to dry and be stable the beams will one be a few days then they come and put a slab there.

Interviewee 8:

Like I say walls were cracking and then the columns were too small you could see they were too small for the structure.

Interviewer: 5. What is your view on the influence of the structural elements on the collapsed sections of the project?

Interviewee 1:

My view on that one was that see normally if you pour concrete you have to leave if for 15 - 21 days. No there it was left for a week and then taken off of the stripping. I believe the concrete was still wet.

I believe that section collapsed because it was not given enough time to cure. To my knowledge a deck must be left for between 15 – 21 days but for a week, really. We didn't see any professional people when started stripping the formwork. The engineer only came there when we were about to pour concrete he was there for about 30 -40 minutes. Another thing that surprises me on that mall non off the inspections failed they always passed. Normally on other sites if something failed it must be redone on this site everything passed. The engineer came before pouring of concrete only for the decks not for the columns, slabs and beams. I remember very clearly.

Interviewee 2:

What I am thinking the columns they build was not big enough to hold the top beam. They had small columns there. The columns were "kokai" like that. We will break some of the columns because they were not right and build them again. Maybe today we will build 5 columns 4 columns were wrong so in the morning you will come and break those columns and start again on top of the old column. Depending on who came and saw that thing if nobody came we should not break that thing. We didn't see the engineer because we didn't know who was who and what he was doing there. If someone come to the site like an engineer we were told to wear safety gear before people come to inspect the site just for him to see everything was right but when he was gone we did our own thing. But you know if you have money you can do anything maybe they paid those site managers.

Interviewee 3:

If they put proper scaffolding there at the beam but they started stripping.

Interview 4:

The problem was the columns were bending and it wasn't straight. The cement was weak, it was mixed on site.

Interviewee 5:

Yes we saw the columns were small and bending. The deck was too heavy for the columns.

Interviewee 6:

From what I have heard from many and from the company was that the columns were small, they were not left to dry, people worked at night, that's what I heard.

Interviewee 7:

The collapse was by the railway side. There is nothing except the lack of concrete I mean the concrete was not strong. I can say the concrete in the beams, slab and columns were weak.

Interviewee 8:
I was not there I can't say.

Interviewee 9:NA

C. Construction Process and Work Performance

Interviewer: 1. What are the process and coordination gaps that may have influence on the collapse of the Tongaat Mall project?

Interviewee 1:
We didn't have a foreman we didn't have a manager we didn't have a supervisor we didn't have a safety guy we didn't have quantity surveyor it was all done by 1 person which was Ronnie. He was doing all the work. We were told Gralio is the main contractor of which Mr. Sighn is the owner. We were told Ronnie was the sub-contractor.

Interviewee 2:
I can say for Ronnie he was there to tell us this was wrong and this was right. Ronnie the foreman was always there what to do. Ronnie was foreman and site manager because it was a big site he had a foreigner guy he was Ronnie's assistant his second hand man he was a Nigerian. He did all the those plans marking columns and pouring all the columns. We would just put our columns were he would he tell us to put our columns. Ronnie read the plans with the assistant. Together they would look at the plans if it was good or bad I would know.

Interviewee 3:
If you came on the site early in the morning we got the site meeting every day only for the engineer steel. The construction had no meetings you came to the work only. I never see meetings. We got the health and safety induction. But we never see the meetings on the site. The people for the scaffolding was not trained if they were trained this mall would never have fallen. We didn't have any PPE. If you came with the sandals you work. No safety belt. With my foreman (Donovan) you signed induction for the safety every day. They would concrete today for the beam maybe leave 15 days but these guys maybe 1 day or 2 days then take away the scaffolding everything.

Interviewee 4:
Yes they checked but they never told us that anything was wrong or to remove or re-do anything even though we thought something was wrong. They were rushing, telling us that the job must be done.

Interviewee 5:

The one other day I was working Ronnie say the column was bad I had to break the column but I built the column on the piece of the old column.

Interviewee 6:

No I wasn't there. On the day that it collapsed I was not at work I did not come to work.

Interviewee 7:

I can say no because he (Ronnie Pillay) wasn't always there behind us to see how we are doing the job it was a big construction site. There were many people around the site in his position. We didn't know who they were. They were walking around we only knew Ronnie to be the supervisor.

Interviewee 8:

They will built long walls and when there is wind it is not dry enough so it does not become strong

Interviewee 9:NA

Interviewer: 2. What are the challenges encountered with project implementation on the Tongaat Mall project?

Interviewee 1:

Ronnie didn't follow any schedule. Everything was rushed. We felt disorientated we had to do everything at one time.

Interviewee 2:

Most thing I can say is that they try to cover the time I think they were late because we had to speed up. Everything was sped up to finish the work faster. There was not enough time to plan that thing the pushing the job faster. Obviously if you speed the the job faster bad things will happen. They had the due date to finish the job they were beyond the time and they had to cover the time. So everything was rushed.

Interviewee 3:NA

Interviewee 4:

Yes on a certain day they would tell us that they must pour concrete and it must be finished today or used up by tomorrow.

Interviewee 5:
We used to work because we knew some of the work. If for example, if steel needed to be welded, we would do that to build maybe a deck but if the supervisors were not there we didn't know what to do.

Interviewee 6:
What happened is that it was spoken about on the radio. You see when the building collapsed we were called to the inside hall. Ronnie was then asked if he has a certificate (qualification) to build a mall of that size and he did not have one. So I may never know how far he went with his studies or how far qualified he is. From what I heard he has been doing this for 15 years but no certificate.

Interviewee 7:
What Ronnie would do he was happy when wall going up. Ronnie rushed with the walls going up.

Interviewee 8:
Everything went fast.

Interviewee 9:NA

Interviewer: 3. Are you familiar with construction failure modes that may have influenced the collapse of the project?

Interviewee 1:
Yes I saw that. You can see at the columns were they are joining. There are joints there and there are joints there…..even the decks and the floating was not straight. I saw bending mainly in the columns and in the decking. The steel fixing guys were rushed. The columns were also too small for the big decks. I didn't see the walls bending but they were not straight. That was because the carpenters were not professional they just choose from any Tom, Dick or Harry of the street. What I would say on the section that collapsed is that the columns were small the decking that fell was because the cement was not dry from the beam and the columns were still wet.

Interviewee 2:
One wall on the main road was bend and cracking. The crack was very bad we were instructed to put weight to push the wall back. They filled sand at the back and then the wall moved we had to push the wall back s normal. When we pushed the wall back the columns from the wall started separating it only pushed back so far. We used the jacks to push the wall back what they did then was to use the cement to cover and fill the gaps that showed the separation from wall to column. Ronnie our foreman

told us to do this. It was obviously wrong because if the wall is falling we should redo the work. They said we will be wasting time and money and just push the wall back and fill the gaps on the side so it looks straight.

Interviewee 3:
By the time the mall fall there was a crack the reinforcing for the slab was cut.

Interviewee 4:
Yes, it was just the big wall at the back that was not right. Also the reinforcement bars were not placed correctly and the deck was shaking, the reinforcement bars were placed on the side. The wall was bend to the inside of the mall. We were asked to push it back.

Interviewee 5:NA

Interviewee 6:
I saw the beams as straight because this thing did not fall it flew.

Interviewee 7:
Yes, because some of the bricks were sliding. The wall wasn't just smooth it wasn't straight. Some of the columns were "kokai" they were not straight.

Interviewee 8:
The walls were cracking that is what I see and columns were small.

Interviewee 9:
The columns were bent and the stripping was done while the columns were still wet.

Interviewer: 4. What are the notable deviations in Tongaat Mall project work processes, which can be found in terms of the Construction Regulations (2003 or 2014)?

Interviewee 1:
I saw a lot of things that were not done professionally and according to the construction law.

Interviewee 2:
I don't know the regulations but we knew something is missing and that something was wrong. I used to work at King Shaka Airport I saw how they do things there you can see how things was done there

and how it was done here it is very different. Now you cannot say anything they will ask you what are you going to do? They didn't put any steel in the foundations they just poured concrete on the sand. For the ground floor they just poured concrete and the columns on top. There was steel on the columns. When pouring of concrete was done in foundations the engineer was not there only Ronnie. Ronnie and the owner Mr. Sighn used to come there every day. The soil under the foundation was cleared and then the columns were cast in position. The piles had reinforcing but not the concrete floor on the ground. The other thing that we saw was that the connection or joiner steel from the kicker or base was too short to make connection with the longer steel in the columns. I think it looked they were trying to safe on the steel not use so much steel. We will leave the site at 16:00 but at night time at 19:00 they would work over time to come to pour. When you come in the morning it is poured. We will work shifts and then we come in the morning the columns are poured we will strip the thing and begin built right on top of that thing. The concrete for the columns and the side walls were poured in the evening. The concrete was not being kept wet (curing) and being covered to keep moisture in. the speeding up the project. There was lack of information on what had to be done.

Interviewee 3:
NA

Interviewee 4:
I do not answer.

Interviewee 7:
Not applicable as the individual is not familiar with the regulations

Interviewee 8:
I do not know I just know things were not right.

Interviewee 9:
I couldn't answer.

D. Construction Supervision

Interviewer: 1. Did you experience any significant relationship between poor construction supervision and building construction practices in terms of the use of substandard designs, materials, manpower and procedures on the project?

Interviewee 1:
Even the supervision itself was poor because that guy Ronnie didn't know what he was doing

according to me he is not a qualified S4 engineer. Most of the people on the site like the builders were just taking chances. The carpenters were taking chances you can just come to site with a hammer and stuff and say I am a builder or a carpenter and they would employ them. There was no formal paperwork or certificates of competency.

Interviewee 2:
I don't think it was good because Ronnie was the only one there he had guys that would do steel fixing there guys doing columns he couldn't cover everything. If you were doing something on the other side of the site he would know if you are doing right or wrong. The other thing if you are paid less money you would do a good job. We received R95.00 a day no pay slip no UIF.

Interviewee 3:
If these guys have a "toolbox" talk everyday maybe no mistake. Now every day you come to work its work its work its work NO toolbox talk. The foreman was not good. You take the guys to change you take them to their space and have the toolbox talk and then guys working safety and then go to work. You come to work they say guys, guys, guys push, push, push.

Interviewee 4:
There was one guy I keep on forgetting his name. Ronnie was there but he had one Nigerian guy that was helping Ronnie. I think he knew about the plans and what job should be done. Then Ronnie would inform the workers. The cement was not strong, steel bars were too small to be used in the beams.

Interviewee 7:
Sometimes we were concerned with things like you can't mix to much sand with the concrete. If we were to raise that with Ronnie he promised to fire us.

Interview 8:
I was sick many days I cannot say much on this.

Interviewee 9:NA

Interviewer: 2. What are the consequences of the problems observed in the supervision of the construction works?

Interviewee 1:

In my opinion Gralio employed the wrong person for the job. Ronnie didn't know what he was doing. Ronnie didn't have construction experience. The workers started doing their own thing because of the lack of supervision. The reason why I am saying that he would ask them to do shutters Ronnie would tell them to do this you get wind walls and stuff even Ronnie doesn't even know what he is saying so the workers had to improvise on what to do. Ronnie will only come and say I want this wall from here to there today and then the workers had to improvise.

Interviewee 2:

Ronnie lacked some information about the job too. I do not think he had good information on what he was supposed to do. There was not enough supervision on the site.

Interviewee 3:NA

Interviewee 4:

Yes we would be able to ask them what to do and tell you what is wrong but the things was maybe they were doing something else they could not cover all of us at the same time to see if we were right or wrong.

Interviewee 5:NA

Interviewee 7:

We will do the job on our own because you know for sure there will be no one coming around to shout and scold us about what we did wrong or what we didn't do wrong. You can do whatever you wanted to. Ronnie will later come by and just be happy that the work is done.

Interviewee 8:

Ronnie did not do many supervision. He was alone.

Interviewee 9:NA

Interviewer: 3. Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the safety officer appointed for the Tongaat Mall?

Interviewee1:

There was no safety officer. Ronnie Pillay was that himself. People wore tekkies and sandals on the

site. People didn't have the right tools for their jobs it was drama. There were no goggles for when they were cutting steel.

Interviewee 2:
We did not know the health and safety officer. He didn't come to look at us he came to look at the work only but most of the times how we know there was a safety officer we were told to dress in the safety gear and all the other things because someone else was coming. I think this person was from the contractor not from the municipality. There was a lady that came there for three weeks with the municipality car a white Polo. She was checking around and by the time we when home a white man came with the same municipality car to come checking. The local municipality came onto the site to survey. They were there during the foundations not during the upper floors. When these people come they don't inspect the work they only spoke to Ronnie. They don't speak to the workers they only speak to Ronnie. Ronnie will take them around the site and show them what is done and what has to be done.

Interviewee 3:
I think he was one of the foreman but I don't know. I know he was a foreman but I didn't know what his job was. The other construction workers didn't have the hardhat, safety goggles, safety boots or safety belt no reflectors. My steel contractor (sub-contractor) we had everything. There were no sign that said you should wear hardhats and goggles no health and safety signs.

Interviewee 4:
No they never came there to inspect the thing. Ronnie was the foreman who told us to wear our safety wear.

Interviewee 5:
I never see the man.

Interviewee 6:
We wore the makoraba. We had the PPE. We had induction in the morning there were meetings and the safety people would arrive.

Interviewee 7:
Yes there was a safety officer on the site he was an Indian man. We were told to wear our PPE on the first day we were employed but he was not ensuring that we were wearing them or not.

Interviewee 8:

I did not see anyone.

Interviewee 9:

I did not see the health and safety agent I did not know him

Interviewer: 4. Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the client?

Interviewee 1:

No I did not see the client

Interviewee 2:

All that I know is Ronnie told us the job here is not part of the council. Ronnie told us Mr. Sighn owned the mall he do everything about the mall. He paid for everything. Ronnie said we cannot complain about anything or tell our councilors about fees or payment because they went to council just to inform them they are going to build a mall. This meant the councilor cannot be involved in the mall. This guy is building his own thing there. If you want a job you work if you don't want a job you go away

Interviewee 3:

I think he was one of the foreman but I don't know. I know he was a foreman but I didn't know what his job was. The other construction workers didn't have the hardhat, safety goggles, safety boots or safety belt no reflectors. My steel contractor (sub-contractor) we had everything. There were no sign that said you should wear hardhats and goggles no health and safety signs.

Interviewee 4:

I saw Mr. Sighn but he didn't talk to workers.

Interviewee 6:

Maybe he did arrive I did not pay attention. Maybe he did arrive but youd find that I did not notice but I did not see him because my work is the last job. I was needed at the end when the other workers had already finished working.

Interviewee 7:

The client Mr. Sighn was on the site but he never talked to us about health and safety.

Interviewee 8:

I never see the client.

Interviewee 9:

I did not see Mr. Singh

Interviewer: 5. Based on your opinion, in what way was the Health and Safety programme maintained and enforced by the contractor on the project?

Interviewee1:

There was no PPE on site. If you come with sandals because your boots are bust you come like that. They just wanted the job to be done they didn't care about the people. There were no site boards indicating health and safety, only big companies do that. There was no site office it was under the decking they had a simple table under the decking and that was their site office. There was no health and safety induction in the mornings. There were no "toolbox" meetings. They will just read the register in the mornings to see if you were present. Ronnie didn't have any assistants. There was this girl she did a 2 year course in quantity surveying in Umlazi she was like a clerk she was there for only two months. Ronnie employed that girl.

Interviewee 2:

We didn't have enough PPE. We didn't have gloves to work with the concrete. We didn't have H&S induction but what he did have there in the morning Ronnie will come those guys with no boots and no helmets they must go home asked to leave the site. Mr Sighn was only there for maybe one hour. Now if they blame the steel now they cannot blame the steel because they knew how the steel was the same with the concrete. They knew how it was.

Interviewee 3:

On this site there was no PPE and then we had no safety boots if you came with the sandal you came with the sandal to work. There were no safety belts.

My foreman for the steel he did the induction for safety and then you started to work.

Interviewee 4:

Yes he used to told us to wear the "makaraba" and safety wear especially if someone was coming. He will check in the morning only if you are wearing your makaraba and safety boots.

Interviewee 5:

The first time we were not wearing then this one guy was coming and he break the legs and hands and then Ronnie was buying the PPE. So after a few injuries did Ronnie buy PPE we did not have them at

first.

Interviewee 6:
NA

Interviewee 7:
Ronnie only ensure safety boots and the uniform only. There were hard hats but if I just feel like wearing that I just take it off my head and put it down. There were construction site boards showing things but they were all laying on the floor.

Interviewee 8:
I only get the boots and overall that is all I can say.

Interviewee 9:
I got boots and an overall. There were hard hats but they were laying on the floor. There was not enough hats for all the workers. The GF will check the work only he did not check for PPE.

Interviewer: 6. What are the notable deviations in Tongaat Mall project supervision processes, which can be found in terms of the Construction Regulations (2003 or 2014)?

Interviewee 1:
There were notable deviations from the regulations. With regards to the supervision processes.

Interviewee 2:
NA

Interviewee 3:
NA

Interviewee 7:
The individual is not familiar with the regulations

Interviewee 8:
NA

Interviewee 9:
NA

E. Institutional Regulatory Framework

Interviewer: 1. Based on your opinion, how did you experience the on-site inspection of the Tongaat Mall project?

Interviewee 1:

Yes I saw someone once with a Golf from the municipality but actually I think those guys came to put on the power on the site. I saw them at the end of the project before the collapse. They spoke to Mr. Sighn. I didn't see any notices indicating that work was stopped. I only saw signs that was placed by Gralio that they were the contractors on the gate. Nothing was told to us that construction must stop.

Interviewee 2:

I didn't see them very often. Only during the foundation pouring. Ronnie told us to stop focus on the Game in the corner there was something wrong and only focus on the Mall. Game was attached to the mall by a wall only.

Interviewee 3:

No I never see. No never see people from DoL.

Interviewee 4:

No I did not.

Interviewee 5:

I did not see them.

Interviewee 6:

No I didn't see anyone.

Interviewee 7:

I cannot remember seeing anybody from Municipality on the site. I never saw a notice to say work has stopped. We only see the company board

Interviewee 8:

I don't know I was ill many days.

Interviewee 9:

I did not see anyone from the municipality on the site.

Interviewer: 2. What is your perception on the enforcement of compliance with Construction Regulations (2003) by the local authority / municipality during the Tongaat Mall design phase?
Interviewee 1: NA Interviewee 2: NA Interviewee 3: NA Interviewee 4: NA Interviewee 5: NA Interviewee 7: NA Interviewee 8: NA
Interviewer: 3. What is your perception on compliance enforcement on the Tongaat Mall project?
Interviewee 1: I would say that our local municipality they also didn't give us a good service because they were so nearby they knew what was going on there but they didn't come regularly to come see. The engineers from the local municipality they should have come to see and visit the site to see what is going on. I feel they neglected us. Interviewee 2: If inspection was done and something was wrong they would tell Ronnie and Ronnie will come and tell us as workers. He would tell us if some of the columns were "kokai" and needs to be redone. Ronnie did not tell us to redo any columns that formed part of the structure that collapsed. What I can say is the wall that was collapsing (deflected) and we had to push it back was on the same side were the mall collapsed. See you can't push the wall and think all be in the same place. The steel the wall the columns were not in the same place. If you push the wall back the column stays in the same place. Interviewee 3: NA Interviewee 4: Nobody ever came from the municipality that we were doing the wrong thing. Interviewee 5: Yes people did tell us to stop work but Ronnie told us to keep working. Interviewee 6:

Maybe he did arrive but could not have recognized or realized them because there were a lot of people on site and we were all doing different things, so I can't really say I saw them.

Interviewee 7:

I cannot say.

Interviewee 8:

I don't know.

Interviewee 9:

I did not see anyone from the municipality on the site.

F. Lessons learnt from the Tongaat Mall accident

Interviewer: 1. Please indicate your experiences in the Tongaat Mall collapse?

Interviewee1:

My experience is that in the near future I would never work for a company or a contractor that do not follow the construction regulations meaning that I will never work for someone who doesn't follow the correct procedures. I don't want to work for someone that do not supply PPE, I do not want to be in that type of situation again. In my entire life. I was injured before the collapse happened they didn't give me anything. I went to the doctor and paid my own fees because of an injured leg that day the building collapsed. I did tell Ronnie and he said I must go home. I do have a note from the doctor.

Interviewee 2:

I can even blame the concrete, the people that made the concrete we used to take cement open it up and push it in the mixer. They would take the bucket and push it in the column. We didn't know how strong the concrete was. I was building walls and columns and mixed concrete I did many jobs. I don't really blame the people who made the concrete we blame the people whom instructed us to make the concrete. Gralio had their own mixing machine there. We used buckets to pour concrete into formwork that we mixed ourselves. If our mixing was to slow maybe 5 trucks will come to give us concrete but if we waited we will mix the concrete. For them not to waste money and getting other trucks we had to mix concrete on the site because you pay more to get the big trucks.

Interviewee 3:

I feel it was dangerous because we were working on the top because we working on the steel. I was changing in the container when the collapse happened I was lucky.

Interviewee 4:

The first thing which was wrong was the wall at the back it bent and we were told to wedge it. People spoke about it but Ronnie said it would not be a problem. We spent 3-4 days wedging it back to place. When we were doing the deck the reinforcement bars were on the side and not on top they did not link with the wall and the deck or at the top of the wall. It's the deck that collapsed. The reinforcement bars were supposed to be placed or at the top of the wall that we wedged. The columns, if we were told to break a column the cement was weak. If we break it the cement go separately and the sand go separately. according to my construction information the deck formwork must stay for 20 days but they removed it after 7 days. If you remove the scaffold you must leave props you cannot take everything away. Even when the deck was wet they used to park cars on it.

Interviewee 5:

The sub-contractors were doing a good job but there was this other one that was doing the walls but then the walls were shaking especially on the side facing the shacks. That wall was moving and shaking but they did not break it everyone just continued.

Interviewee 6:

There is nothing I want to add.

Interviewee 7:

People will have excuses all the time that I'm sick can I have permission to go back home and when people are going home like that it become lots of job needs to get done less people are there to do the job so they just take anyone to do it. Let's say 5 bricklayers say they are sick I don't feel well today I want to go home. They just take people like me and say do the job you have seen them doing it without me having experience. I applied for a job last year and the contractor ask me have ever worked before and I say yes and I told him Tongaat Mall. He said the one that collapsed I said yes and he didn't employ me

Interviewee 8:

NA

Interviewee 9:

I did not see anyone from the municipality on the site.

Interviewer: 2. Please discuss your ideas concerning the construction operations of the project?

Interviewee1:

No, when excavation was done there were no signs indicating that its construction site nothing was professional. Due to the fact that we were looking for employment we had to hold on.

Interviewee 2:

For the columns they should have given maybe 2 or 3 days for the concrete to dry maybe it should have been better. Secondly, the columns that build was so long / tall and too small / thin. Even if you look at the column you can see how "kokai" they are. The columns by the railway I did them I didn't know how I just did them just to get my money. in my way I think you will come and tell me this is right this is wrong but if you don't come or complain I will think it is the right thing and I am good.

Interviewee 3:

These people were running for the money if you are not running for the money you are working nicely maybe this building will never fall. If they didn't push, push, push maybe it never falls.

Interviewee 4:

It was not right because even when we said so Ronnie would tell us if we do not want to work we must leave.

Interviewee 5:

We were told just working and were told to just follow orders. We had no say. If we ask questions they will chase you out.

Interviewee 7:NA

Interviewee 8:NA

Interviewee 9:

They would be pouring the concrete in the afternoon and in the morning they will be stripping it off. Because the column concrete is wet it will crack when the load is becoming higher heavier the columns are small to the pressure was too much the deck now started to push away all the steel. The walls were built high with no bracing to keep the wall up. The walls were 220mm walls with no reinforcing and they were very high. They built the walls up to 2.6m high in one day to push for faster work. The wall was on top of the deck. One of the walls fell in and we had to push it back. They didn't use any DPC in the foundation floor.

Interviewer: 3. Please discuss the implications of the building collapse for the client, contractor, designer, and municipality?

Interviewee 1:NA

Interviewee 2: NA

Interviewee 3: NA

Interviewee 4: NA

Interviewee 7: NA

Interviewee 8:NA

Interviewee 9:NA

Interviewer: 4. Please indicate how you perceived the status of health and safety with regards to the Tongaat Mall project?

Interviewee1:

To me it was very scary. To people being pulled out by excavators it was very scary. I don't want to work for a construction company ever again. I lost hope for the construction industry. I don't have much to say about safety, because there was no safety. No gloves. People were sharing dust masks people were sharing PPE. You see Ronnie people would be sharing dust masks. Ronnie said there was not enough mask in stock.

Interviewee 2:

In my way it wasn't according to the rules of safety.

Interviewee 3:

If you start the work and you go to the site it is your family you take care they must be right. So my safety is very important. Toolbox talk very important.

Interviewee 4:

It was not right because even when we said so Ronnie would tell us if we do not want to work we must leave.

Interviewee 5:

Yes even then steel was installed and placed correctly. Sometimes the main problem was a shortage of columns. Sometimes decks and beams were placed and more columns would be needed and built after the deck was placed.

Interviewer: 5. Please provide your perspective on the outcomes of the Tongaat Mall collapse in terms of monetary loss?

Interviewee1:

They killed my budget. I was left without work for a long time. It took me 9 months to get a job. I live in Tongaat. Because of my families of my lack of income I cannot study or take care.

Interviewee 2:

In my way whatever we did there wasn't right. We all knew that one day that thing will collapse. We

were the one working there and see how thing are done there. One of the sub-contractors asked us will the columns hold the load of the deck because the columns looked to small / thin. Ronnie was part of the big company that we were working on they had big projects maybe they know because they were building for many years they should know what they are doing maybe it would come right we didn't know.

I left for myself there because they were bullying us to do things. Sometimes the money is short sometimes the time is short and they would force you to do things. You were scared to ask questions. 2 weeks before the collapse I left. I did find work after I left many people left there they would hire people and chase them.

Interviewee 3:

I didn't get paid when the building fall because the steel is there. My family go to school now there is no money for the school.

Interviewee 4:

According to everything will be ok later but I lost my time there I also lost my time and my experience because what they did there was different from what I did on other sites I lost my confidence and experience I would have gained given all the effort we put in and know I have a bad reputation for working at that mall.

Interviewee 5:

I was there on the site when the collapse happened I was digging for another column when the building collapse. I work now in Stanger.

Interviewee 6:

I lost a tool box of mine because they did not allow us to enter the site all my plastering tools and shovels are still on the site.

Interviewee 7:

In my family my sister is bringing in the money with me not having a job it affects us big time because now I have 2 children. I cannot support my children I live in a family of 12 including my kids it is 14. I think the mall would have made the community better.

Interviewee 8:

Interviewee 9:

If the mall was here there would be jobs it would help the people.

ANNEXURE E: DOCUMENT ANALYSIS

Timeline of events	Final Coding
1. In November 2006 the eThekwini municipality received an application for building plans from the owners of the land (Strathmore Property Investment Trust).	Regulatory Control
2. In January 2007, the city received earthworks plans for approval. These applications were also declined by the city and they lapsed 12 months after they were submitted. Again this was done by the former owners of the property.	Regulatory Control
3. The current owners (Rectangle Property Investments) submitted an application for approval of earthworks (not building plans) in February 2013. This application was refused on 13 May 2013.	Regulatory Control
4. In March 2013, the city became aware that the property had been extensively excavated and that construction workers had commenced piling for construction. 5. On 8 April 2013, the city wrote to the owners calling on them to cease all building works forthwith and to submit an application in terms of the building regulations act.	Regulatory Control
6. On 8 May 2013, the building inspector visited the site and observed that the owners had not complied with the direction given to them and building works were still conducted on site.	Regulatory Control
7. Summons for the aforementioned contravention were served on the owner's representatives on site on the same day.	Regulatory Control
8. Another inspection of the property was conducted on 24 June 2013 and it was discovered that the owners had still not complied with the direction given to them.	Regulatory Control
9. The city issued a formal notice of intention to approach the courts with this matter.	Regulatory Control
10. On 3 July 2013 another inspection was conducted and again there was no compliance with the directions given. On this day pictures were taken in preparation of action.	Regulatory Control
11. On 4 July 2013 attorneys representing the owners (Rectangle Property Investments) wrote to the city requesting that the matter be held in abeyance for two weeks indicating their intention to oppose any application against the owner.	Regulatory Control

12. On 24 July further inspection of the property revealed that despite the request to hold matters in abeyance, construction was continuing unabated.	Regulatory Control
13. On 31 July 2013, the city brought an urgent application direct to the owners to suspend any further building operations, directing the owners to suspend any further building operations, directing the owners to bring an application for approval of building plan within 30 days.	Regulatory Control
14. The order was confirmed on 14 November 2013	Regulatory Control
15. Prior to the accident the municipality had already started a process of obtaining a Contempt Warrant.	Regulatory Control
Affecting factors / Leading events	**Final Coding**
1. The developer ignored summons issued 6 days prior to the tragedy to cease work on the site. Construction continued unabated.	Regulatory Control
2. In court papers municipality alleged that Gralio disregarded an interim order and final order granted against the company to stop construction of the mall.	Regulatory Control
3. Contractor's previous housing developments involved in investigations according to Manase Report for "shoddy" construction work.	Regulatory Control / CIDB grading
4. GF was given instruction by GF to continue work knowing that a stop order has been issued.	Regulatory Control
5. No health and safety audits were carried out in the four months preceding the collapse.	Regulatory Control
6. According to the safety agent appointed by GC there was no signing off on any scaffolding or supports to be removed at any stage during the time (4 months) he was appointed by Gralio Contractors.	Regulatory Control
7. According to the H&S agent no consent has been given to remove formwork, props or scaffolding on the day of the accident.	Regulatory Control
8. Safety folder disappeared on the day of the accident.	Regulatory Control
9. GF had been assigned 6 safety posts – law allows a person to hold a maximum of 2 such posts.	Regulatory Control
10. Post tensioning sub-contractor was aware that a court order was issued but was told the situation was sorted out and work continued.	Regulatory Control
11. Earthworks plans were rejected 4 times for issues that could be	Regulatory Control

rectified by the architect.	
12. Plans were rejected in March 2013 and then again May, July and finally in August 2014.	Regulatory Control
13. Earthworks plans were approved in principle by the municipality land use department due to the fact consent given by Transnet as the building was within 10 meters of the railway.	Regulatory Control
14. The required consent from Transnet was never obtained.	Regulatory Control
15. To date no plans have been submitted to the municipality's Development, applications and approvals department	Regulatory Control
16. Developer failed to obtain permission to demolish the existing building before construction began.	Regulatory Control
17. Law enforcement officer with municipality visited the site on 8 May 2013 and informed the GF that construction was illegal. The officer showed him the contravention notice and ordered the GF to stop construction.	Regulatory Control
18. Fine was issued to the amount of R2500 – R1000 for failing to comply with a notice to cease building and R1500 for building without approved plans.	Regulatory Control
19. On 9 May the law enforcement officer returned and found construction had continued. The officer issued another fine to the amount of R2500. To the GF and waited to for the construction workers to vacate the site.	Regulatory Control
20. The last fine was paid. Indicating admission of quilt.	Regulatory Control
21. Construction continued abated the matter was referred to the municipality's legal department. Photos were taken and a letter from the city's legal department sent a letter to the developers.	Regulatory Control
22. Singh's other company, Woodglaze, was accused of fraudulently obtaining R236 mil from the Social Housing Regulatory Authority by setting up a social housing company, Moko Rental Housing Project, to obtain funds to buy flats from itself.	Regulatory Control
23. GC was unable to indicate what qualifications the CG staff had	Regulatory control / CIDB rating
24. According to a statement made by the GC the mall was always going to collapse, even if the concrete had the required strength and steel bars. The GC believed the poor design by the structural engineer meant the mall would collapse.	Regulatory Control / H&S ACT

25. The structural engineer was reassured by the contractor during the projects weekly meetings that there was nothing to be worried about. During one meeting the structural engineer was told that the drawings were approved.	Regulatory Control
26. According to the GC in hiring a qualified and competent professional team the GC is absolved of all responsibilities	Regulatory control / Construction Regulations and H&S act
Leading event / Affecting Factors	**Final Coding**
1. A slab of concrete sagged by 7cm.	Structural Failure
2. Concerns over the lift shaft design were raised. These plans were altered.	Structural Failure
3. Concerns over 10m walls without any support were raised. These plans were altered to include support.	Structural Failure
4. According to the brickworks supervisor, 10 plan revisions were done in a space of 3 months.	Structural Failure
5. Concerns about the thickness of the columns were raised by the GF.	Structural Failure
6. There were three points weakness close to each other with one of the weakest links being the one of the beams.	Structural failure / Construction Failure
7. Foundation of one of the columns that supported the beam in question was inadequate as there was only one pile and required 3 piles.	Structural Failure / Construction Failure
8. Various engineers involved in the inquiry had reached an agreement that the triggers for the collapse involved beam number 7 and columns 243 and 319.	Structural Failure
9. Column 243, a critical column required to support a lot of work and was close to its load-carrying capacity.	Structural Failure / Construction Failure
10. Column 243 failed along with beam 7.	Structural Failure / Construction Failure
11. Engineers suggested that if load-carrying capacity was reached the column should have been made bigger.	Structural Failure / Construction Failure
12. Engineers suggested in the event of an inadequate foundation in column 319 measures to compensate should have been carried out as well as underpinning.	Structural Failure / Construction Failure
13. Negligence in relation to design load of column 243 but structural engineer calculations were not interrogated by consulting engineers.	Structural Failure / Construction Failure

14. Negligence on behalf of the structural engineer depended on whether the structure was braced or not. According to the structural engineer the column 243 was braced thus adequate to take the load.	Structural Failure / Construction Failure
15. Design Specifications: Column 243 was in the upper limits of "slender", it was inadequately designed for its purpose.	Structural Failure
16. Design Specifications: Under design of this column resulted in it collapsing.	Structural Failure
17. Construction Load: Column 319 with single piling would have failed.	Structural Failure
18. The steel that had been used did not fail, but was insufficient to handle the stresses caused by the 150 tons. This was evident by the fact that the steel did not break but " the steel was pulled straight out of the concrete"	Structural Failure / Construction Failure
19. As the collapse started it put pressure on beam 7 which collapsed. This put pressure on a neighboring concrete slab that swung around. This slab collapsed as the columns under it could not handle the swinging motion.	Structural Failure / Construction Failure
20. According to the structural engineer various changes were done to the design these were affecting the integrity of the structure.	Structural Failure / Construction Failure
21. According to the structural engineer he was never appointed to perform any construction monitoring services.	Structural Failure / Construction Failure
Leading events / Affecting Factors	**Final Coding**
1. According to the GF the GC ordered 2 beams were to be built under the sagging slab.	Construction Failure / Construction Work
2. According to the GF the supporting columns should have been bigger to avert the collapse. These concerns were raised with the GC.	Construction Failure / Construction Work
3. According to the GF slabs had been poured at least 21 days before scaffolding was removed.	Construction Failure / Construction work
4. Formworks were removed on the day the slab collapsed.	Construction Failure / Construction work
5. On 7 October 2013 during an inspection of a slab, the post-tensioning sub-contractor noticed that 5 cables were missing and that some bars had been incorrectly laid.	Construction Failure / Construction work
6. According to construction workers the scaffolding supporting the beams on which the concrete slab rested was removed to soon due to it being needed elsewhere.	Construction Failure / Construction work

7. According to the construction worker the neck of the column (under the beam) exploded when the supports were removed.	Construction Failure / Construction work
8. The strength of the concrete was in places less than a third of what was specified by the contractor. The concrete failed to reach even half of the required strength. The weak concrete was used in the portion that collapsed.	Construction Failure / Construction Work
9. The concrete failed to reach the 30 megapascals (MPa) after 28 days.	Construction Failure / Construction Work
10. According to Concrete Testing Laboratory the test results were sent to the GC it was assumed the person receiving the results would take action.	Construction Failure / Construction Work
11. The GC mixed the concrete on site.	Construction Failure / Construction Work
12. The Concrete testing Laboratory indicated that there was nothing wrong with the type of cement used.	Construction Failure / Construction Work
13. According to the laboratory the concrete could be weak because of insufficient cement used, or too much water was added.	Construction Failure / Construction work
14. The laboratory indicated that there were substantial variances in the strength of concrete since contracted by the GC June 2013. .	Construction Failure / Construction work
15. Concrete was tested at three days, seven days and 28 days. According to the design by the structural engineer all concrete had to have a strength of 30 MPa after 28 days.	Construction Failure / Construction work
16. Concrete test of concrete slabs carried out by the Concrete Testing Lab prior to the malls collapse showed that 64 samples taken from the concrete that the GC mixed on site, only 14 met the 30 MPa requirement.	Construction Failure / Construction work
17. 36 concrete samples were tested on cement supplied by the ready-mixed cement company NPC. It was found that only three of these samples missed the 30MPa requirement at 29MPa.	Construction Failure / Construction work
18. The GC provided only the concrete test results taken from the slabs that research the required 30MPa.	Construction Failure / Construction work
19. According to the inquiry some test results came back as low as 9MPa – only strong enough to be plaster on internal walls.	Construction Failure / Construction work
20. Concrete test samples or “cores” were taken from supporting columns and beams of the malls debris.	Construction Failure / Construction work
21. General construction defects were noted by the engineers. Some of	Construction Failure

the columns were not being perfectly vertical which could have made them weak and meant capacity to support was reduced.	/ Construction work
22. Beam 7 had only 7 steel bars of which 6 was cast in the concrete. The concrete making up the beam was not poured in one session. One portion of the beam had been allowed to dry for two weeks before the rest of the beam was poured, creating a cold joint.	Construction Failure / Construction work
23. No bonding of the cold joint described as "bond failure".	Construction Failure / Construction work
24. Strength test were never carried out on the concrete used in the columns supporting the mall.	Construction Failure / Construction work
25. GF was not aware of any results of any tests carried out on concrete that was poured at the construction site.	Construction Failure / Construction work
26. No reasons were given by the GF why no concrete tests were conducted on the columns.	Construction Failure / Construction work
27. GF indicated that he did not know that the tests carried out at the time of construction on the concrete strength of the slabs and beams were below the required 30 mega-pascals require.	Construction Failure / Construction work
28. According to the GF the fact that the concrete was not the required strength was never brought to his attention.	Construction Failure / Construction work
29. Concrete tests were carried out by a laboratory but only on slabs and beams.	Construction Failure / Construction work
30. GF said he was not aware that the weakest concrete from the tests carried out after the accident came from concrete that had been mixed by the GC.	Construction Failure / Construction work
31. GF indicated that there had never been any written permission given for pouring concrete after the steel work had been put in place.	Construction Failure / Construction work
32. GF admitted that on one occasion permission for the pouring of the concrete had not even been received from the structural engineer.	Construction Failure / Construction work
33. Permission was given to pour concrete by the foreman doing the steelworks.	Construction Failure / Construction work
34. The GC may have been using old drawings while building the mall. The GC indicated he had newer drawings but because according to him there had been no changes to the columns, the old drawings were used for the columns.	Construction Failure / Construction work
35. A beam holding a concrete slab was missing reinforcing bars	Construction Failure / Construction work

36. According to the steel sub-contractor 19 steel bars were fitted in the beam. This was done in accordance with the engineer's plans	Construction Failure / Construction work
37. The beam were to be fitted with 19 Y32 reinforcing bars it was found that there were only 7 beams indicating 12 bars were missing	Construction Failure / Construction work
38. 36 samples taken by the structural engineer and tested by the laboratory were taken from one beam and 6 columns. Only the concrete from 2 columns met the minimum required strength of 24 megapascals (MPa)	Construction Failure / Construction work
39. The beam had not been cast in a single pouring. It had a joint and broke at this point of weakness	Construction Failure / Construction work
40. There were also seven reinforcing rods in the beam instead of the required 19, although only 6 were cast in concrete	Construction Failure / Construction work
41. Design Specifications: The consulting engineers had no criticism on the design of the beam but it had not been constructed in accordance with the with the construction drawing	Construction Failure / Construction work
42. Column 243 had not been constructed to the design specifications in terms of strength	Construction Failure / Construction work
43. Beam 7 had only 7 steel bars of which 6 were cast in the concrete. The concrete making up the beam was not poured in one session. One portion of the beam had been allowed to dry for two weeks before the rest of the beam was poured, creating a cold joint.	Construction Failure / Construction work
44. Beam 7 failed when form scaffolding was removed that was supporting the beam and concrete slab	Construction Failure / Construction work
45. When scaffolding was removed the beam was required to support a weight of 150 tons – a weight it could not carry because of the weakness of the beam	Construction Failure / Construction work
46. Concerns about the accuracy of the structure	Construction Failure / Construction work
47. Only 1 of the 7 metal bars reinforcing in beam 7 had the required length and strength	Construction Failure / Construction work
48. It was indicated that the metal bars reinforcing was too short in beam 7	Construction Failure / Construction work
49. Company that supplied the scaffolding and formwork indicated that scaffolding and design drawings on how it was to be installed were provided	Construction Failure / Construction work
50. Scaffolding designs were based on engineers drawings received from	Construction Failure

the GF	/ Construction work
51. It was indicated that the collapse occurred when scaffolding and formwork was being removed	Construction Failure / Construction work
52. It was indicated that design drawings for the scaffolding and formwork had been done but NO scaffolding design drawings were requested for the section that collapsed. The scaffolding material used was the property of the identified sub-contractor. At no stage were the sub-contractor asked to provide drawings in connection with the collapsed section.	Construction Failure / Construction work
53. According to the structural engineer concrete tests were never forwarded to him. The contractor communicated to him that the concrete strength was in accordance with the structural engineering designs	Construction Failure / Construction work
54. The structural engineer never authorized the casting of beams	Construction Failure / Construction work
55. The structural engineer had not authorized the pour of beam 7, indicating there was no request to inspect it when reinforcing was made	Construction Failure / Construction work
Leading event / Affecting factor	**Final Coding**
1. Construction defects (deflection) of a slab was noted by the GF and construction was halted.	Construction Supervision
2. General Foreman admitted to not having any formal qualifications.	Construction supervision
3. GF had been assigned 6 safety posts – law allows a person to hold a maximum of 2 such posts.	Construction supervision
4. According to post tensioning sub-contractor the structural engineer had only been present at 2 of the 10 inspections to check post-tensioning cables of the concrete slabs.	Construction supervision
5. According to post tensioning sub-contractor inspections were done prior to concrete being poured.	Construction Supervision
6. According to reports the structural engineer was responsible for the structural design and should have exercised a greater role in checking work followed the design. According to the report he did not meet his professional obligations.	Construction Supervision
7. GF could not explain the test results as he was not responsible for the mixing of the concrete.	Construction Supervision

8. GF was not aware that he had to ask for the results of strength tests carried out on concrete poured at the site.	Construction Supervision
9. GC was unable to indicate what qualifications the CG staff had.	Construction Supervision
10. Personnel of other companies contracted by GC were the only individuals who appeared to have any formal qualifications.	Construction Supervision
11. The GC indicated that he had trusted his GF, backed up by inspections by the structural engineer to ensure the job was completed properly.	Construction Supervision
12. According to the GC he relied on the structural engineer for quality control, reinforcing inspection and certifying structural stability compliance on completion.	Construction Supervision
Leading event / Affecting factor	**Final Coding**
1. Durban High court was requested to impose a fine on Rectangle Property Investments for the collapse of the mall or jailed for contempt of court.	Cost of Accident
2. Legal representatives acquired for inquiry and impending investigation.	Cost of Accident
3. Unidentified member of the public perished in the accident.	Cost of Accident
4. The partly built mall has to be knocked down following a high court order made days before the collapse.	Cost of Accident
5. Investigation fees by expert engineer for the insurers after the collapse.	Cost of accident
6. Medical costs of various injured workers.	Cost of accident
7. Work men compensation required	Cost of accident
8. Lost sales opportunities	Cost of accident
9. Social income due to the mall in the area	Cost of accident
10. Price of site closure due to the collapse	Cost of accident
11. Loss of future work due to bad reputation incurred by collapse and media coverage of the event.	Cost of accident
Leading events / Affecting factors	**Final Coding**
1. Consulting engineer for Gralio Contractors, found material defects that could have led to the collapse.	Material failure / Material defects

ANNEXURE F: DOCUMENT ANALYSIS