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Causes of defects in the South African housing construction industry: Perceptions of built-environment stakeholders

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Abstract

This article emanates from research investigating the biggest cause that leads to defects in houses; the most common type of defect, and why projects fail in project-management terms (due to defects). Results of quantitative research among architects, consulting engineers and building contractors within the construction industry in the Western and Eastern Cape provinces of South Africa, as well as a literature review, form the basis of this study. Architects, consulting engineers, and general building contractors are randomly selected and surveyed using an online questionnaire. The study reveals that inadequate artisan skills are the biggest cause leading to defects in houses, and that cracks are the most frequent type of defect occurring. Projects fail in project-management terms because of defects as the construction time of the projects is prolonged. The study also reveals that construction-related causes of defects dominate over design-related causes. The results should be of value to both construction industry professionals and their clients.

Keywords: Defects, rework, quality management

Abstrak

Die artikel spruit voort uit 'n navorsingsprojek om te bepaal wat die grootste oorsaak van defekte in woonhuise is; watter defek die meeste voorkom, en waarom projekte misluk in terme van projekbestuur (as gevolg van defekte). Resultate van 'n kwantitatiewe ondersoek tussen argitekte, raadgewende ingenieurs en boukontrakteurs asook 'n literatuurstudie vorm die grondslag van die studie. Argitekte, raadgewende ingenieurs en boukontrakteurs is ewekantsig geselekteer en ondervra deur middel van 'n Internet-aanlynvraelys. Die ondersoek wys daarop dat onvoldoende ambagsvaardighede die grootste oorsaak van defekte in woonhuise is en dat krake die meeste voorkom. In terme van projekbestuur lei projekte daaronder deurdat defekte die kontrakperiode verleng. Die studie toon ook aan dat konstruksieverwante defekte meer dominant is as ontwerpverwante defekte. Die studie behoort insiggewend te wees vir beide konstruksie professionele persone sowel as kliënte.

Sleutelwoorde: Defekte, herdeurwerk, kwaliteitsbestuur

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1. Introduction

Douglas & Ransom (2007: xv) state that, despite the growing awareness as to many of the common causes and consequences, failures still seem to bedevil the building industry in the United Kingdom (UK) and elsewhere in the developed world. There is a perception that defects within the South African construction industry in newly completed buildings are increasing and becoming a serious problem, as increasingly more buildings are being built. Despite the fact that a great deal of technical and legislative information on good house construction practices is available, unacceptable construction quality is apparent throughout the entire spectrum of housing in South Africa. The National Home Builders Registration Council (NHBRC) rectified more than 200 houses at an estimated cost of R40 million in the 2010/2011 financial year (Mahachi, 2010: 56). Corruption is currently identified as one of the major barriers to achieving construction quality in South Africa (CIDB, 2011b: 8).

The South African construction industry experienced a boom in 2009 and 2010, with many infrastructure developments taking place in the country as a result of the 2010 Soccer World Cup held in South Africa. There is a shortage of skilled people in the South African construction industry; local and international companies within the construction industry are joining forces in order to meet the current demand (Makhene & Thwala, 2009: 130). Worldwide, the South African government is one of the governments that have delivered the highest number of houses to the poor by means of various delivery mechanisms; this forms part of their vision to provide adequate housing for all, as reflected in the National Housing Policy Framework (Ndawonde, 2009: online).

Housing is meant to address the basic human need for shelter and security. Since 1994, the South African government has initiated and implemented several housing delivery programmes as well as subsidy mechanisms to provide houses to the poor (RSA DH, 1994). It also states that the country's vision is to increase housing's share in the total state budget to 5% and to increase housing delivery on a sustainable basis to a peak level of 338.000 units per annum, in order to reach the Government of National Unity's target of 1,000.000 houses within five years (RSA DH, 1994). Pottie (2003: 429) states that "while considerable housing delivery has occurred since 1994, housing expenditure as a proportion of national expenditure has not yet reached its stated goals".

Research by Olaosebikan (2010: 3) indicates that the government's focus was initially on quantitative housing delivery with qualitative

shortcomings; however, this focus has now shifted to the quality of the end product that is delivered. It also shows that defects in houses manifest primarily through cracking, dampness, detachment, and water leakages.

Defects are categorised as being deficiencies in design, material, construction or subsurface (FindLaw, 2011: online). The latter can be either patent or latent. Patent defects can be clearly recognised during inspection, the construction period or the project's defects liability period. Latent defects appear over time, usually once the building has been occupied (Che Mat, Hassan, Isnim, Mohidisa & Sapeciy, 2011: 238).

It may be argued that the risk of defects occurring in housing projects is greater, due to incompetent and unqualified construction professionals. This may be ascribed to the great demand for houses, government policies for job creation and the assistance of emerging construction-industry professionals. This article presents part of the findings of a research project, the primary aim of which is to establish the factors that relate to defects occurring in housing projects in the Western and Eastern Cape provinces of South Africa.

2. Review of the literature

The public perception of what constitutes a building 'defect' is often inconsistent with the legal definition of a 'defect'. Problems as a result of the natural ageing of a building and its components or a lack of proper maintenance are referred to as 'defects' by law, whereas they do not, in fact, represent defects for which producers will be liable. 'Defects', liable by producers, are those representing a blemish in design, materials or workmanship (Alhajeri, 2008: 420).

According to Alhajeri (2008: 421), the word 'defect' is defined in the Oxford English Dictionary as the lack of something essential or required, an imperfection. It is also defined as "failing in", as a "shortcoming" or a "blemish" whereby something falls short. The word 'defective' is defined as having a defect or defects, i.e. a state of being incomplete, imperfect, faulty, lacking or deficient. In the construction context, the term 'defect' is generally refers to construction faults that exceed ordinary imperfections, affecting a basic structural element of the building works, and turning the building, installation, or structure into a state of functional ruin (Alhajeri, 2008: 421).

According to the Webster's Dictionary, a defect is defined as the lack of something necessary for completeness; a shortcoming. It is

also defined as an imperfection, fault, or blemish (Ahzahar, Karim, Hassan & Eman, 2011: 250).

A building defect may include any problem that reduces the value of a home, condominium, or building. Building defects can be the result of design errors by professionals, a manufacturing flaw, defective materials, improper use or installation of materials, not conforming to the design by the contractor, or any combination of the above (Ahzahar *et al.*, 2011: 250).

2.1 Housing standards in South Africa

Housing is an important part of people's lives. It provides shelter during windy and rainy seasons and keeps many families warm during the cold winter months. It is, therefore, important that due diligence be applied during the construction of a house. According to Balchin & Rhoden (1998: 214-215), there are a range of standards applied to housing. These include building regulations and target standards. The following criteria must be met if a dwelling is to be considered fit for human habitation:

- Structural stability;
- A lack of dampness;
- The provision of adequate heating, lighting and ventilation;
- Adequate piped supply of water, and
- An effective drainage system.

Where a dwelling fails to meet any of these criteria and is not considered suitable for occupation, the premises will be considered unfit for human habitation. The local authority is then obliged to consider the most satisfactory course of action to deal with the problem (Mkuzo, 2011: 33).

According to Lund (2007: 20), poorly built houses impact negatively on the government's striving towards sustainable development. South Africa is a resource-scarce country and every available Rand in the government's coffers needs to be spent as wisely as possible. The article also mentions that all the nine provinces in South Africa have different challenges regarding the delivery of houses. A total of 40.000 defective RDP houses (nationwide) have had to be flattened and rebuilt at a cost of more than R1 billion (this amounts to approximately 10% of the National Housing Department's annual budget), due to poor quality. Lund (2007: 20) also refers to the (then) Minister of Finance, Trevor Manuel, stating: "One of the examples of the shortfall in delivery of government housing was the

poor quality of homes being built". Until 2009, the Department of Human Settlements spent R863.9 million nationwide on fixing more than 131.000 RDP houses. The Department also demolished and rebuilt poorly built houses totalling 2.489 in the 2010-2011 financial year. More than 5.000 houses with faults were fixed in the 2010-2011 financial year at a cost of R971.1 million. So far (2009), 131.380 houses have been corrected. These houses did not need to be rebuilt, but certain aspects had to be fixed in order to conform to quality standards.

Ndaba (2010: online) mentions that it has been acknowledged that fraud, delays, corruption, absentee contractors, ghost houses, shoddy workmanship and corruption in respect of waiting lists are chronic impediments to the proper delivery of housing. He also states that poor housing quality derails government's ability to improve the lives of all South Africans, especially the poor. Millions of Rands have been allocated to fixing defects and rebuilding houses due to poor workmanship and maladministration. In the Eastern Cape's Queenstown area alone, the NHBRC ordered that 700 RDP houses be rectified at a cost of R3.4m (Human Settlements South Africa, 2009). Human Settlements Minister, Tokyo Sexwale, stated that "the cost of demolishing and rebuilding defective RDP houses has shot up to R1.3 billion after a national housing audit uncovered shoddily built homes in every province" (Mkhwanazi, 2009: 3).

2.2 Quality in the South African construction industry

Joubert, Cruywagen & Basson (2005: 39) conclude that the South African building industry has a negative image in terms of achieving quality and that it neglects the use of Quality Management Systems (QMSs). They also state that "it is abundantly clear that South African companies can absolutely not postpone the institution of adequate systems any longer". Zunguzane, Smallwood & Emuze (2012: 20) state that quality is a fundamental term in the construction industry; the non-achievement of such a crucial aspect of construction can result in the failure of a construction project and in the dissatisfaction of clients and/or building occupants.

Quality with regard to construction projects is a major concern to clients and, therefore, the non-achievement of quality leads to client dissatisfaction (Auchterlounie, 2009: 250). Hanson, Mbachu & Nkado (2003: 198) state that client dissatisfaction poses a serious threat to the sustainability of the South African construction industry. Crosby (1979: 250-251) regards quality as the parameter that makes the difference between success and failure. Love & Edwards (2004:

270) mention that general contractors, who implement a QMS, experience a significant reduction in rework and a competitive superiority among client stakeholders.

Research conducted in South Africa among general contractors reveals that the majority of these contractors do not implement documented QMSs and rely on informal actions to achieve quality (Smallwood & Rwelamila, 1998: 1786).

There is a significant need in South Africa for the implementation of QMSs within the construction industry. General contractors do not implement strategic quality planning, such as ISO 9000 accreditation. They are fully aware of the system and the successes that it has achieved, but lack competent senior management and organisational structures to implement and sustain the systems (Smallwood & Rwelamila, 1998: 1787).

2.3 Defects in construction

In general terms, defects or defective work occur when the standard and quality of workmanship and materials, as specified in the contract, are deficient (Georgiou, 2010: 371). Defects can be classified into two main categories, namely patent defects and latent defects. Atkinson (1999: online) defines defects as a breach of the terms and conditions of the contract by contractors. Defects may occur in any part of a construction project and at any stage of construction. Douglas & Ransom (2007: 6) define a 'defect' as a shortfall in performance occurring at any time in the life of the product, element or building in which it occurs.

In considering issues within the defect domain, it is important to define what constitutes faults, failure and defects, and what types of failures are evident. The Building Regulations and British Standards do not differentiate between faults and failures and define these as:

- Fault: A departure from design requirements where these were not themselves at fault.
- Defect or failure: A shortfall in performance occurring at any time in the life of the product, element or dwelling in which it occurs (Ilozor, Okoroh, Egbu & Archicentre, 2004: 328).

Atkinson (1987), cited by Mills, Love & Williams (2009: 12), provides a clear definition between a failure and a defect: "A failure is a departure from good practice, which may or may not be corrected before the building is handed over. A defect, on the other hand, is a shortfall in performance which manifests itself once the building is operational". Mills, Love & Williams (2009: 13) suggest that defects

can be classified as being minor or major. Minor defects are those that arise from poor workmanship or defective materials used in the erection or construction of a building, but do not render the building unsafe, uninhabitable, or unusable for the purposes for which the building was designed or intended. If the building is unsafe, uninhabitable, or unusable for the purposes for which the building was designed or intended, it is classified as a major defect. Knocke (1992: 50) mentions that defects are fundamentally the physical manifestation of an error or omission.

Defective construction works can be defined as works that fall short of complying with the express descriptions or requirements of the contract. The majority of modern buildings and civil structures are complex and involve the use of a great variety of engineering methods and processes. Therefore, most projects face the possibility of defects and defective work, which generally result in structures that cannot perform their originally intended roles (Ojo, 2010: 3).

Defective construction contributes to both the final cost of a project and the cost of maintenance, which can be substantial. Defective construction includes activities such as compaction not done to specifications, which leads to ground movement and eventual failure of foundations. This may lead to the complete failure of a structure (Zietsman, 2008: 108).

According to Rhodes & Smallwood (2002: 12), the methods of defect detection include observation, inspection, checking work and test samples. The following are some warning signs of possible defects in houses:

- Deep cracks in the foundation or basement walls: This may be a sign that the foundation was laid on a poorly compacted base or poorly graded soil;
- Sagging floors or leaning walls: A shifting foundation or structural problems (with support beams) could be the problem;
- Windows and doors that never sit well in frames or close properly: This problem could be due to beams and joists not being correctly sized or assembled;
- Cracks in interior walls: Wide cracks could signal a foundation problem. Generally, fine cracks are cosmetic due to normal ageing. Ahzhar *et al.* (2011: 250) state that structural defects resulting in cracks are a common type of building defect. A case study undertaken by Rhodes University's Public Service Accountability Monitor (PSAM) also identified that different

kinds of cracks were a common structural quality defect in houses within the Ngqushwa Local Municipality (South Africa) (CIDB, 2011b: 9). Results of a survey in England and Wales also revealed that the most common type of defect in houses was cracking of walls (Baiche, Walliman & Ogden, 2006: 288). A study undertaken by Fauzi, Yusof & Abidin (2011: 496) in Malaysia also identified cracking of walls and floors as the most common type of defect in houses;

- Water damage: Warning signs include mould, rot, paint peeling, staining, corrosion, swelling or discoloration of interior walls. Possible causes: improperly installed roofing, no waterproof barrier or done incorrectly, lack of a drainage space behind brick wall, poorly installed windows and doors. Although a study by Rhodes & Smallwood (2002: 13) identified that cracking is the most common type of defect, they also state that dampness-related types of defects dominate the industry. The study also reveals that maintenance contractors spent the most amount of time rectifying dampness-related defects. A study undertaken in Malaysia by Ahzahar *et al.* (2011: 253) ranked corrosion of steel as the second highest occurring type of defect in buildings;
- Flooding, sewer and drain backups;
- Switched hot and cold water, and
- Lack of required permits: This indicates that building authorities have not performed the required inspections (Consumers Union, 2004: 27).

The conditions under which housing construction takes place are most often far from ideal, with the main focus on speedy delivery. Defects resulting from inaccurate construction can be avoided by ensuring that proper inspection mechanisms are in place. All activities taking place in the construction process can be clearly described and each activity can be independently inspected for accuracy. Although the inspection of accuracy forms part of the overall quality-assurance techniques, there is little emphasis on this (Zietsman, 2008: 113).

Defects result in customer dissatisfaction and could result in rework, which contributes to the cost of construction and thus reduces profitability. Quality management, which includes quality assurance, quality control, and quality improvement, can mitigate and prevent the occurrence of defects (Rhodes & Smallwood, 2002: 1).

Construction defects usually include any deficiency in the performing of the design, planning, supervision, inspection, construction, or observation of construction of any new home or building. The building is deficient if there is a failure during construction – in other words, if the building does not perform in a manner that was intended by the buyer (FindLaw, 2011: online).

The results of the 2011 Construction Industry Indicators (CIIs) (that measure the performance of the South African construction industry) show that approximately 86% of the projects surveyed in 2011 were apparently defect free or had few defects at practical completion/handover; 12% of the projects had some defects, and 2% had major defects or were totally defective (CIDB, 2011a: 6). The study also indicates that clients were satisfied with the resolution of defective work during the construction period on 82% of the projects, and were neutral or dissatisfied on 18% of the projects surveyed. Satisfaction with the resolution of defects as well as the reduction of defects observed was significantly better than observed in the previous years (CIDB, 2011a: 6).

2.4 Types of defects

Manning (2005: online) mentions that all types of defects can typically be grouped into the following four major categories: design deficiencies, material deficiencies, construction deficiencies and subsurface deficiencies. Findlaw (2011: online) describes the major categories as follows:

- **Design deficiencies:** Buildings and systems (designed by professionals such as engineers) do not always work as specified; this can result in a defect. Typical design deficiencies relate to building outside the specified code. A typical design defect is roofs that result in water penetration, poor drainage or inadequate structural support.
- **Material deficiencies:** The use of inferior building materials can cause significant problems such as windows that leak or fail to perform even when properly installed.
- **Construction deficiencies:** Poor quality workmanship can result in long lists of defects, e.g. plumbing leaks.
- **Subsurface deficiencies:** Many houses are built on hills or other areas where it is difficult to provide a stable foundation. A lack of a solid foundation may result in cracked foundations or floor slabs as well as other damage to the building. Subsurface conditions that are not properly compacted or prepared

may cause problems – these include improper settling to the ground or the shifting of a structure (e.g. a house).

2.5 Causes of defects

Stephenson, Morrey, Vacher & Ahmed (2002: 398) state that the causes of defects fall into the following basic categories:

- Natural phenomena such as storms, resulting in damage from floods, exceptionally high winds, lightning, earthquakes;
- Design errors;
- Workmanship errors;
- Faulty materials;
- Procedural errors;
- Failure to maintain properly, and
- Abuse or misuse of the building.

They also mention that, although defects caused by 'natural phenomena such as storms, resulting in damage from floods, exceptionally high winds, lightning, earthquakes', 'failure to maintain properly' and 'abuse or misuse of the building' are not the direct responsibility of the designer or builder. It is important to recognise and be aware of these types of problems, as they also provide causes of possible defects.

According to Rhodes & Smallwood (2002: 13), the causes of defects can be related to design, construction, procurement and prevailing environmental conditions. They also describe the origin of defects as being inadequate management and technical skills.

Weldon (1998: 199) states that building defects or failures may arise due to a variety of factors, including poor design, failure of the material, poor construction, and lack of maintenance.

3. Research methodology

This article presents part of the findings of a research project on defects in buildings, using a descriptive quantitative research approach. It first involved an in-depth study of the current theory of defects and quality management systems by means of a literature review. The review of the existing theory focused on categories of defects, causes of defects, consequences of defects, quality assurance and defect costs.

The second part of the research entailed a web-based survey to secure primary data from built environment stakeholders (architects,

consulting engineers and building contractors). A quantitative method of research was implemented to analyse ordinal scales by means of nonparametric statistical tests, using the mean scores, as advocated by Jamieson (2004: 1217). For the purpose of distributing the questionnaire, electronic mail (e-mail) was used and SurveyMonkey was used for collecting the results. The results of the questionnaire were stored within the SurveyMonkey platform and later downloaded for analysis.

The questionnaire was designed to determine built-environment stakeholders' views on two aspects:

- The causes of defects in buildings.
- The type of defects mostly occurring in buildings.

Questionnaires were completed anonymously to ensure a true reflection of the respondents' views and to meet the ethical criterion of confidentiality. It was assumed that the respondents were sincere in their responses as they were assured of their anonymity. A 5-point rating scale, also known as a Likert-type scale (Leedy & Ormrod, 2005), was used to elicit participants' opinions on various statements.

The population consisted of 400 randomly selected professionals, from whom 102 questionnaires were completed on-line, representing a 25.5% response rate. The response group included contractors (50%), architects (29%), engineers (17%) and 'other' (4%) (developers and municipal officials) from the Western Cape (52%) and Eastern Cape (48%) provinces. The majority (64%) of the respondents were between 36 and 55 years old and 48% had more than 20 years' experience in the construction industry. The majority of the respondents (60%) are directors within their firms. This respondent profile indicates that respondents have the necessary experience and knowledge to provide reliable information.

4. Results and discussion

For the purpose of analysis and interpretation, the following terminology was used regarding mean scores: 'strongly disagree' or 'very seldom' (≥ 1.0 & ≤ 1.8); 'disagree' or 'seldom' (> 1.8 & ≤ 2.6); 'neutral' or 'average' (> 2.6 & ≤ 3.4); 'agree' or 'often' (> 3.4 & ≤ 4.2) and 'strongly agree' or 'very often' (> 4.2 & ≤ 5.0).

4.1 Causes of defects

Respondents were requested to state to what extent they agreed that the listed items are causes of defects in houses, where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree.

Table 1: Causes of defects

<i>Causes of defects</i>	<i>Mean</i>	<i>Rank</i>
Inadequate artisan skills*	4.25	1
Unqualified contractors*	4.20	2
Lack of quality management during construction*	4.19	3
Lack of inspection during construction*	4.02	4=
Lack of management of construction process*	4.02	4=
Inadequate labourer skills*	3.98	6
Contractor errors*	3.86	7
Non-compliance with specifications**	3.81	8
Inappropriate specifications**	3.55	9
Unqualified designers**	3.52	10
Lack of communication between designer and contractors***	3.45	11
Lack of motivation of contractor (resulting in forgetfulness or carelessness)*	3.41	12=
Defective materials used*	3.41	12=
Lack of quality management during design**	3.41	12=
Design errors**	3.37	15
Conflicting details on drawings**	3.17	16
Lack of motivation of designer (resulting in forgetfulness or carelessness)**	3.12	17
* Contractor related ** Consultant related *** Both		

Table 1 shows that respondents rated 'inadequate artisan skills' as the biggest cause that leads to defects in houses; this was indicated by the mean value of 4.25 signifying 'strongly agree' on the Likert scale. 'Unqualified contractors' was ranked as the second biggest cause of defects; this reflected a mean value of 4.20, signifying 'agree', while 'lack of quality management during construction'

was ranked as the third highest cause of defects; this had a mean value of 4.19 (also signifying 'agree'). Rhodes & Smallwood (2002: 11) conducted a study in South Africa in which they rated the 'lack of quality management' as the biggest cause leading to defects on construction projects. Zietsman (2008: 113), however, rates the 'lack of inspection during construction' as the biggest cause. Ali & Wen (2011: 68) rank 'lack of experience and competency of labourers' highest in the Malaysian construction industry. Zunguzane, Smallwood & Emuze (2012: 36) rank 'poor workmanship' highest as the main cause of defects in low-income housing.

'Lack of motivation of designer (resulting in forgetfulness or carelessness)' was ranked as the lowest cause of defects in buildings; this being indicated by a mean value of 3.12 ('Neutral'), while 'conflicting details on drawings' was ranked as the second lowest cause (Mean value 3.17 ('Neutral')) and 'design errors' as the third lowest cause of defects (Mean value 3.37 ('Neutral')).

It is noted that the first seven ranked causes identified were construction related. This should serve as a warning to industry professionals with regard to the causes of defects. Utilising competent people within all construction-related areas is vital to ensure sustainable quality and reduction of defective works. The literature also states that construction-related causes are significant with regard to defective works.

4.2 Types of defects

Respondents were requested to state the frequency of their involvement in the following types of defects in housing projects, where 1=very seldom, 2=seldom, 3=average, 4=often and 5=very often.

Table 2: Types of defects

<i>Types of defects</i>	<i>Mean</i>	<i>Rank</i>
Cracks (e.g. in floors walls and beams)*	4.00	1
Dampness	3.86	2
Roof problems**	3.64	3
Water leaks (plumbing)*	3.49	4
Detachment (e.g. plaster from walls paint peeling)*	3.35	4
Structure instability (e.g. foundation problems)**	3.18	6
Insulation problems**	2.99	7

<i>Types of defects</i>	<i>Mean</i>	<i>Rank</i>
Electrical problems	2.86	8=
Blemishes (e.g. scaling honeycomb)**	2.86	8=
Corrosion (steel)**	2.68	10
* See Table 3		
** See Table 3		

Table 2 shows that respondents ranked 'Cracks (e.g. floors, walls and beams)', indicated by the mean value of 4.00, as the most frequent type of defect in houses. Further analysis indicated that 31% of the respondents stated that cracks occur 'very often' in houses, while 47% indicated 'often'; thus, 78% of the respondents either indicated 'often' or 'very often' that cracks were the most common defect on housing projects.

Dampness (with a mean of 3.86) is ranked as the second most common type of defect in houses, indicating 'agree' on the Likert scale. The lowest ranked type of defect on housing projects is 'Corrosion', with a mean of 2.68, indicating 'average' on the Likert scale.

Cracking is normally a structural deficiency, but the nature and causes thereof might be for different reasons, e.g. material deficiencies, subsurface deficiencies or conditions. Cracks and other defects can also be the result of poor workmanship (incompetent or shortage of skilled artisans) and possibly a consequence of non-compliance with building regulations during the construction of houses. It is for this reason that the quality of site supervision is very important to ensure that defects are limited; the implementation of a quality management system will assist this process.

The results correspond with the results discussed in the literature.

The various causes of defects (Table 1) were grouped into two categories, i.e. contractor related* and consultant related**. The various types of defects (Table 2) could not be grouped together easily and an exploratory factor analysis (EFA) was conducted whereby a 2-factor solution was found to be most suitable. The EFA excluded 'Dampness' and 'Electrical problems'. Cronbach's alpha coefficient of reliability (Nunnally, 1979: 85) was determined for each of the scale scores derived from the grouped items, as indicated in Tables 1 and 2. The results are shown in Table 3.

Table 3: Cronbach's alphas for scale scores

Scale scores	Number of items	Cronbach's alpha
Causes of defects*: Contractor related	9	0.80
Causes of defects**: Consultant related	7	0.79
Types of defects+: Cracks detachment water leaks	3	0.72
Types of defects++: Corrosion blemishes insulation problems structure instability roof problems	5	0.83

Cronbach's alpha interpretation levels as evidence of reliability (internal consistency) are described as 'Good' (0.70-0.79) and 'Excellent' (0.80-0.99) (Nunally, 1978: 85). The values shown in Table 3 thus indicate either good or excellent levels of internal consistency for the scale scores. Descriptive statistics for the scale scores are presented in Table 4.

Table 4: Frequency distributions

	Mean	Rank
Causes of defects*: Contractor related	3.92	1
Causes of defects**: Consultant related	3.43	2
Types of defects+: Cracks detachment water leaks	3.86	1
Types of defects++: Corrosion blemishes insulation problems structure instability roof problems	3.33	2

Inferential statistics confirmed that contractor-related causes of defects were more prevalent than consultant-related causes ($t = 5.56$, $d.f. = 80$, $p = <.0005$; Cohen's $d = 0.62$, medium practical significance) and that defects such as cracks, detachment and water leaks were more prevalent than defects such as corrosion, blemishes, insulation problems, structure instability and roof problems ($t = 5.58$, $d.f. = 81$, $p = <.0005$; Cohen's $d = 0.62$, medium practical significance).

5. Conclusion

The results of the survey among professionals (architects, contractors and engineers) showed that the biggest contributing factor towards defects is inadequate artisan skills. The study also identified cracking as the most frequently occurring defect. This relates to being a structural deficiency, although the nature and causes of cracking

might be for different reasons. The study also revealed that projects fail in project-management terms, due to defects prolonging the construction time of projects.

The literature indicated that cracking is a frequently occurring manifestation of defects, and dampness-related manifestations predominate. This is confirmed, to a degree, by the empirical results from this research. Dampness was rated as the second most frequently occurring type of defect in houses. Respondents also rated dampness as the biggest problem about which residents complained, and that contractors spent the most time rectifying dampness-related defects in houses.

Defects result from non-conformance to requirements and invariably result in rework. The overall causes of defects can be attributed to design, construction, material and subsurface conditions. Ultimately, the origin of defects lies in inadequate management or inadequate technical skills. The descriptive survey reflects a degree of denial with respect to the liability of designers for defects, but it clearly indicates that construction-related causes dominate.

Quality assurance can reduce or eliminate defects by implementing a quality-management system. This, however, requires that designers, contractors and clients have the requisite skills. Procurement-related interventions may mitigate the occurrence of defects.

In summary, within the South African construction industry, factors relating to defects can potentially be avoided if qualified professionals are appointed to exercise due diligence and if professional teams are given the opportunity to guide contractors during the contract. The cost of appointing reputable professionals in their advisory capacity has to be weighed against the cost of both social and economic constraints. The appointment of qualified construction-industry professionals to implement and maintain quality-management systems will alleviate the current problems in respect of housing delivery within the country.

The serious shortage of competent people at both local and national government level to evaluate and administer construction projects and identify contractual irregularities on all sides ultimately contributes to defective construction. Contracting and subcontracted bodies must take the responsibility to identify and report questionable BEE practices so that institutions such as the CIDB can remove them from their databases as reputable practices; this alone will reduce and ensure more sustainable housing delivery.

Although not discussed in this article, corruption within the South African construction industry may also contribute to irregularities with regard to procurement. The full extent of how it contributes to defects is, however, not yet clearly documented. The authors are of the opinion that, in some circumstances, irregularities during procurement can directly be related to the appointment of incompetent contractors. However, respondents did not rate procurement-related factors as a major contributor to defective construction. This, however, might change in future, due to the large number of corrupt activities currently being exposed within the construction industry. Bowen, Edwards & Cattell (2012: 885) state that corruption is a pervasive stain on the construction industry in many countries, and South Africa is no exception. They also state that factors instrumental in corruption include the skills shortage within the industry, a perceived absence of deterrents and sanctions, and poor ethical standards.

Although the research results are limited to the views of respondents in the Western and Eastern Cape provinces only, there is no reason to believe that this is not the same for the other provinces in South Africa.

6. Recommendations

First, with regard to the causes of defects, it is recommended that professionals, especially contractors, concentrate on improving or implementing an effective quality-management system. They should also consider the factors relating to defects more deeply, so that preventative action can be taken at the outset of a project, as well as in the long term. Defects must be viewed as a risk, due to the likely financial implications.

Secondly, the professional teams must ensure that they become more knowledgeable with regard to the effects of defects. Defects do increase the project parameters of time and cost and affect other elements such as quality.

Thirdly, although contractors are aware of the shortage of skills within the construction industry, more should be done to encourage education and training. Contractors should take the initiative to encourage their employees to obtain further education or training. This must be regarded as growth within the organisation and not as an expense or a burden.

Fourthly, professionals must ensure that they concentrate on identifying and exposing corrupt activities within the construction industry. Corrupt activities within the industry portray a negative

image of South Africa to the rest of the world and decrease our investment potential. This has a negative effect on all construction professionals. The MBA and CIDB also have a role to play in countering corruption by informing members about the consequences of corruption as well as identifying and reporting corrupt practices to the authorities.

Lastly, pertaining to defective construction, professionals must ensure that they reduce or eliminate defective work within the industry. Competent people must be appointed to ensure that the technical requirements are being met. Professionals must be familiar with the relevant requirements of building standards and codes; if they are not, they must be educated or trained. Experienced construction-industry professionals must be utilised to educate the youth to ensure that lessons learnt in the past can be applied in future.

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