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RESEARCH ARTICLE:

Improving South African Masonry Construction Industry

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Abstract

Given the current state of the masonry construction industry (MCI) in South Africa (SA), this study is long overdue. The issues that require immediate attention are: (1) noncompliance; (2) unethical behaviour and (3) lack of knowledge. Evidence to be presented later demonstrates that not all designers and contractors adhere to building policies, regulations and standards. As the demand for buildings constructed of masonry increases significantly over the next few decades, an intolerably high level of adverse overall impact will result. The study's aim is to propose a first step toward a remedy strategy to improve the SA MCI's current state. The objectives are to: (1) present through already published case studies and reports how lack of compliance, ethics and knowledge affects the MCI and (2) suggest recommendations to improve the situation. The study concludes that compliance (predominantly), ethics and knowledge need to be improved in MCI. The study identifies how SA government can improve MCI by systematically implementing ISO 9001: 2015 to improve (1) compliance, (2) ethical behaviour and (3) knowledge in MCI.

Keywords*: structural masonry; masonry construction industry; quality management system*

Introduction

This study examines the potential advantages for the South African masonry construction industry of adopting a quality management system (QMS) based on the ISO 9001:2015 standard. Following that, the study used previously published case studies and reports to demonstrate the impact of not implementing a quality management system in the masonry construction industry (MCI). The study identified significant opportunities for the South Africa (SA) government to improve MCI through systematic implementation of ISO 9001: 2015 to enhance (1) compliance (2) ethical behaviour and (3) knowledge. Standards are often disregarded when products and services meet our expectations. We do, however, notice when standards are not met. We notice when products and services are of poor quality and unreliable. Standards help to ensure that products and systems operate properly and safely. Rather than developing their own standards, organisations are increasingly relying on pre-existing standards as part of developing a quality assurance system, as is the case in SA. Quality management in construction differs from quality management in manufacturing. Quality in construction projects includes not only the materials used but also the overall management approach to completing the task to the satisfaction of the customer/owner (Rumane, 2017).

According to Hoyle (2017), the business environment and changes in that environment have an impact on an organisation's quality management system (QMS). To develop or adopt an effective quality management system for the SA MCI, it is necessary to first understand the context of the organisation system to which the QMS will be applied. Organisations must attract, capture, and retain key stakeholders. All of them are necessary but some are more important than others. Customers are stakeholders but they also generate revenue, which is a company's lifeblood. One of ISO 9001:2008 requirements were to identify and meet customer and legal requirements. In the 2015 version, interested parties' requirements must be determined and considered because they may have an effect on the organisation's ability to consistently provide products and services that meet customer, statutory and

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regulatory requirements. Emerging manufacturers, masonry designers, construction contractors and poorly skilled/trained labourers are all examples of MCI stakeholders. It is critical to understand the impact of interested parties on the organisation, to ascertain their needs and to monitor and review information about them. Many ISO 9001 requirements are generic in nature and apply to all organisations regardless of their size, complexity, or nature of their products or services. Knowledge and ethical conduct are necessary to incorporate quality into products and systems. Furthermore, to be able to comply, one must have knowledge about the subject. As a result, knowledge, ethical behaviour, and compliances are critical for all MCI stakeholders to realise through policies. SA MCI's direction is left to chance in the absence of leadership and QMS. Every conscious thought and action must be guided by a policy that reflects the MCI values. Creating a quality policy for MCI entails developing or adopting a policy that addresses three major issues: (1) noncompliance (2) unethical behaviour and (3) a lack of knowledge. Policies are better understood when expressed in employee-friendly terms. MCI needs such policy. The MCI is diverse, with skilled and unskilled, professional and unprofessional labour (Marglin, 2017). Kamanga and Steyn (2013) stressed the shortage of a skilled workforce in South Africa as a generic problem. Furthermore, engineering development has been slowed by a lack of skills, which further affects building standards and efficiency as well as limiting the improving of social and economic infrastructure (Bikitsha and Amoah, 2022).

The MCI requires the mixing of mortar in which various constituents such as sand, cement, water and a person mixing mortar physically, engage in the process of producing a durable or weak mortar in its hardened state. The MCI has a long history of problems, such as failing to provide movement joints when constructing walls, which is widely acknowledged in the industry. Previously, statutory bodies attempted to solve the problems by adapting and/or adopting building policies, regulations and standards but they usually failed, as evidence suggests (Crofts, 2014; Khuzwayo, 2016; Crofts, 2018b; Crofts, 2018c). Failure to adequately teach masonry as a subject at the undergraduate level, as is the case in many South African institutions offering civil engineering, adds to the problem. As a result, as demonstrated by the case studies presented in this study, patterns emerge over time, such as noncompliance, unethical behaviour and the lack of knowledge, which most studies suggest are interconnected (Hofmann *et al*., 2008; Palil and Mustapha, 2011; Alkhatib *et al*., 2020). For Carpenter *et al*. (2014), engineers in training must be cognisant of the fact that technological advancement and emerging global issues will require a strong sense of ethical responsibility. As a result, they must be prepared to reason through and act appropriately when confronted with ethical dilemmas as professionals. Carpenter *et al*. (2014) compared different institutional approaches to ethics education in order to better prepare students to be ethical professionals. The findings indicate that co-curricular experiences have a significant impact on ethical development, that quality of instruction is more important than quantity of curricular experiences, that students with stronger ethical reasoning skills are less likely to be satisfied with ethics instruction and that institutional culture has an effect on how students behave and articulate ethical concepts. Institutions must enhance their curricular and co-curricular offerings to support students' ethical development and ensure compliance (Carpenter *et al*., 2014).

SA's MCI has various stakeholders, which are briefly discussed below:

- The Construction Education and Training Authority (CETA) establishes a strong foundation of skills as a foundation for infrastructure development and economic empowerment. CETA's Education and Training Quality Assurance (ETQA) by SAQA enables it to accredit and monitor providers of skills training (Construction Education and Training Authority 2023).
- Building Contractors who plan and coordinate construction activities and are responsible for completing projects on time and within budget. Contractors are accountable for the entire construction process and must determine the most efficient methods for completing the project according to the specifications (Tobias, 2023).
- The Department of Labour (DoL) is critical in reducing unemployment, poverty and inequality by implementing a series of policies and initiatives in collaboration with social partners that are aimed at improving economic performance and competitiveness, developing skills and creating jobs (Geminiani and Smallwood, 2008).
- The Engineering Council of South Africa (ECSA) regulates the engineering profession. ECSA's primary responsibilities are to accredit engineering programmes, to register individuals as professionals in specified categories and to regulate the practice of registered individuals (Engineering Council of South Africa: Code of Conduct, 2020).
- The client should play a critical role in promoting a systematic approach to health and safety management in construction. Clients who lack construction expertise rely on professional experts for guidance on how

to best fulfil their responsibilities. Both the Principal Designer and Principal Contractor will require client support and input in order to perform their duties effectively (Ai Solutions, 2023)

- The National Home Builders Registration Council (NHBRC) establishes technical standards for design and construction. The NHBRC assists and protects residential clients who are exposed to contractors who provide housing units that are substandard in design, workmanship and material quality (National Home Builders Registration Council, 2023).
- The South African Bureau of Standards (SABS) promotes and maintains commodity standardization, quality and service provision. SABS provides industry-specific services such as registration, monitoring and consignment inspection.
- Government (typically local government) performs a broader function through municipal authorities, which is to review proposals and ensure they comply with applicable building codes. Additionally, they monitor construction sites regularly to ensure overall compliance with applicable building codes. On sight of non-compliance, violation warnings and stop-work orders may be issued even before the construction process is complete.

The MIC requires a design thinking approach, which innovates new solutions based on a "bottom-up" human-centred approach from consultants to the governmental level, which includes but is not limited to ECSA (competent person), NHBRC (housing enrolment), and SABS (standards). This is achieved by consultants providing technical services on behalf of the government that will ensure good-quality public infrastructure. This is achieved by the national government ensuring that there are effective building policies, regulations and standards in place to create an environment whereby consultants, contractors, manufacturers and suppliers have sufficient knowledge and skills to service the masonry industry. Figure 1 presents the hierarchy of the MCI.

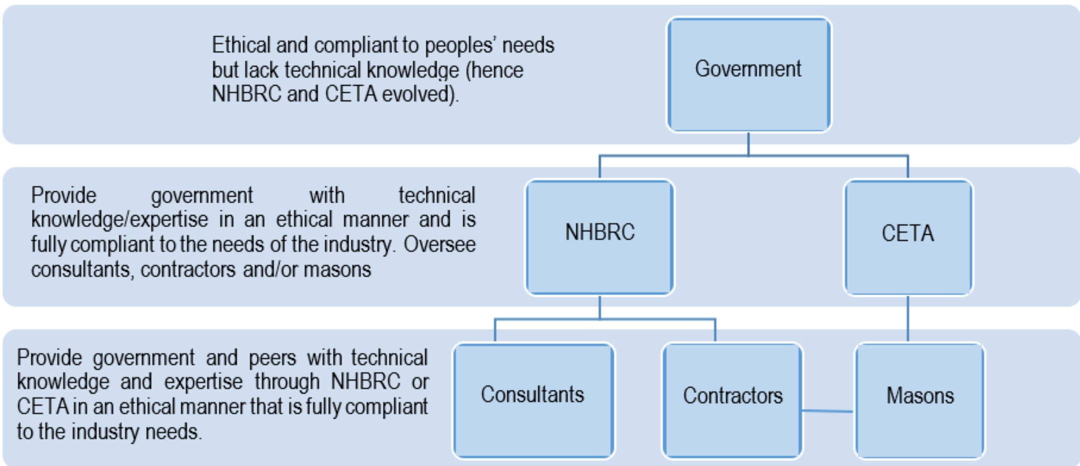

Figure 1: Intersecting hierarchy of the MCI

This concept has wide applicability in a myriad of other disciplines involving understanding and intuition of critical MCI. It requires such knowledge to recognise the key connections between sections of a network (Plate, 2010) and sustainable management (such as in the masonry industry). This requires integration and the recognition of the interconnections in MCI (Tippett, 2005). Some of the interconnections combine to form feedback loops, which are vital in a system's behaviour. MCI analysis, therefore, includes recognising the feedback loops and understanding how they could affect a complex system's behaviours (Plate and Monroe, 2014).

Methodology

The case studies presented in this paper demonstrate the masonry industry's compliance, ethics and knowledge issues. Some case studies have published reports of the failures of masonry structural elements as construction material. Viewing the masonry industry as being similar to the perception of risk (Hansson, 2002) allows the study to assume two possibilities:

- Where there is an element of ignorance (lack of knowledge) and in addition, a lack of ethics, compliance is highly improbable. For example, it is implicitly understood that most civil engineering students in SA do not receive specific education on structural masonry (Crofts, 2018a) but that in itself does not exonerate them from the responsibility of acquiring such essential knowledge. Furthermore, as noted in the literature review, ethics is barely discussed during training across the different learning spaces which contribute to the problem.

Where there is ignorance but good ethics practised, compliance is probable. Here again, if Civil Engineering students are ignorant because they have not been trained adequately in masonry design, detailing and construction, it is incumbent on them to learn, inquire or admit their limitations and commission a structural masonry practitioner to assist them. Knowledge is essential for compliance as elucidated by the following examples:

- Masons require training about the correct method/s of mixing sand cement mortar, otherwise compliance is highly improbable.
- A competent building contractor should be knowledgeable about the quality of building materials to be used in a structure in order to comply with the design specification.
- Building inspectors should have sufficient training to enable identification of any potential problems during construction that may contribute to inferior buildings.

The study engaged in a search for published literature discussing masonry problems within a South African context by focusing on poor-quality (noncompliance), unethical behaviour and lack of knowledge in MCI. This study explored data within the past twenty years. The stakeholders listed below are among the most active and commonly known in MCI. During the search, it was easier to see/determine 'compliance/noncompliance' as essential terms rather than ethics and knowledge-related concerns, unless they were explicitly mentioned, for example, with words such as: 'corruption' or 'lacked knowledge'. In addition, the functions and responsibilities of key stakeholders in the masonry industry and how they sometimes fail to meet public expectation such as good-quality building, was considered as non-compliance.

The structure below guided the presentation of each case study/ investigation in terms of three (3) categories, namely, poor quality (five case studies), ethics (two studies) and compliance (eight studies):

Presentation of Findings

Category 1: Poor Quality

Case Study 1 – Manomano and Tanga (2018): Amathole District in South Africa built houses for 250 residents who later participated in a survey in 2015. The sample consisted of housing officials, representatives of political parties, municipal managers, councillors and social workers who were interviewed. Although the district has eight municipalities, this study focused on the four where housing programmes were put into practice. The results revealed that most of the houses, been constructed from substandard materials. There was evidence of poor workmanship such as cracked walls. The quality of the houses posed a threat to the health and safety and human dignity of the residents. The identified MCI failure is in line with non-compliance by the NHBRC and the Government with regards to The Application of the National Building Regulations (SANS 10400-A 2022). Furthermore, a breach of the Consumers' Protection Measures Act, 1998 (Housing Consumers Protection Measures Act 95 of 1998): Quality of Material and Workmanship: 10.1-10.5 has implications.

Case Study 2 – Mchunu *et al*. (2019): An evaluation of the expectations of the beneficiaries about their housing and its infrastructure at eZamokuhle Township (China 1, China 2, Jabavu, and Smallvile) was conducted prior to 2019. It also assessed the level of satisfaction or dissatisfaction. The results revealed that lack of adequate housing not only jeopardizes development but also creates social and economic challenges. The residents were deeply dissatisfied with the built environment, the quality of housing and basic services such as electricity and sanitation which are inseparable from housing. The study recommended commitment from government to providing good-quality housing. The identified MCI failure is registered as non-compliant by the NHBRC and the Government with respect to The Application of the National Building Regulations (SANS 10400-A 2022). A breach of Consumers' Protection Measures Act, 1998 (Housing Consumers Protection Measures Act 95 of 1998): Quality of Material and Workmanship: 10.1-10.5, was evident.

Case Study 3 – Zunguzane *et al*. (2012): The perception of both owners and contractors was sourced through a quantitative survey of 74 housing beneficiaries in Port Elizabeth prior to 2012. Perceptions of contractors registered with the NHBRC were also included. The study revealed that the key cause of deficiencies in low-income houses is linked to the use of potentially insufficiently qualified emerging contractors and the contractors' use of unskilled labour. In addition, poor workmanship was the main cause of the defects and was ranked first by the survey respondents. A vast majority of participating contractors advised that using unskilled labour and substandard methods of construction was the cause of faults. The identified MCI failure is recorded as non-compliant by the NHBRC and the Government with The Application of the National Building Regulations (SANS 10400-A 2022). Furthermore, breach of Consumers' Protection Measures Act, 1998 (Housing Consumers Protection Measures Act 95 of 1998): Quality of Material and Workmanship: 10.1-10.5, was noted.

Case Study 4 – Buys and Le Roux (2013): Quantitative research among architects, consulting engineers and construction contractors in the Western and Eastern Cape provinces of SA, was conducted prior to 2013 and received 102 online responses. The study indicated that poor workmanship was the main cause of house defects. Insufficient artisan skills were the biggest contributing factor to deficiencies. Dampness and humidity were identified as common forms of defects in homes. Deficiencies resulted from non-compliance with standards. Design, construction, material and subsurface conditions may be related to the overall causes of the defects. The cause of the defects was poor management or insufficient technological skills. Skills shortage within the sector, a perceived absence of deterrents and penalties, and low ethical standards were factors instrumental in corruption. Interestingly, in this study, poor ethics and lack of knowledge were specified. The identified MCI failure is registered as non-compliant by the NHBRC and the Government with The Application of the National Building Regulations (SANS 10400-A 2022). Furthermore, a breach of Consumers' Protection Measures Act, 1998 (Housing Consumers Protection Measures Act 95 of 1998): Quality of Material and Workmanship: 10.1-10.5, was noted.

Case Study 5 – Crofts (2014): Duduza a township in SA experienced a Tornado in 2011. The number houses severely damaged were 558, 150 of which were totally destroyed. The results revealed that failure modes were partly due to defects or shortcomings in the buildings. This was as a result of the non-application of good building details and basic structural design principles. The use of building materials beyond their structural capabilities not only compromised structural integrity but also added to the annoyance and discomfort of the occupants. It also implicated costly routine maintenance. The fundamental causes of the defects were traced to deviation from the standards of structural design/ engineering, poor workmanship, lack of experience and attention to detail and carelessness or lack of compliance. The identified MCI failure is recorded as non-compliant by the NHBRC and the Government with The Application of the National Building Regulations (SANS 10400-A 2022). A breach of Consumers' Protection Measures Act, 1998 (Housing Consumers Protection Measures Act 95 of 1998): Quality of Material and Workmanship: 10.1-10.5 exists.

Category 2: Ethics

Case Study 6: Bowen *et al*. (2012): A web-based questionnaire survey was launched in mid-January 2011 and remained accessible online until mid-March 2011. The aim of the study was to determine the perception of corruption as a prevalent problem. The study concluded that corruption centres largely on appointment irregularities and tendering. Instrumental factors in corruption include scarcity of expertise within the sector, a perceived lack of deterrents and penalties, and low ethical standards. Procedural barriers, fear of victimization and personal attitudes all serve as barriers to the battle against corruption. Opportunities for corruption were found to exist across the entire spectrum of activities involved in the construction procurement process. Officials in the public sector were deemed the most complicit in corruption. In addition, political power and nepotism which exerts pressure, leading to corrupt actions, was also cited. The identified MCI failure is in breach of the Code of Conduct for all Parties engaged in Construction Procurement - in terms of the Construction Industry Development Board Act (Construction Industry Development Board Act 38 of 2000) by some government representatives.

Case Study 7 – Bowen *et al*. (2007): A survey study was conducted prior to 2007 to investigate ethics in the construction industry. The number of professionals who responded to the mailed questionnaires was 107. The study concluded that the infringements of professional obligations include conflicts of interest and the release to a third party of sensitive and proprietary information; all practitioners and clients are guilty of these violations. Such results are interlinked with the dominance of personal ethics over corporate ethics in professional decision-making processes. The respondents generally admitted that clients often influenced their professional duties and obligations, especially with regard to environmental concerns and the disclosure of sensitive and proprietary information. The study recommended that as the principle of conflict of interest is the most violated professional responsibility within the construction industry, policy is needed to safeguard the trust and confidence of stakeholders in the professional practices of the construction industry. The identified MCI failure is a breach of the Code of Conduct for all Parties engaged in Construction Procurement - in terms of the Construction Industry

Development Board Act (Construction Industry Development Board Act 38 of 2000) by some ECSA registered personal.

Category 3: Compliance

Case Study 8 – Crofts (2018a):

Report 1: Industrial Building - Partial Failure of a Gable Wall in July 2005. A 230 mm thick gable wall, with roller shutter doors, of a Kaya Sands factory was blown inward during a windstorm. A structural steel superstructure was covered with a metal sheeting and masonry walls. The gable wall, 30 m long with a back wall in the centre; at the apex, the wall was about 9 m high. A qualified individual designed and provided a completion certificate for the structural steel superstructure but overlooked a substandard masonry gable wall. The gable wall structure fell beyond the limits of the SANS 10400-K: Walls (2015) set of deemed-to-satisfy rules and had to be designed from first principles. The identified MCI failure was reported as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012), by ECSA registered personal.

Report 2: Academic Building - Gradual Structural Deterioration of Masonry Envelope. No year was given on the study. Deeply recessed windows to fit a cubistic architectural style were used forming cavity walls of 115 mm thick masonry leaves of a cavity of 345 mm. A concrete frame supported the masonry shell, with the cavity wall panels 6 x 3.7 m in length. Some wall panels cracked laterally and dislodged from the supporting framework. The frame, with widely spaced slender hoop iron with a sweeping long bent between the mechanical anchors, attached to the concrete column, was anchored to the wall panels. It was evident that drainage holes were not supplied to the cavity walls. The single-leaf wall panel geometry falls outside the SANS 10400-K: Walls (2015) and SABS 0164: Part 1 (1980): Rigid metal anchors should be distributed uniformly in centres not exceeding 300 mm. According to SABS 0164: Part 1 (1980) (the standard restricts a cavity to 150 mm) a diaphragm wall must be formed by cross-bonding of the masonry leaves with internal wallets. SANS 2001-CM1 (2012) offers damp-proof course information to avoid increasing humidity in walls. The identified MCI failure is recorded as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012), by ECSA registered personal.

Report 3: Industrial Building – Collapse of a Gable Wall during Construction in mid-2015. A gable wall collapsed during construction in Ophirton Township in SA, resulting in fatality and damage to the nearby building and property. The 220 mm thick gable wall was 29 m long at the apex, 12 m high, with vertical control joints spaced at 4.6 m centres. No windstorm was recorded. No approved building plans from the local authority were received. It was evident that the entire gable wall was free standing and not fixed onto the steel frame. Dissimilar masonry units (concrete and fired clay) were built in the same wall panel despite this not being allowed if the wall ends are in contact with each other (SANS 2001 structured building specification sequence, i.e. Clause 4.3.7 of SANS 2001-CM1:2007; SANS, Building works, Section CM1: Masonry wall). The multi-leaf wall was not mechanically or otherwise cross-bonded (SANS Clause, 3.24.2 2001-CM1:2007). The DoL released a notice of prohibition in respect of the OHS Act, Act No 85 of 1993 which was later revoked in late 2015 without any gazetted findings. The identified MCI failure is registered as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012), by some clients and government representatives.

Report 4: Golf Club Hall - Collapse of a Gable Wall in 2015. One of the hall's gable walls collapsed, damaging the 300 m^2 roof. No injuries were reported. For that particular day, the weather record indicated no heavy wind speed action in the vicinity. The gable wall was 14 m in length, 6.5 m high to the top and was only protected by return walls at the ends. The side walls that supported the roof trusses were 20 m long and restrained by returning walls at both ends, while the gable wall on the other side of the building had internal partition walls that provided lateral support. The evidence indicates that the gable wall geometry fell outside the scope of the set of deemed-to-satisfy rules of SANS 10400-K: Walls (2015) due to slenderness, thus needed the expertise of a qualified person registered with ECSA (Engineering Profession Act 46) but was not engaged. The multi-leaf wall was not mechanically or otherwise cross-bonded (SANS 2001-CM1 (2012) Clause 3.24.2). The identified MCI failure is recorded as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012), by some clients and government representatives.

Report 5: Commercial Building in Kwazulu-Natal - Collapse of Façade during a Storm in 2008. A strong wind triggered the collapse of two cavity wall panels at a KwaZulu-Natal shopping centre. One panel, which was 6 m x 6 m in size, collapsed over an entrance at first floor level while the other panel's outer leaf leaned against the inner leaf. The evidence revealed that the cavity in the wall was 150 mm and bound with masonry reinforcement (brick force) and binding wire, as opposed to the use of wall ties. The wall connections are subject to a sound design considering the wind pressure for the particular type of terrain hence the indication that the design was inadequate. The identified MCI failure is recorded as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012), by some clients and government representatives.

Report 6: Reoccurring every year – Masonry Envelopes for Mass-Produced Standard-Sized Prefabricated Steel Buildings (Farm Buildings). Appearing in public, are cost-efficient, flimsy, unclad structural steel buildings which often end up covered with masonry walls. Side walls (without penetration) remain functional as a broken section if properly supported between superstructure columns (normally a portal frame). As a result, gable walls often fail because the wall geometry falls beyond the reach of SANS 10400-K: Walls (2015) in the absence of a supporting column and requires the expertise of a competent person. The design purpose of these farm buildings does not generally accommodate masonry cladding. The gable wall on the leeward side is frequently dented in at the back wall, resulting in a dramatic zip failure as the gable wall falls away from the house. SANS 2001-CM1 (2012) clause 4.4.5 does not allow for toothing-in as a way of joining intersecting walls. The identified MCI failure is registered as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012), by some clients and government representatives.

Report 7: Commercial Building in Sandton – Random Collapse of Façade in 2016. In 2016, the building's masonry façade located in Sandton partially collapsed. The parapet wall was around 38 m long and projected 4 m beyond the roof line. The evidence indicated that a 230 mm freestanding boundary wall exceeded 1 800 mm in height and wall geometry which falls beyond the reach of SANS 10400-K: Walls (2015). It requires the expertise of a competent person to design it. The identified MCI failure is registered as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012) by some clients and government representatives.

Report 8: Mall on East Rand – Collapse of Façade in 2008. In 2008, a part of a masonry façade at a Mall in East Rand collapsed into a parking area, killing three people. The standing wall at a roof level consisted of a 230 mm thick masonry wall 2 900 mm in height, with 575 mm x 230 mm piers placed at 5 000 mm centres past the wall's face. The pier was dented in with a substantial gap between the pier and the wall at the tenth level. Problems of lack of bonding for neighbouring façades between pier and wall had apparently been noticed earlier and steel brackets had been added. It was evident that the freestanding multi-leaf wall, as well as the adjacent parapet wall, were not cross-bonded, rendering the wall structurally impeded. The wall collapsed in a near-horizontal line along a bed joining ten courses above the level of the roof and not along the lowest bed joint. The walls were constructed in one continuous line, regardless of the published guidance provided in SANS 10400-K: Walls (2015) and SANS 2001-CM1 (2012) on the control joints. The identified MCI failure is recorded as noncompliant with the SANS 10400-A (2022) and SANS 2001-CM1 (2012). Table 1 provides a summary of failures from eight (8) case studies. They are grouped into categories for discussion.

Table 1: Stakeholders implicated and areas of concern

		NATURE OF CONCERN (CATEGORY)		
	Stakeholders	**Compliance**	**Ethics**	**Knowledge**
1	**CETA** (labour)			
2	**Contractor** (builder)			
3	**DoL** (OHS)			
4	**ECSA** (competent person)	CD8-R1, CD8-R2	CD7	CD8-R1, CD8-R2
5	**End user** (client)	CD8-R3, CD8-R4, CD8-R5, CD8-R6, CD8-R7		
6	**NHBRC** (housing enrolment)	CD1, CD2, CD3, CD4, CD5, CD6	CD4	CD4
7	**SABS** (standards)	CD8-R8		
8	**Government** (superior)	CD1, CD2, CD3, CD4, CD5, CD8-R3, CD8-R4, CD8-R5, CD8-R6, CD8-R7, CD8-R8	CD6, CD7	

Discussion

Without a doubt, noncompliance is an issue in SA MCI, followed by unethical behaviour and a lack of knowledge. There were twenty-five instances of noncompliance recorded. Four instances of unethical behaviour were reported. There were three records of insufficiency of knowledge. The government was implicated in thirteen incidents;

NHBRC was implicated in eight incidents; The end user was blamed for five incidents; ECSA was implicated in five incidents; SABS was implicated in only one incident. Figure 2 below provides a visual impact.

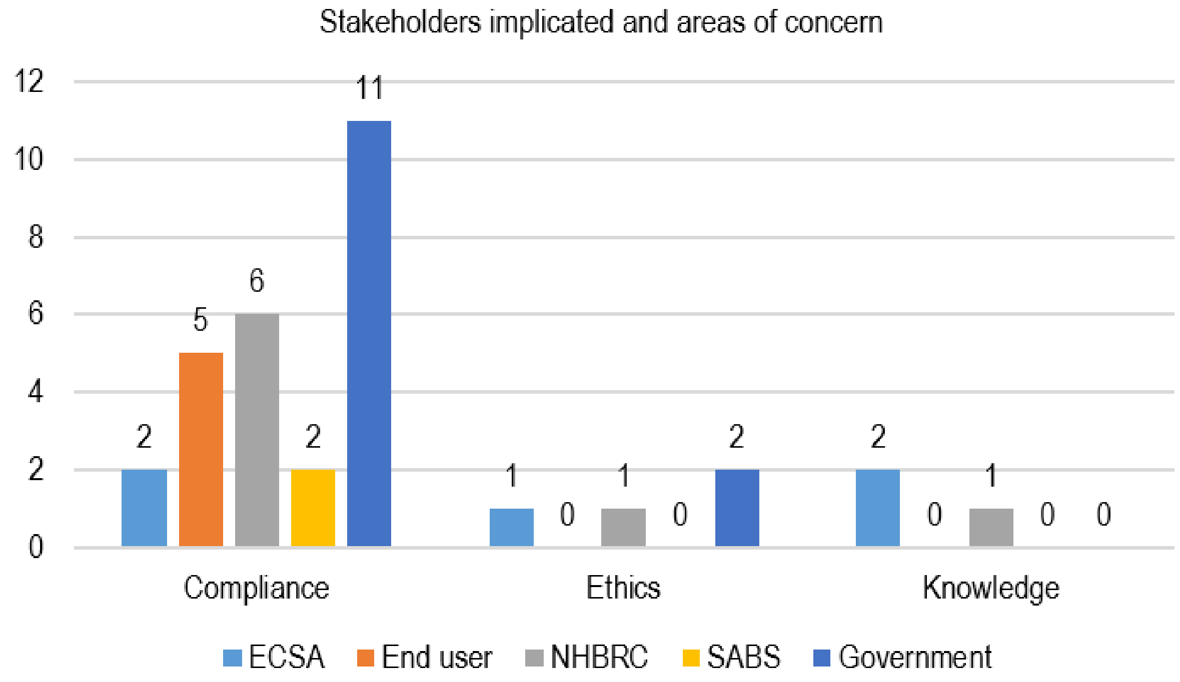

Figure 2: Stakeholders implicated and areas of concern

It is unsurprising that there are few records of unethical behaviour or lack of knowledge in MCI context. There is little research on ethics and knowledge in MCI context worldwide. On different social scales, behaviours (such as compliance and ethical behaviour) and institutions (such as NHBRC and Government) are similar phenomena; both can be cultural characteristics. In most cases, behaviour is an expression of an individual cultural trait, while institutions are group-level cultural traits. Both are created, learned, modified, copied and re-transmitted within a larger population, diffusing and evolving. The same holds true for knowledge. For example, as noted by Crofts (2018a), the functional regulations contained in the NBR and Building Standards Act for the maximum size of masonry wall panels with concomitant support conditions are provided in the deemed-to-satisfy requirements (empirical rules) of SANS 10400-K:2011. They require expertise of a competent person identified in the Council for the Built Environment Act 43 (2000) as per their individual appointments in terms of SANS 10400-A:2010. However, the lack of South African graduate engineering courses in which structural masonry as a course offered could be intensifying the problem. Conceivably, some graduate engineers' schooling, training and experience would necessarily preclude them from recognizing and evaluating risk areas for masonry (Crofts 2018a). Figure 3 illustrates the interrelated noncompliance, unethical behaviour, lack of knowledge within MCI that could be remedied by adopting a policy such as ISO 9001:2015 to collectively address (1) noncompliance; (2) unethical behaviour; and (3) lack of knowledge at all levels and stakeholders of MCI, namely: CETA (labour), Contractor (builder), DoL (OHS), ECSA (competent person), End user (client), NHBRC (housing enrolment), SABS (standards) and Government (superior).

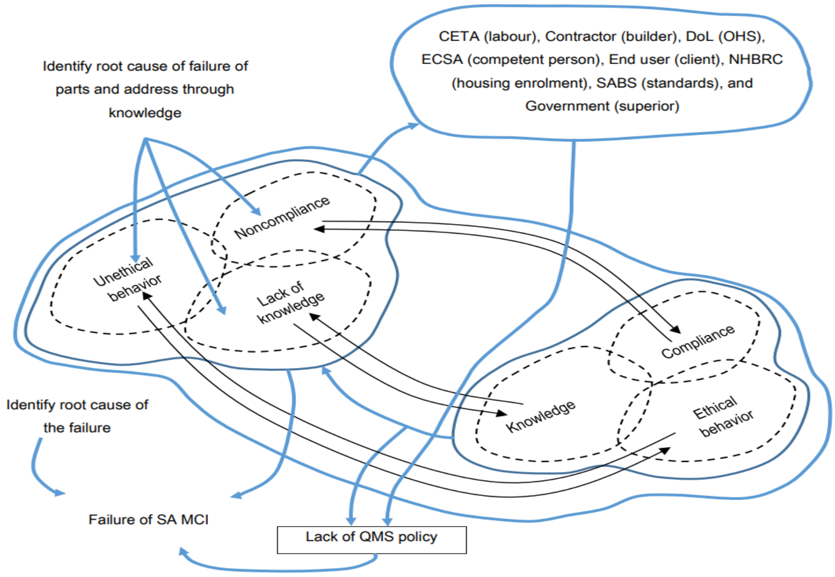

Figure 3: MCI failure mechanism

The interconnectedness of problems indicates the MCI failure of in compliance, ethics and knowledge, as illustrated above. Three parts require immediate attention, namely:

- Noncompliance which is reflected through substandard materials, substandard construction practices and unacceptable design practices.
- Unethical behaviour (not morally correct) which reflects through wittingly using substandard materials, substandard construction practices and unacceptable design practices.
- Lack of knowledge which reflects through unwitting use of substandard materials, undertaking substandard construction practices and unacceptable design practices.

Everyone in MCI, including masons, design engineers, construction supervisors, manufacturers, and officials, has a critical role to play in improving the SA MCI by first acquiring sufficient knowledge to understand the role and responsibility that comes with their respective duties, conducting themselves ethically and adhering to applicable policies, regulations, and standards.

Conclusion

This study is long overdue in light of the current state of MCI. There is evidence that not all designers and contractors follow all applicable building policies, regulations and standards. Noncompliance is a problem in MCI, with 25 instances recorded, followed by unethical behaviour and a knowledge deficit. The government was involved in thirteen incidents, while the NHBRC and ECSA each had eight. Three instances of knowledge inadequacy can be attributed to the end user. The absence of South African graduate engineering courses in structural masonry may be exacerbating the problem. Certain graduate engineers' education, training and experience should be mandatory to enable them to identify and evaluate masonry risk areas. This proves interconnectedness of MCI problems, namely: noncompliance, unethical behaviour and lack of knowledge. The interconnectedness of problems indicates a systemic failure of MCI and parts failure in individual components, namely: compliance, ethical behaviour and knowledgeability. Noncompliance is manifested through the use of substandard materials, construction practices that are substandard and design practices that are inappropriate. Unethical behaviour or morally reprehensible behaviour is linked to the deliberate use of substandard materials; substandard construction practices and unacceptable design practices. Unintentional use of substandard materials substandard construction practices and unacceptable design practices are all symptoms of a lack of knowledge. The study demonstrates the enormous potential for the SA government to resolve MCI issues through a parts-to-whole approach. The first step towards achieving this goal could be a policy of correction through a multidisciplinary framework and or a white paper addressed to the MCI to convince stakeholders that systematically adopting a QMS such as ISO 9001:2015 sets MCI industry in a better position to improve (1) compliance, (2) ethical behaviour and (3) knowledge.

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