Stakeholders' Compliance and Accountability with Health and Safety in the South African Construction Industry

Kellie Nhlamulo Kwinika, Hannelie Nel and Annlizé Marnewick
Post-Graduate School of Engineering Management
Faculty of Engineering and the Built Environment
University of Johannesburg
Auckland Park, South Africa
kwinikakellie@gmail.com, hannelien@uj.ac.za, amarnewick@uj.ac.za

Abstract

The paper presents case study findings on the effect of poor health and safety performance and the high rate of non-compliance by construction stakeholders in South African construction sites. A case study of the Tongaat mall collapse, which was caused by a failure of columns, was conducted. The accident was studied to assess whether or not stakeholders were compliant with the provisions of health and safety legislation. The study also evaluates whether the inquiry that was established to investigate the accident managed to hold the stakeholders accountable for their actions or inactions. The findings from the case study suggest that the non-compliance of stakeholders led to an accident that could have been avoided. Furthermore, gaps were identified in the legislation in so far the regulating body was responsible for holding non-compliant parties accountable. The research provides select contributing factors to the slow progress in health and safety performance in the industry. Understanding and addressing the issues highlighted in the research may contribute towards increasing the improvement of health and safety performance in the South African Construction Industry.

Keywords
Stakeholder Accountability, Compliance, Health and Safety

1. Introduction

The construction industry has been described by different scholars as one of the most dangerous sectors in which to work (Okorie, Emuze, Smallwood and van Wyk, 2014; López-Alonso, Ibarrondo-Dávila, Rubio-Gámez and Munoz, 2013). This observation is supported by the high numbers of incidents and accidents in the South African construction industry (CiDB, 2009). In an effort to mitigate poor health and safety performance, South Africa (RSA) has invested much effort in the development of construction legislation and policies.

Despite the efforts that have been invested in legislation to improve health and safety performance, it has been acknowledged that non-compliance with the legislation and the related regulations is a major challenge in the industry. In the 2015/16 financial year, there was an average of 12 500 construction sites in South Africa, and 40% of these sites were non-compliant with the provisions of health and safety legislation (Department of Labour (DoL), 2017). Investigations identify deliberate ignorance of the law in the interest of profit maximization (Petterson, 2016).

Poor performance of health and safety in the South African construction industry presents a significant cost to the country (Haupt and Pillay, 2016). The Construction Regulations were introduced to improve health and safety in the industry, but cost, quality and time are still considered more important (Smallwood and Haupt, 2007). The issue of health and safety in the industry is not only a local problem; the United Kingdom is also recording poor performance with minimal documented improvement (Manu, Ankrah, Proverbs and Suresh, 2014). In 2014, the Council for the

Built environment (CBE) in South Africa released a statement voicing concerns on the rise of construction accidents in the industry (Council for the Built Environment, 2014).

The non-compliance of stakeholders is partly due to low fines and lack of prosecution for not adhering to due procedure (Musonda and Pretorius, 2015). In 2016, the minister of the DoL suggested that the legislation be amended to empower the DoL to enforce punishment which will ensure that the concerned parties are held accountable (eNCA, 2016).

This research is an effort to understand corporate health and safety requirements on construction sites and an attempt is made to establish the required duties and responsibilities of construction companies onsite. Furthermore, it seeks to understand whether the parties found guilty of non-compliance are held accountable for their actions or inaction. The research builds on the newly-established industry-focused Construction Regulations which adopt a multi-stakeholder distribution of responsibility (Mwanaumo, 2013).

2. Literature review

2.1. Health and Safety

First world countries like the United State of America, the United Kingdom and Japan have similar structures to South Africa in their respective safety management systems (Lin Toe, Yng Ling, and Weng Chong, 2005). Using safety attributes from these countries, Lin Toe *et al*. (2005) combined the attributes into four main groups to form a framework for managing safety on construction sites, namely; policy, process, personnel and incentives.

Policy focuses on legislation that regulates health and safety on construction sites. In implementing safety legislation on a site, a process of how work must be carried out by construction personnel must be implemented to complement the legislation. Construction personnel contribute through their positive attitudes and behaviour; and incentives encourage improved health and safety records (*ibid.*).

The South African construction regulations have adopted a multi-stakeholder approach where responsibility is shared by all stakeholders (Mwanaumo, 2013). It moves away from the traditional approach whereby the main contractor is deemed to be solely responsible for health and safety, and is considered more effective than leaving health and safety responsibility to the main contractor only (Bong, Rameezdeen, Zuo, Li and Ye, 2015). Countries like Australia (Bong, *et al*., 2015) and the United Kingdom (Kikwasi and Smallwood, 2016) have adopted the multi-stakeholder approach as well.

2.2. Accountability and Compliance

Non-compliance with safety procedures is among the leading factors that contribute to the high fatality rate in the construction industry (Wilkins, 2011). In the event of a construction accident, Section 32 of the Occupational Health and Safety Act, No 85 of 1993 (OHS Act) states that an inquiry must be established to investigate the accident. The concerned parties are summoned to appear before the commission (Vertical accountability) and the task of the commission is to investigate negligence on the part of the concerned parties in discharging their duties as defined by Act (Procedural accountability) (DoL, 2015). The Construction Regulations are structured such that accountability occurs hierarchically (Hierarchal accountability): it starts from the Client and moves down towards the Designer and the Contractor (Thomas, 2006).

The duties imposed on these parties are meant to safeguard the health and safety of persons on a construction site. In the event where the DoL investigates an incident, the actions or inactions of the parties mentioned above are investigated to determine compliance with the requirements of the Construction Regulations (eNCA, 2016). Failure to comply with the Regulations may lead to imprisonment or a fine (DoL, 2014). Geminiani and Smallwood (2008) elaborate on the consequences or penalty that the parties may face if they fail to comply; stating that an organization (Organizational accountability) or an individual (Individual accountability) may be prosecuted. In a case of individual accountability, the responsible person may be criminally prosecuted (Legal accountability). Regulations must ensure that personnel responsibilities are clearly defined; and it must prescribe the use of documentation to describe how individual decisions adhere to the regulations (Breaux, Anton, and Spafford, 2009).

According to Bovens (2007) and Schillemans (2015) the accountability process follows three phases, namely: the information phase, the debating phase, and the consequence phase. The information phase is the stage where supporting documents, reports and evidence are provided to the forum. The debating phase then follows. In this phase the submitted information is put to test through questions from the forum to the actor. The final phase is the consequence phase where the forum concludes its findings which may be accompanied by a form of punishment. This process may be compared to the approach taken by the DoL during accident investigations. The DoL approaches construction accidents by setting up a Section 32 inquiry to investigate the accident. This inquiry comprises of a commission which acts as a forum to receive information, debate the information by questioning the concerned parties (different actors), and at the end it offers its findings to stakeholders.

Table 1 lists selected studies by various scholars which focused on the aftermath of accidents. These studies provide lessons which may be applied in the current research.

Table 1- Various accidents that led to lessons learned

Author (s)	**Sector**	**Accident**	**Problem Identified**	**Lesson Learned**
(Lavarenne, *et al*., 2016)	Energy	Nuclear Incident	The lack of an effective accountability system in regulating the nuclear sector led to an accident that could have been avoided.	An effective regulatory body is required for an effective accountability system.
(Kenny, 2014)	Transport	Railway Accident	The accident investigation did not consider all factors that may have caused the accident.	Comprehensive investigation ensures correct identification of the cause of the accident.
(Kee, *et al*., 2017)	Transport	Sinking of MV Sewol	The aim of the investigation was to name and shame.	The root cause to be extracted from an accident investigation to avoid similar errors in the future.
(Sinkovics, *et al*., 2016)	Construction	Building Collapse	In implementing health and safety measures not all stakeholders were consulted and consequently one problem was solved while another was created.	Avoid unintended consequences through the consultation process.
(Uhlmann, 2013)	Mining	Explosion	Lack of corporate prosecution.	Corporate prosecution encourages corporate compliance.

3. Research Methodology

A case study of the Tongaat mall collapse was conducted to obtain insight to the stakeholders' views (client, designer, and contractor) as to the cause of the collapse. The lack of compliance with the Act by stakeholders was identified and evaluated to establish its contribution to the collapse of the mall. Thereafter, the actions taken by the commission to ensure stakeholders were held accountable for non-compliance are discussed.

The purpose of research was to identify shortcomings during the Tongaat mall investigation, with a focus on compliance and accountability, and to make recommendations which promote an effective or improved approach to compliance and accountability for construction stakeholders. The case study method provides an opportunity to obtain the main parties' perspectives and in so doing to understand behavioural conditions (Zainal, 2007). It is important to understand how stakeholders viewed their roles as stipulated by the Act, and to understand how accountability was enforced in the Tongaat case.

Case study methodology was employed by Musonda and Haupt (2008) to study designer's contribution to construction health and safety. Similarly in the Tongaat case, detailed insight of the stakeholder's contribution is required, and it was recognized that case study methodology would be equally successful in achieving the objectives of the research. Explanation building and pattern matching were employed to analyse the study. Explanation building is the analytical strategy that was used to analyse the case. It is a procedure that is guided by an initially formulated theory; this theory is then refined after conducting the study to modify the initially formulated theory (Tellis, 1997). Pattern matching is a technique where established patterns in the data is compared against the initially developed patterns or propositions (Yin, 2009; Almutairi, *et al*., 2014). The collected evidence (case data) was matched against the knowledge in Table 2 derived from literature.

Table 2. Knowledge derived in literature used in pattern matching

Stakeholder's role and responsibility
Did the client apply to the provincial director for a work permit?
Did the client prepare a baseline risk assessment during the pre-construction phase?
Did the contractor appoint a competent supervisor?
Did the contractor ensure that the structure is not loaded in a manner which rendered it unsafe?
Did the contractor take all reasonable steps to prevent collapse of any structure or part of structure during construction?
Did the contractor prepare a site based health and safety plan and health and safety file?
Accident investigation and accountability
Are lessons extracted from the investigation to avoid a repetition of similar errors in the future?
Is the focus on the mechanism generating the error than on human error (blame searching)?
Does the forum conduct its own investigation to collect evidence and the necessary documents before the cross-examining the involved parties? (information phase)
Is the accident investigation holistic in its approach? Are all stakeholders directly and indirectly involved in the accident consulted? (debating phase)
What are the consequences of the corporate actions or inactions? Imprisonment of corporate officials in opposed or financial penalties? (consequence phase)
Are regulating body in the construction industry effective in implementing the accountability systems?

4. Findings

4.1. Description of the Accident

The Tongaat Mall was a ZAR 220 million project in the north of Durban, KwaZulu Natal in South Africa. The project was funded by a property development company, Rectangle Properties CC (DoL, 2014). 65 workers were on duty on the day that a slab at the building collapsed on 19 November 2013, leading to the death of two people and 29 injured. Figure 1 provides a graphic of the collapse of the slab.

A combination of two factors led to the collapse of the mall. Firstly, the pile foundations to some columns were overloaded and under-designed; and secondly, a poorly constructed beam was a significant factor (DoL, 2016). Figure 2 is a photo of the site taken after the accident.

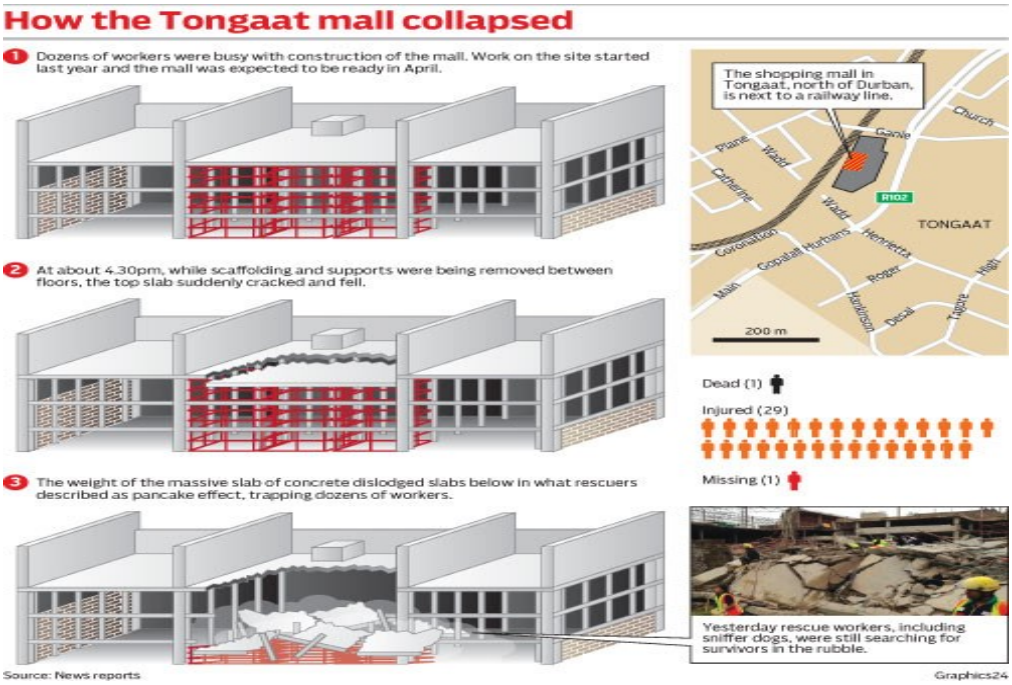

Figure 1. Collapse of the Tongaat mall slab (Louw, 2013)


Figure 2. Aftermath of the Tongaat mall collapse (ENCA, 2015)

4.2. Proceedings of the Section 32 Inquiry

The Section 32 Commission established to investigate the cause of the slab collapse comprised of a team of experts and witnesses in the construction industry. The following unfolded from the DoL.

The DoL appointed the head of the hearing to preside over the proceedings with two co-presiding officers and a forensic officer. The DoL then took control of the accident site. Entry was restricted to ensure evidence was not tampered with. The DoL's inspectors were sent to obtain evidence in the accident site, and the presiding officer met the legal representatives of the affected stakeholders to discuss how the hearing will proceed. The process lasted approximately months. In the same period, the list of expected witnesses was drafted, and the presiding officer announced that the commission expected twenty to fifty witnesses. Affected parties were subpoenaed to appear before the inquiry. Six months was the estimated period for the inquiry, with an estimated cost of ZAR2 million.

The first session of the hearing was set between 11 and 14 February 2014. The hearings were held from Tuesday until Friday from 9am until 5 pm, with Mondays being used for preparation by the commission. On the first session of the hearing the following people testified: the foreman at the construction site on the day of the collapse; the post-tensioning sub-contractor; a second sub-contractor; and the expert engineer called to assist. The second session of the hearing was held from between 2 and 4 April 2014, approximately six weeks after the first round. On this session the following people were called to testify: workers under the slab; a steel fixer; and an eThekwini municipality representative (law enforcement officer).

The third session was held from between 4 and 6 June 2014, two months after the last session. This session was a cross-examination of witnesses from the second session. Site visits also occurred regularly to gather more evidence, and tests were conducted on the collapsed concrete slab. The fourth session was held from between 21 and 25 July 2014 during which the client testified. Again the site was visited with the interested parties to extract more evidence. The inquiry then adjourned and was set to commence in September 2014.

The firth session was held from 4 to 5 September 2014. During this two day session the following people provided testimony: the column shutters and scaffolding materials supplier, and an expert design engineer who was mandated to investigate the designs. The sixth session lasted two more days from 17 to 19 November 2014 during which an expert engineer testified on the concrete tests results and quality control.

The second stakeholder, the designer, testified on two sessions. The first session was on the 4th and 5th of December 2014, and the other was from the 10th to the 12th of December 2014. In these sessions expert engineers were called to testify. The ninth session was held in March 2015, almost three months after the last session in December 2014. This session saw the last stakeholder, the contractor, take the stand to testify. On 27 March 2015, the Commission held the last session which presented closing arguments for the three stakeholders. The Commission also briefed the National Prosecuting Authority (NPA) on the process that unfolded and familiarized the NPA with the construction processes. The Commissioner indicated that the report with recommendations will be handed over to the Minister of Labour after sixty days.

On 24 May 2016, the Minister of Labour presented the findings and recommendations of the inquiry. This occurred one year after the last session of the inquiry in March 2015 and two and half years after the accident occurred. The report was handed over to the NPA to study and to decide whether sufficient evidence existed for criminal prosecution. The report, however, was not made available to the public.

4.3. Non-Compliance in the Tongaat Mall Collaps

Contractor

The Inquiry revealed that the contractor did not notify the provincial director of the construction of the mall and did not possess approved plans to construct the mall. Furthermore, the contractor failed to produce a health and safety file, a risk assessment certificate, or building plans upon request. The expert questioned the foundation strength and the supervision in this regard. The contractor testified that workers were appointed based on their experience and not on formal qualifications. He argued that qualifications and formal education do not guarantee competency. This was revealed by the contractor whilst responding to a question by the presiding officer asking him to produce the legal appointment documents of the people working on site to ascertain their level of their competency.

Further, it was heard in the inquiry that the contractor had no formal contract with the shutter supplier; that the concrete strength was significantly lower than specified; and that the quality control was poor. The contractor blamed the design for the collapse; and the foreman was unaware of the regulatory requirements to receive concrete test results.

Client

The client admitted that they did not have approved plans to construct the mall; and that he was not well informed of the Construction Regulations. The client conceded being unaware of the requirement to appoint a competent contractor to carry out the work of the magnitude of Tongaat mall. He did, however, proclaim that he trusted the contractor to perform such work based on his experience.

Designer

The designer worked from architectural designs that were not approved.

Regulating body

The inquiry and the release of the findings took over two years since the accident occurred. The final report of the inquiry was not made public; it was only submitted to the NPA; and the commission did not subject the non-complying parties to penalty.

4.4. Findings

Table 3 compares the findings between the literature survey and case study. The first part of the findings was to test compliance of the stakeholders' roles and responsibilities which were established in literature. Both the client and the contractor failed to fulfil their statutory duties. The 'no's'' to all the questions relating to the discharge of duties is the indication of non-compliance. The case study did not present any evidence that tested the role and responsibilities of the designer.

The second part of the findings deals with incident investigation and accountability. The findings from the Section 32 inquiry set up by the DoL indicates success in two phases of the three phases of accountability. The information phase was implemented successfully, and the inquiry allowed the process of collecting evidence and necessary documents to happen. The second phase, the debating phase, was also implemented successfully. All the stakeholders involved were provided an opportunity to present their case. The final phase, the consequence phase, is a phase where the guilty parties ought to be fined or face prosecution. The DoL indicated that it did not have the authority to prosecute; however, it was empowered to submit a fine. The DoL indicated that companies easily pay fines and as a result fines are ineffective. The DoL handed over the report to the NPA for them to determine whether there were grounds for prosecution.

Table 3. Summary of findings from the case

Stakeholder's roles and responsibilities: compliance	
Research issues	**Case study findings**
Did the client apply to the provincial director for a work permit?	No
Did the client prepare a baseline risk assessment during the pre-construction phase?	No
Did the contractor appoint a competent supervisor?	No
Did the contractor ensure that the structure is not loaded in a manner which rendered it unsafe?	No
Did the contractor take all reasonable steps to prevent collapse of any structure or part of during construction	No
Did the contractor prepare a site based health and safety plan and health and safety file?	No
Incident investigation and accountability	
Are lessons extracted from the investigation to avoid a repetition of similar errors in the future?	No

Is the focus on the mechanism generating the error than on human error (blame searching)?	Yes
Does the forum conduct its own investigation to collect evidence and the necessary documents before cross-examining the involved parties? (information phase)	Yes
Is the incident investigation holistic in its approach? Are all stakeholders directly and indirectly involved in the accident consulted? (debating phase)	Yes
What are the consequences of the corporate actions or inactions? Imprisonment of corporate officials imposed or financial penalties? (consequence phase)	No
Is the regulating body in the construction industry effective in implementing the accountability systems?	No

Table 4 demonstrates the use of the pattern matching technique to examine the influence of ineffective Section 32 on stakeholders' compliance in a construction site. Documentary review was employed to test the patterns in the findings against the predicted patterns. The pattern that was identified both in the article and DoL reports was that the contractor was not following procedure or was non-compliant. The second pattern was the gap that exists in the legislation that limits the DoL as the regulating body to enforce compliance. Similarly, in the DoL reports, it was of great concern that the department did not have the power to prosecute, and as a result stakeholders do not ensure compliance to necessary regulations. It is therefore valid to conclude that the South African regulating body is ineffective in holding stakeholders accountable, and as a result stakeholders are not encouraged to be compliant to health and safety regulations on construction sites.

Table 4. Case study pattern matching

Proposition	(McDiarmid, 2014)	**DoL reports**
The South African regulating body is not effective in holding stakeholders accountable, and as a result does not promote compliance to legislation on construction sites.	Contractor failed to follow correct procedure.	The stakeholders were generally non-compliant to the statutory requirements.
	Gaps exist in the legislation and such renders the DoL ineffective in holding parties accountable.	Section 32 inquiry commission was ineffective in holding guilty stakeholders accountable.

5. Discussion and Conclusion

The findings provide important lessons as they unveil the level of non-compliance in the Tongaat mall case. Although the findings in this single case study cannot be generalised to the entire construction industry, they do provide informed conclusions of the current practice in the industry.

The literature underpins the importance of enforcing compliance in order to minimize incidents in the construction industry. The regulating body in South Africa, the DoL, must be empowered to enforce compliance, and to hold offenders accountable for their actions or inaction. The Tongaat mall case presents a situation in which compliance with statutory requirement was poor. Both the client and the contractor opted to proceed with construction work without a permit to work, or at least informing the department as per statutory requirement. The contractor also failed to develop a health and safety plan or a risk file; and the client did not ensure that it was implemented in terms of the responsibility bestowed on him or her.

The root cause the incident can be attributed to non-compliance of the stakeholders. A competent construction manager or an alternate supervisor ought to be appointed by the contractor to manage construction work and to ensure occupational health and safety compliance. If a competent supervisor had been present doing the work, they may have ensured the construction method complies with the required standards. Further, the concrete test results could have offered an indication of an imminent incident.

The findings against the contractor suggest that he was not competent to perform the work. The failure to work from drawings and the failure to conduct cube tests were two of the factors highlighted as proof of incompetence. The client was expected to appoint a competent contractor and ensure that he executes the work accordingly. The client's involvement in the project was minimal since the majority of the responsibility was surrendered to the contractor. It may be argued that this was due to unwillingness of the client to comply with legislation.

The client was involved in only two occasions, namely the appointment of the contractor and halting the work when issued with court papers. As discussed in the literature review, the client has an active role to play throughout the project lifecycle; in particular, at the beginning of the project where he/she is expected to apply for permit to work. Furthermore, he/she was expected to ensure that the contractor had implemented a health and safety plan. The client also confirmed to be unaware of the requirements of the Construction regulations. Such a position automatically places the client in breach of compliance.

The DoL as the regulating body has a duty to ensure the legislation is upheld and respected by all construction stakeholders. Parties failing to comply with the statutory requirements must be held accountable, and key to ensuring compliance is the response to non-compliant parties. After a rigorous process of ascertaining accountability, the commission failed to punish the non-compliant parties. Instead, the commission recommended an investigation by the NPA for possible prosecution. One and a half years since the report was handed over to the NPA, no action materialized. The Minister of the DoL conceded to the shortcomings in the legislation, in particular the lack of power to prosecute or hand down harsher penalties. As it is, the DoL can issue a fine for non-compliance, which appears to be ineffective given that the amount is relatively low for corporate companies.

Another great concern noted on the part of the regulating body is the length of time it took to complete the inquiry. Extended inquiry processes exacerbates the pain of the victims. The Sandton bridge collapse is another example of delays in the accounting processes; two years since the collapse, the inquiry is yet to commence.

The research conducted in this case study clearly demonstrates how non-compliance by stakeholders contributes to the accidents and incidents on a construction site. Furthermore, the study demonstrates how the Section 32 inquiry was ineffective in holding stakeholders accountable for non-compliance to necessary and established regulation.

References

Almutairi, A. F., Gardner, G. E. & McCarthy, A., Practical guidance for the use of a pattern-matching technique in case-study research: A case presentation. Nursing and Health Sciences, Volume 16, p. 239–244, 2014.

cidb, Construction health and safety in South Africa, Pretoria: cidb, 2009.

Council for the Built Environment, 2014. [Online]
Available at: https://www.ecsa.co.za/news/Latest%20News/Construction%20Incidents.aspx
[Accessed 09 May 2017].

DoL, Property developer concedes in the Department of Labour-appointed Commission that the doomed mall plans were never approved, Pretoria: DoL, 2014.

DoL, Those responsible for the Tongaat Mall collapse to be held liable. [Sound Recording] (eNCA), 2016.

DoL, Inspector's Perspective of Construction Health and Safety in South Africa. Pretoria, DoL, 2017.

ENCA, 2015. ENCA. [Online]
Available at: https://www.enca.com/south-africa/contractor-points-design-engineer-tongaat-mall-collapse-probe
[Accessed 25 October 2017].

eNCA, Report back on the Tongaat Mall collapse. [Sound Recording] (eNCA.com), 2016.

Haupt, T. C. & Pillay, K., Investigating the true costs of construction accidents. Journal of Engineering, Design and Technology, 14(2), pp. 373 – 419, 2016.

López-Alonso, M., Ibarrondo-Dávila, M. P., Rubio-Gámez, M. C. & Munoz, T. G., The impact of health and safety investment on construction company costs. Safety Science, Volume 60, p. 151–159, 2013.
Louw, R., Graphics24. [Online], 2013.
Available at: http://www.grafika24.com/how-tongaat-shopping-mall-collapsed/
[Accessed 25 October 2017].
McDiarmid, N., Lessons from Tongaat mall: SHEQ. Institute of Municipal Engineering of Southern Africa, 39(2), pp. 35-39, 2014.
Musonda, I. & Haupt, T., Designer's contribution to construction health and safety (health and safety) – A case study of a public works project. Florida, ASOCSA, 2008.
Musonda, I. & Pretorius, J. H. C., Effectiveness of economic incentives on clients' participation in health and safety programmes. Journal of the South African Institution of Civil Engineering, 57(2), pp. 2-7, 2015.
Petterson, D., Tongaat Mall inquiry complete. [Online], 2016.
Available at: http://www.infrastructurene.ws/2016/05/25/tongaat-mall-inquiry-complete/
[Accessed 4 July 2017].
Smallwood, J. & Haupt, T., Impact of the South African Construction Regulations on Construction Health and Safety Construction, Architects' perceptions. Journal of Engineering, Design and Technology, 5(1), pp. 23-34, 2007.
Tellis, W. M., Application of a case study methodology. The qualitative report, 3(3), pp. 1-19, 1994.
Yin, R. K., Case study research design and methods. 4th ed. Los Angeles: Sage, 2009.
Zainal, Z., Case study as a research method. Jurnal Kemanusiaan , Volume 9, pp. 1-6, 2007.

Biographies

Kellie Kwinika completed his Bachelor degree in Civil Engineering from the University of Kwazulu Natal, South Africa in 2011, and Master degree in Engineering Management from the University of Johannesburg, South Africa, in 2018. His main research interests are compliance and accountability in the construction industry, with a focus health and safety. He currently works for the largest producer of electricity in Africa, Eskom Holdings SOC Ltd, South Africa. He has been employed at Eskom as a civil engineer since 2012. In his 6 years working experience he has been involved in the construction of Ingula pumped storage scheme, a multibillion rands hydro power plant.

Professor Annlize Marnewick is an Associate Professor at the Postgraduate School of Engineering Management, Faculty of Engineering and the Built Environment, University of Johannesburg where she focuses on the supervision of research master's and doctoral students. Before joining the academia she has been involved in the industry with a technical record of 15 years in architecture, design and the implementation of system and software engineering projects with specialisation in requirements engineering. She is a registered professional engineer (Pr Eng) with the Engineering Council of South Africa (ECSA).

Dr Hannelie Nel is a Senior Lecturer at the Postgraduate School of Engineering Management, Faculty of Engineering and the Built Environment, University of Johannesburg. She holds a Doctorate in Engineering Management with twenty years' experience in both industry and academia. Dr Nel is a Fellow of the Southern African Society for Industrial Engineering and currently serves on the Boards of Denel and the Society for Engineering Education. She is an Associate Member of the Institute of Directors in South Africa; and a Member of the International Women's Association.