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A Trade-based Risk Management Approach towards the Elimination of Defects in Residential Construction

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Abstract: The construction industry seems to have settled down to a level of inefficiency saddled with a culture of handing over buildings with defects with mechanisms for dealing with patent, latent, serial and other defects. While it is important to understand direct and root causes of defects, the key to success lies in implementing strategic solutions in an environment where subcontracting is rampant: Accordingly, this study takes a trade-based risk management approach to identify problematic trades by undertaking a risk assessment. While Queensland Building Construction Commission's top ten defects provide an indication of what such trades may be, this study argues that it fails to provide a comprehensive overview of the defects regime related to single and two-storey houses, therefore, this study focusses on all 34 trades that requires a license to practice. Trades that are *high risk*, *moderately high risk*, and *moderately risky* have been identified through an on-line questionnaire survey sent to approximately 500 respondents which seek information on the *likelihood* and the *impact* of defects for each licensed trade including reasons for high risks. The scores received are translated to risk levels and multiplied together to arrive an overall risk score which is classified into *high*, *moderate*, and *low risk* using a risk classification matrix. Accordingly, 14 problematic trades have been identified with Waterproofing being the riskiest trade followed by Swimming Pool Construction and Concreting. The study emphasises the value of this approach to practitioners and regulators to develop strategies for ensuring buildings are defect free.

Keywords: Defects, risk, trade, root causes, management and regulatory strategies

1. Background

Despite laws and regulations, standards and codes of practice, licensing, and management approaches such as quality management, residential buildings are handed over with defects. Under the Domestic Building Contracts Acts 2000 of Australia, a 'defects document' needs to be provided to the client at completion providing details on (a) the agreed list of defects (b) time frame for completion, and (c) defects only the homeowner believes to exist (i.e. differentiating those that the contractor disputes). By permitting buildings to be handed over with defects, it seems that industry has accepted a level of inefficiency rather than working towards a zero defects culture. Moreover, in a highly subcontracted environment with mandatory licensing, one would expect specialisation would reduce defects but it is yet to reap benefits. Clearly, all is not well which highlights the need for better statutory and management strategies to overcome this perennial problem in Queensland. The statutory body regulating building work in Queensland is QBCC (Queensland Building and Construction Commission) whose mission is to improve standards, equity and confidence in the building industry has a major role to play.

2. Defects and defective work

The literal meaning of the word 'defect' is easy to comprehend. However, its extension to construction may not be so. According to Georgiou, Love, and Smith (1999) there are many definitions which clouds understanding. However, to develop management strategies to overcome defects, it would be necessary and useful to review briefly judicial, contractual, and regulatory aspects including defect causation. The judicial interpretation of the term defective 'simply denotes that the subject matter whether it be *workmanship, design or material*, is ineffective for the purposes for which it was intended' (Loots & Charrett, 2009, p. 183). However, this explanation (drawn mainly from an insurance context) is open for interpretation without a clearer definition of what constitute a defect. It would, therefore, be useful to examine contractual interpretations: It was found that the word 'defect' or 'defective' is used in a general sense and is not a defined term usually. This realisation is somewhat baffling given the importance of defects and the Defects Liability Period. Accordingly, it would be useful to examine the implications of regulatory framework for residential work in Queensland as these would override any provisions within construction contracts (incidentally, residential contracts are different to commercial contracts).

While the defects-regime vis-à-vis types of defects, their impact and frequency, associated costs, etc. are bound to vary from country to country and from region to region depending on the residential-construction culture (Abeysekera, 2002), there is a lack of information on the defects-regime in Queensland. The top ten defects spelled out in QBCC's annual report (Queensland Building and Construction Commission, 2014, 2015) is connected with its home warranty insurance scheme (HWIS) and provides only a limited understanding. This report may assist in defects to be classified as major or minor as noted by Georgiou et al (1999) but QBCC's defects are based on claims-volume (under the home warranty scheme), so the status-quo prevails with a lack of information on the defects-regime. Moreover, QBCC's HWIS relates only to structural defects affecting the structural adequacy of a building (Category 1) such as a leaking roof or shower, settlement of a foundation and the like with other defects labeled as non-structural defects (Category 2). Additionally, there is a lack of understanding of patent defects (those that occur during construction), and to what extent latent defects (i.e. defects that occur during its lifetime) are not reported and/or unclaimed under the QBCC's HIWIS. So is the case with serial defects 'where a set percentage or more of the same part of the works is affected or likely to be affected by the same or a substantially similar defect or defects' (McNair, 2016, p. 268; Patterson, 2013),

QBCC's definition on defects is far reaching; it defines a defect vis-à-vis *defective building work*, i.e. any work 'that is faulty or unsatisfactory' which includes work that 'does not comply with the Building Act 1975, Building Code of Australia or an applicable Australian Standard'. Additionally, work is deemed defective if a manufactured product 'has been used, constructed or installed in a way that does not comply with the product manufacturer's instructions' (Queensland Building and Construction Board, 2017). This explanation is in line with the judicial definition given by Loots and Charrett (2009) referred to earlier with defects arising from unsatisfactory or faulty workmanship, design or materials while providing objective standards for assessing defects and defective performance.

3. Defect causation and defective performance

Defective performance arising out of workmanship issues brings to focus trade work and work carried out by tradesmen. It was noted earlier that a significant portion of work is carried out by subcontractors and they need to be licensed to undertake work in Queensland. It is difficult to fathom that licensed contractors particularly subcontractors produce defective work given that subcontracting promotes specialisation. However, it is clear that defects are pervasive due to one reason or the other. Nevertheless, this is unacceptable, and industry needs to work towards a zero-defects culture. Accordingly, the attempt of this study is to eventually develop management and other strategies that would assist in achieving this broad goal. Accordingly, it would be necessary to develop an understanding of defect causation particularly due to workmanship issues as noted in the introductory paragraph in Section 2.

According to Aljassmi and Han (2014), 'cause is a reason for the existence of undesired results' which in this case are 'defects'. They distinguish between root causes and direct causes with the former providing fundamental reasons for defective work; lack of knowledge and skills seems to be a good example of a root cause. Observations of project systems and people's behaviour provide further insights into the actual mechanics of defect causation (Aljassmi & Han, 2014).

On the other hand, direct causes are driven by contextual conditions such as arising out of the drive for shorter completion periods and rapid work (resulting in defects), commencing work with incomplete design documentations, and making-do with whatever resources that is available. According to Reason (1990), direct causes of defects can be categorised into two broad types, viz. *errors* and *violations*. When an outcome is worse than expected, but not solely due to chance or circumstances and involves some element of surprise, then the act is considered as an *error* (Aljassmi & Han, 2014). Errors occur unintentionally but are caused by psychological or cognitive limitations (Love, Edwards, Irani, & Walker, 2009). Love et al. (2009) summarise the reasons for errors as follows:

- Mistakes: Occur due to ignorance of correct task or method; it is either rule-based or knowledge-based
- Slips and lapses of attention: Occurs due to forgetfulness, habit or similar psychological issue; normally occurs at the level of execution and when tasks are routine.

On the other hand, *violations* occur when deliberately not following clear instructions to complete work. Such violations could be the result of low motivation, moral, or lack of supervision (Love et al., 2009); an intentional act that is difficult to eradicate, unlike errors which could be dealt by removing root causes.

Aljassmi and Han (2014) provides further insights vis-à-vis the following nine defective-act-clusters:

- Poor workmanship: A skill-based error. This is considered to be one of the predominant causes of defects (Love & Josephson, 2004) (Aljassmi & Han, 2014).
- Impaired material use: Use of unsuitable, damaged or unfitting materials. It could be a knowledge-based error or rule-based error.
- Task sequence omission: Failing to carry out the required steps during the execution. This may result in excessive rework costs; occurs due to a violation or knowledge-based error.
- Deviations from intended dimensions: Defects that occur due to inadequate measurements. This is again skill-based error triggered by tradesman's inaccuracy or on a rare occasion violation may be the cause.
- Instruction contravention: Errors occur when instructions given in drawings, specifications, and guidelines are not followed. Could be a violation too.
- Professional principles/conventions noncompliance: Any tasks performed by the professionals, non-confirming with established practices are conventions non-compliance. Lack of technical knowledge, under qualification, inexperience is the major causes of such errors.
- Official rule noncompliance: Non-complying to the statutory requirements. It could be due to an unintentional error (rule-based error), or sometimes contractor or subcontractors may intentionally violate for their interest.
- Items interdependence disregard: Lack of coordination between interdependent tasks or units involved. For example, if scaffolding is removed before concrete has reached sufficient strength a defect could arise.
- Adoption of misguiding instruction: This could arise, for example, by blindly following design and drafting errors.

The above understanding provides an opportunity to develop strategies for defects management both in relation to root causes and direct causes. For example, it was reported earlier that workmanship issues are one of the predominant causes of defects. Investigations reveal that at present neither craftsmen nor the subcontractors are graded in Queensland. Accordingly, this may be an option to pursue (see Abeysekera & Thorpe, 2002) combined with mandatory training for craftsmen, and for subcontractors as well as part of the licensing regime license. Summarised below are some of the strategies that may be considered and arguably, these could be linked with the causes noted earlier:

- Tightening licensing regimes for high-risk trades

- Stage payments only after relevant certificate from building certifier
- Monetary retentions from last stage payment to cover defects liability period
- Use of an independent person (such as a project manager) for regular inspections
- Limit 'span of control' by restricting the number of projects supervised by foremen
- Mandatory training for subcontractors and tradesman
- Performance grading of subcontractors
- Trade testing craftsmen

4. Risky trades and risk management

The first strategy referred to above brings to focus the notion that some trades may be riskier than others due to a higher frequency of occurrence of defects and/or their impact on performance. The top ten defects reported by QBCC highlights related trades. However, to manage defects, it is not sufficient to examine related trades only given that the QBCCs top-ten does not provide a full picture of defects or provide information on the prevailing defects-regime in Queensland as explained in Section 2. Additionally, an examination of the top defects from 2011-2015 showed that the top ten defects changed from year to year (Queensland Building and Construction Commission, 2014, 2015) sometimes with repeating trades as shown in Table 1 hinting what the problematic trades could be (though not sufficient; see Section 7: Results). A study by Smith, Smith, and Mitchell (2013) in Southeast Queensland found that there were minimum defects connected with front-end trades than middle and back end trades but failed to indicate the criticality of these defects or the trades connected with frequent defects. Furthermore, studies carried in other countries have indicated different types of trades pertaining to their residential-construction-culture (Forcada, Macarulla, Gangolells, & Casals, 2014; Forcada, Macarulla, & Love, 2012). Accordingly, considering the reasons given herein and earlier, there is a need to consider all trades as defects pervade all trades; it is not sufficient to examine only those trades or defects that fall within QBCC's top ten defects; they do not provide a full picture of the defective regime as well.

Table 1: QBCC's top ten defects and frequency of occurrence during the five year period (2011-15)

	Type of defect	No. of times during the last five years
1	Waterproofing	5
2	Roof and wall claddings	5
3	Plumbing and drainage	4
4	Wall and floor tiling	4
5	Carpentry	4
6	Painting and decorating	3
7	Plastering drywall	3
8	Joinery	3
9	Plastering solid	2
10	Glass, glazing and aluminium	2
11	Foundation Work (Piling and Anchors)	1
12	Sheds, carports, and garages	1

The notion that different trades have different levels of risk was first exposed by Abeysekera and Soysa (2012) studying the link between monetary retentions rates for subcontract work in New Zealand. They found that although retention rates did not show an association with overall risk computed as a product of likelihood and consequence (based on contractor's perceptions), it was shown that trades that had a high default risk for either likelihood or consequence, retention rates were high. Additionally, it was found that trades with a high default risk resulted in seemingly subcontractor-harsh retention regimes suggesting the need to investigate such trades further to evaluate whether there were overwhelming reasons for such exceptions. The study concluded that performance default risk and retention regimes were linked to this extent although for a given level of risk, subcontractor friendly or unfriendly regimes could be achieved by a mix of retention rates and release mechanisms. In this regard, it was seen that contractors in New Zealand seem to prefer high retention rates than longer defects liability periods for trades which have high-risk levels. Although retentions are linked with defects, irrespective of whether there is a need for retentions or not (see Abeysekera, 2015), the notion that some trades are riskier than others were established through this study. Accordingly, this became a source of inspiration, and a basis for this study, i.e. to assess whether certain trades were riskier (more problematic) due to defects.

QBCC's recent legislative reforms shifting accountability for defective work from the main contractor to the subcontractor also further justifies the focus on troublesome trades in an environment where subcontracting is rampant. The reformed policy is to ensure that subcontractors are held accountable for defective work performed by them. With this policy change, QBCC can direct the subcontractors to rectify the defective work if the main contractor is unwilling to rectify defective work of the subcontractor. However, the main contractor cannot escape from their responsibility of supervision, and if held accountable for not properly supervising the work of subcontractors, the contractor will be subject to disciplinary action (Duffy, 2015). Accordingly, the benefits of the trade-based approach to defects are useful for both contractors and clients with regards to knowing what the troublesome trades are and developing strategies for managing such trades and associated defective work.

It must, however, be pointed out that the trade-based approach does not specifically address problematic defects; instead it attempts to identify problematic trades that results in defects to identify statutory or managerial solutions. This approach does not signal that there is no need to investigate specific defects that are frequently seen or has high impact; indeed, there is. It is a useful approach towards creating zero defects. However, the risk-based approach focusing on all trades seems more useful and necessary as subcontractors in the building industry secure work based on their specialisation also given that the current licensing regime for subcontractors is trade-based. Accordingly, this approach would make it possible to develop implementable managerial and statutory solutions for managing defective work as against managing work that is sub-standard, for example on starting and completing on time.

Risk management involves four steps, namely, risk *identification*, *assessment*, *response*, and *monitoring*. The purpose of *risk identification* is to eliminate them or to have control over them. If risks are identified before any consequence, risk management is more effective improving profitability, competitive advantage, etc. For example, if high-risk trades are identified early in the project, it minimises operational risks (defects and delays), financial risks (cost of rework), reputation risks (not-so-good subcontractor), insurance risks (higher premiums), and legal risks (Beyer, 2012). On the other hand, *risk assessment*, assists in identifying the extent of the risk to prioritise the risk. According to Gajewska and Ropel (2011), two methods can be used for *risk assessment*, i.e. qualitative and quantitative methods. The former is much simpler than the latter and is more suited when there is a lack of exact numerical data and when there is a lack of resources. The method involves assessing the magnitude of potential consequences (impact) and the frequency (probability) of these consequences with risk being assessed as the product of consequence and frequency; higher the probability of worse impact, greater is the risk (PERSEUS, 2012).

5. Aims, objectives, and methodology

Based on the hitherto discussions, it should be clear that the main aim of this research is to identify moderate to high risk (problematic) trades focussing on single and two-storey house construction so as to develop strategies for managing such trades. Accordingly, the research was divided into two stages with this paper focusing on Stage 1:

> Stage 1 - Risk identification and assessment: The first stage was conducted to identify moderate to high-risk trades with respect to defects (defective work)
>
> Stage 2 – Risk response: Second Stage survey was to identify strategies for managing troublesome trades (moderate to high-risk trades) identified by the first stage survey. (Note: This

paper does not cover this part).

One of the first challenges was to identify a suitable list of trades for which purpose the following four classifications were considered:

- Trades as listed in the Australian Standard Method of Measurement of Building Works
- Trades listed in the New Zealand Standard Method of Measurement of Building Works
- Australian and New Zealand Standard Industrial Classification (ANZSIC) (1993)
- QBCC's trade contractor categories (as listed under the Trade Contractor licenses)

While there were similarities between all four classifications, it was argued that the use QBCC's list of trades was more appropriate as the scope of each category was well defined and is linked with the licensing regime (see, Queensland Building and Construction Commission, 2017). Accordingly, it was decided to use the Delphi method to seek responses from expert industry personnel on these trades. However, given the shortage of time and the difficulty of enlisting highly motivated and expert respondents in a short time (see Beretta, 1996for a review of the Delphi Method), it was decided to use a structured questionnaire. The sample of respondents were builders, architects, and building surveyors.

The first stage of the survey covers 34 trades listed by the QBCC. Survey questions for each trade are the same with three questions: The first question requests participants to indicate the likelihood of having defects for the particular trade. The second question requests participants to indicate the impact of having defects for that particular trade. Both of these questions require an answer on the scale of '1 to 5' where '1' being very low and '5' being very high. The third question requires the respondent to provide reasoning if the likelihood or impact has been rated 4 or above in the short answer format. The questionnaire was developed through Google Form and the link to the questionnaire was sent to participants electronically.

6. Data and data analysis

The questionnaire was sent mainly to builders (300), architects (125) and building certifiers (55) by email either to their organisation or their personal email addresses with email information obtained through the Queensland Yellow Pages business directory. Approximately 500 emails were sent but only 24 responses were received as follows: Site supervisor-6; Foreman-2; Building certifier-1; Managing Director- 2 (Builder); Architect- 4; Project Manager- 4; Quantity Surveyor-1; Customisation officer-1; Consultant-2; Contract Administrator-1. The level of experience of respondents varied from 2 years to 41 years in the residential construction industry with 22 respondents having five years or more.

Table 2: Conversion of likelihood scale to risk scale

Likelihood				
Very high (5)	High (4)	Moderate (3)	Low (2)	Very low (1)
0.9	0.7	0.5	0.3	0.1

Table 3: Conversion of impact scale to risk scale

Impact				
Very high (5)	High (4)	Moderate (3)	Low (2)	Very low (1)
0.8	0.40	0.20	0.10	0.05

As noted before, the main goal was to identify troublesome trades by conducting a qualitative risk analysis. The participants were asked to weigh the *likelihood* and the *impact* of defects for the particular trade using a '1 to 5' scale with '1' being very low and '5' being very high. All the responses were aggregated, and a weighted average score for *likelihood* and *impact* was calculated. These individual scores were then converted to individual risk scores using the information given in Tables 2 and 3. To arrive at the overall risk, the risk matrix given in Project Management Institute's Body of Knowledge was used (see Table 4). The cells with white coloured numbers indicate *high-risk*. Cells with italicised numbers indicate *moderate-risk*, and unshaded cells with black numbers indicate *low-risk*. It would be useful to establish a new category labeled as *moderately-high-risk* with risk scores in cells bordering white letters in Table 4, i.e. from 0.08 to 0.14. This matrix would then include situations where either *impact* or *likelihood* is individually high or situations that are on the borderline of being high-risk.

Table 0: Risk classification matrix

Risk Score for a Specific Risk					
Likelihood	Risk Score = Likelihood x Impact				
0.9	*0.045*	*0.09*	0.18	0.36	0.72
0.7	0.035	*0.07*	*0.14*	0.28	0.56
0.5	0.025	*0.05*	*0.10*	0.20	0.40
0.3	0.015	0.03	*0.06*	*0.12*	0.24
0.1	0.005	0.01	0.02	0.04	*0.08*
	0.05	***0.10***	***0.20***	***0.40***	***0.80***
	Impact				

Source: Project Management Institute (2000)

7. Results

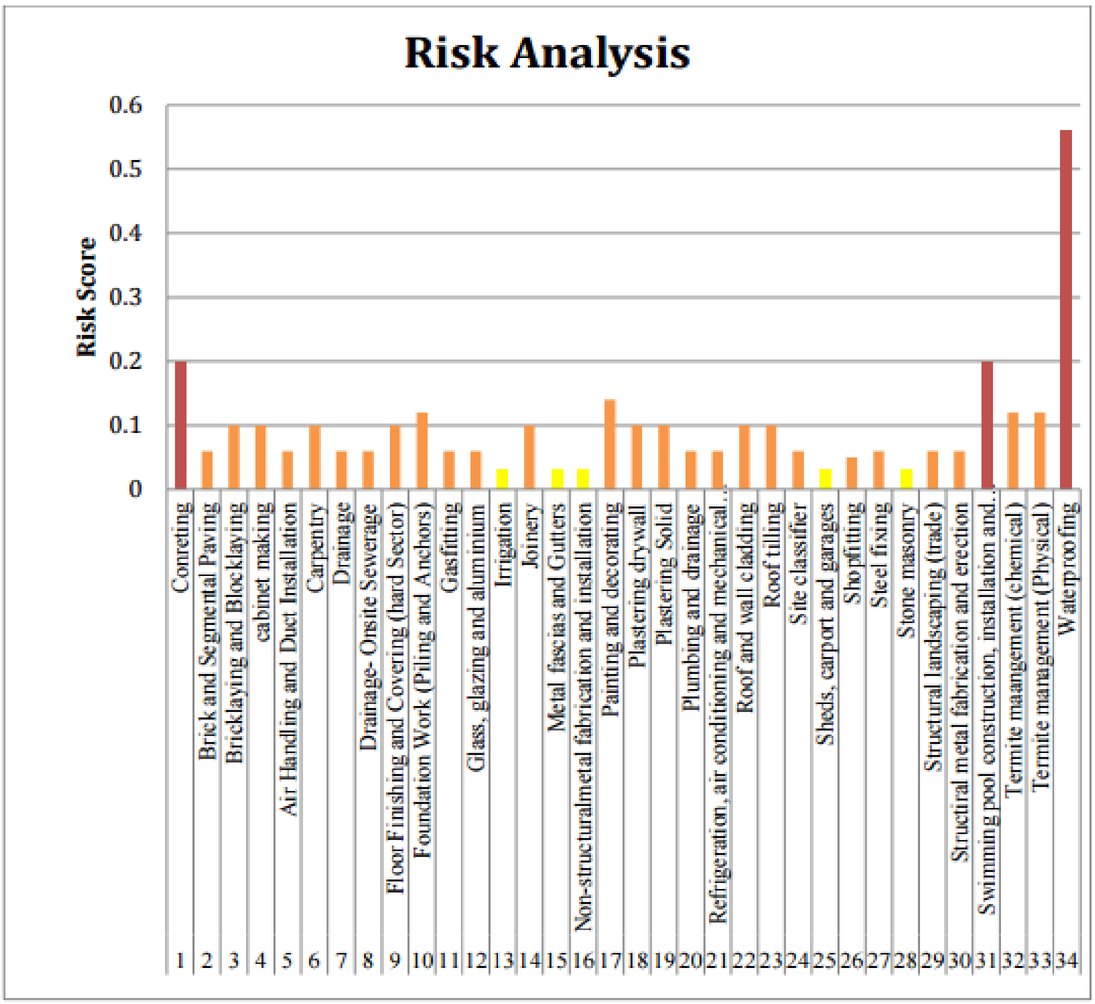

Figure 1: Risk analysis of 34 trades listed by QBCC

The overall defects-risk identified by the first stage survey is presented in Figure 1. It is clear that Waterproofing is far the riskiest (0.56; likelihood 0.7 and impact 0.8) with Swimming Pool Construction (0.2) and Concreting (0.2) coming next with similar levels of likelihood and impact (0.5 and 0.4 respectively). These are the **'high risk trades'** in relation to defects.

As mentioned before, trades with risk scores between 0.14 and 0.12 were labelled as **'moderately high risk'**. *Painting and Decorating (0.14), Termite Management, and Foundation Work (Piling and Anchors)* are trades that fall within this range. Interestingly, Painting and Decorating had a likelihood score of 0.7 similar to *Waterproofing* which was a high risk trade. Others with a **'moderate risk'** were (i.e. scores from 0.09 to 0.12) *Brick and Block Laying, Cabinet Making, Carpentry, Joinery, Floor Finishing and Covering, Plastering (drywall and solid), Roof and Wall Cladding, Roof Tiling* all with a score of 0.1 (with likelihood and impact scores of 0.5 and 0.2 respectively).

To summarise, the top 14 problematic trades were as follows with the first three trades being the most problematic: *1. Waterproofing 2. Swimming Pool Construction 3. Concreting 4. Painting and Decorating 5. Termite Management 6. Foundation Work 7. Brick and Block Laying 8. Cabinet Making 9. Carpentry 10. Joinery 11. Floor Finishing and Covering 12. Plastering (drywall and solid) 13. Roof and Wall Cladding 14. Roof Tiling.* When compared with the trades connected with QBCC's top 12 frequently reported defects (see Table 1), *Concreting, Termite Management, Brick and Block Laying, Cabinet* trades were unconnected. In contrast, there was one trade that frequently appeared on QBCC's top ten defects list (4 times in five years) which this study did not find, i.e. *Plumbing & Drainage.* The other two trades that did not appear were *Glass, Glazing and Aluminium* and *Sheds, Carports, and Garages*. As to why this was the case needs further investigation particularly with respect to Plumbing & Drainage.

To understand the reasons for high-risk scores, respondents who gave scores of 4 or more (out of 5) for either *likelihood* or *impact* were asked to explain the reasons as noted earlier. The responses received were on the lines of 'excessive rework costs, sub-standard workmanship, the difficulty of repair, impact on other trades, lack of attention to detail, lack of proper testing and acceptance regimes, and endless problems.'

8. Conclusions

The main aim of this study is to identify problematic trades due to defects in the construction of single to two-storey houses in Brisbane and surrounding areas in the State of Queensland. All in all, this study established 14 trades that were problematic out of the 34 listed by QBCC. This amount is a significant number as it accounts for 41% of all trades; in other words, over a third of the trades are seen as either *high-risk, moderately high-risk*, or moderately risky based on the risk classification matrix.

As things stand, *Waterproofing* is the riskiest. *Swimming Pool Construction* and *Concreting* were the other two trades that were considered as high risk. However, defects related to the *Concreting* trade did not appear in the QBCC's top ten defects. There were 11 other problematic trades suggesting the need to investigate **management, statutory, and other strategies** for avoiding defects. A seemingly potential strategy is to tighten QBCC's licensing regime for the problematic trades as QBCC's licensing procedure does not differentiate many trades. This and others strategies need further investigation under Stage 2 of this study as noted before including an investigation into the root causes, to change the profile of problematic trades.

The robustness of the procedure adopted for this study could be improved by using a hybrid Delphi approach as envisaged earlier to futher justify the validity and the reliability of these results. The sensitivity of the results needs to be examined vis-à-vis the appropriateness of the risk matrix as well. However, the risk-based methodology adopted herein paves the way for a new approach towards defects management that both industry (clients and contractors) including regulatory bodies could adopt. The results could then be used for developing suitable strategies to ensure that buildings are defects free.

References

Abeysekera, V. (2002). Understanding culture in an international construction context. In F. Fellows & D. Seymour (Eds.), *Perspectives on culture in construction*. Rotterdam, The Netherlands: International Council for Research and Innovation in Building and Construction (CIB), 39-51.

Abeysekera, V. (2015). *Wither Monetary Retentions for Subcontract Work? A Theoretical Framework for Rationalising the Use of Retentions*. Paper presented at the Eighth International Conference on Construction in the 21st Century (CITC-8), Changing the Field: Recent Developments for the Future of Engineering and Construction, Thessaloniki, Greece.

Abeysekera, V., & Soysa, M. (2012). *Monetary retentions for subcontract work*. Paper presented at the World Construction Conference 2012: Global Challenges in Construction Industry, Sri Lanka.

Abeysekera, V., & Thorpe, A. (2002). Responding to inadequacies of craft training vis-a-vis Sri Lankan brickwork. In S. O. Ogulana (Ed.), *Training for construction industry development*. Rotterdam, The Netherlands: International Council for Research and Innovation in Building and Construction (CIB) and Asian Institute of Technology, Thailand, 177-191.

Aljassmi, H. A., & Han, S. (2014). Classification and occurrence of defective acts in residential construction projects. *Journal of Civil Engineering and Management, 20*(2), 175-185.

Australian and New Zealand Standard Industrial Classification (ANZSIC). (1993). Construction Trade Services: Austrlian Bureau of Statics.

Beretta, R. (1996). A critical review of the Delphi technique. *Nurse Researcher, 3*(4).

Beyer, C. E. (2012). Construction Defects: A Primer For Construction Financial Managers. Retrieved from Insurance Thought Leadership website: http://insurancethoughtleadership.com/construction-defects-a-primer-for-construction-financial-managers/

Duffy, S. (2015). SHIFTING FOCUS: SUBCONTRACTORS' RESPONSIBILITY FOR DEFECTIVE WORK. Retrieved from http://www.mcw.com.au/page/Publications/Construction/shifting-focus-subcontractors%E2%80%99-responsibility-for-defective-work/

Forcada, N., Macarulla, M., Gangolells, M., & Casals, M. (2014). Assessment of construction defects in residential buildings in Spain. *Building Research & Information, 42*(5), 629-640.

Forcada, N., Macarulla, M., & Love, P. E. (2012). Assessment of residential defects at post-handover. *Journal of construction engineering and management*, *139*(4), 372-378.

Gajewska, E., & Ropel, M. (2011). *Risk Management Practices in a Construction Project – a case study.* (Master of Science), Chalmers University Of Technology, Göteborg, Sweden.

Georgiou, J., Love, P. E. D., & Smith, J. (1999). A comparison of defects in houses constructed by owners and registered builders in the Australian State of Victoria. *Structural Survey, 17*(3), 160-169. doi:10.1108/02630809910291343

Loots, P., & Charrett, D. (2009). *Practical Guide to Engineering and Construction Contracts*: CCH Australia Limited.

Love, P. E., Edwards, D. J., Irani, Z., & Walker, D. H. (2009). Project pathogens: The anatomy of omission errors in construction and resource engineering project. *Engineering Management, IEEE Transactions on, 56*(3), 425-435.

Love, P. E., & Josephson, P.-E. (2004). Role of error-recovery process in projects. *Journal of management in engineering, 20*(2), 70-79.

McNair, D. (2016). *Investing in Infrastructure, International Best Legal Practice in Project and Construction Agreements – 2016* Retrieved from https://www.pwc.com.au/legal/assets/investing-in-infrastructure/investing-in-infrastructure-v4.pdf

Patterson, L. (2013). Be aware of serial defects clauses. Retrieved from http://www.building.co.uk/be-aware-of-serial-defects-clauses/5061768.article

PERSEUS. (2012). Qualitative Risk Analysis (consequence X likelihood). *AMP Toolbox.* Retrieved from http://www.perseus-net.eu/site/content.php?artid=2204

Project Management Institute. (2000). *A Guide to the Project Management Body of Knowledge*. Pennsylvania, USA: Project Management Institute, Inc.

Queensland Building and Construction Board. (2017). *Rectification of Building Work Policy*. Retrieved from Queensland Building Construction Commission: http://www.qbcc.qld.gov.au/sites/default/files/Rectification%20Of%20Building%20Work%20Policy.pdf

Queensland Building and Construction Commission. (2014). *Annual Report 1 December 2013 to 30 June 2014*. Retrieved from https://www.qbcc.qld.gov.au/sites/default/files/QBCC_Annual_Report_-_1Dec13_-_30Jun14.pdf

Queensland Building and Construction Commission. (2015). *Annual Report 2015*. Retrieved from https://www.qbcc.qld.gov.au/sites/default/files/QBCC_Annual_Report_-_1_July_2014_to_30_June_2015.pdf

Queensland Building and Construction Commission. (2017). License Classes. Retrieved from http://www.qbcc.qld.gov.au/when-you-need-licence/licence-classes

Reason, J. (1990). *Human error*: Cambridge university press.

Smith, J., Smith, B., & Mitchell, G. (2013). Review and analysis of the residential building certification process in south east Queensland. *Structural Survey, 31*(1), 21-34. doi:10.1108/02630801311304396