



**University of Southern Queensland**  
**Faculty of Health, Engineering and Sciences**

**A Trade-based Approach for Defects Management in Residential  
Construction**

**A dissertation submitted by**

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ENG4111 and ENG4112 Research Project

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## ABSTRACT

This project aims to understand how to manage defects in single and two storey residential projects in Queensland taking a trade-based approach given that most work is subcontracted. Despite various construction acts, regulations, standards, codes, licensing regimes, other management approaches such as quality management, risk management, defect management, building are still handed with defects. In developed countries such as Australia, subcontractors do most of the on-site work. However, despite subcontractor or trade contractor being the specialists in the specific area, there are yet many problems associated with subcontractors. It is this phenomenon that led to the further investigation in this area.

Although Queensland Building and Construction Commission (QBCC) produces the list of top ten defects each year in its annual report, due to some of its limitations, it does not provide the whole picture of defects actually occurring in this industry. Thus it was deemed necessary to conduct a risk analysis of various trades used in residential construction. An online questionnaire survey was chosen as a research method, which was further divided into two stages. For the first stage, a qualitative risk analysis adopted from Project Management Body of Knowledge was undertaken to identify the troublesome trades. After the identification of the troublesome trades, second stage survey was undertaken to identify the strategies that would assist in minimising defects for those troublesome trades.

After receiving the ethics approval from University of Southern Queensland ethics committee, the questionnaire was distributed to approximately 500 participants. Unfortunately only 24 (4.8%) responses were received for the first stage survey and only 14 (2.8%) responses were received for the second stage survey. The main finding from the first stage survey was the identification of high-risk trades. Out of thirty-four trades used in the first stage survey, three trades were identified as high-risk trades, which are as follows:

- Waterproofing
- Concreting
- Swimming pool construction, maintenance and installation

With this knowledge, potential mitigation techniques could be implemented in construction to assist in minimising defects. The second survey identified that the majority of respondents believe that the licensing regime should be tightened for trades such as waterproofing and Swimming pool construction, installation and maintenance. For Concreting trade majority of respondents choose payment of work done should only be made after receiving relevant certificates from building certifier. For Painting and Decorating trade respondent believed that there is a need to grade trade contractor as Grade 1,2 etc. (to motivate subcontractors for better performance).

Further research on the feasibility of introducing the grading system for subcontractors and further study on how licencing system could be tightened for high-risk trades is proposed through this project.

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## Nomenclature and Acronyms

QBCC	Queensland Building and Construction Commission
PMI	Project Management Institute
HIA	Housing Industry Association
BCA	Building Code of Australia
QDC	Queensland Development code
SPA	Sustainable Planning Act
QA	Quality Assurance
QC	Quality Control



# Chapter 1 Introduction

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## 1.1 Background of the Study

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Despite various construction acts, regulations, standards, codes, licensing regimes, other management approaches such as quality management, risk management, defect management building are still handed with defects. It is evident from (Queensland Building and Construction Commission 2015) annual report that in 2014/15 alone received 4,793 complaints about defective work. There are many other defects that are seen to occur during the construction process, which gets rectified before the practical completion and does not appear on QBCC top ten lists (Sommerville & McCosh 2006). It is this phenomenon that led to the investigation that is described in this study.

In developed countries such as Australia, subcontractors do most of the on-site work. According to Pratt (2011) in residential projects almost 80% of work is performed by subcontractors and often most of the on-site work is carried out by the sub-trades leaving the main builders as the co-ordinator of various sub-trades. However, despite subcontractor or trade contractor being the specialists in the specific area, there are yet many problems associated with subcontractors.

## 1.2 Research Objectives

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The primary objective of this project is to understand how to manage defects in single and two storey residential projects within Queensland. Furthermore, the primary objective also involves taking a trade-based approach towards the investigation. To assist in completing this primary objective, the research project will be conducting a literature review on the key principles relevant to this project. These key principles are; the nature of residential construction, the methods used for the construction of residential projects, Regulatory mechanism of residential construction in Queensland, different building trades required to construct single or double-storey residential building, types of defect and its causes, management approaches such as defect management, risk management and quality management. The research project will also discuss the methodology used to achieve a conclusion to the primary objective. The project's methodology will include the different data collection methods available to the research project and justify the data collection method, which was ultimately used. The different data collected for the project will also be analysed along with a discussion and visual representation of the different data collected compared to each individual result. Finally, the research project will conclude issues rose throughout the project and ultimately conclude the primary objective of the project. Recommendations for possible future research will also be determined through the conclusions reached.

Although the project has a clearly defined primary objective, there are a number of additional objectives based on the key principles mentioned earlier. These additional objectives are as follows:

- Understand broadly the technology used for building houses in Qld with specific reference to trades.
- Understand the nature of defects in residential construction with respect to trades.
- Understand about quality management and risk management bodies of knowledge, but specifically related to defect management.
- Synthesise a set of trades that can be used for this study.
- Understand the nature of trade-based risk focussing on the defect by undertaking a survey (having obtained ethics approval).
- Identify strategies for managing critical trades by focusing on high-risk trades.

Refer to Appendix A for detailed Project Specifications

The first additional objective of the research project involves investigating the technology and methods of construction used for residential projects in Queensland. Research into this objective will reveal what are the common trades involved with residential projects.

The second additional objective of the research project involves research into the nature of defects. This will demonstrate how there are a number of different defects found in residential projects as well as their causes.

The third additional objective of the project is the investigation into the core areas of information relating to quality and risk management. Furthermore, the study into quality and risk management will be done in relation to defect management. Early research into defect management revealed that quality management and risk management are an integral part of defect management (Perkins 2011).

Poor quality of work done in construction projects is a major cause of reworks (Neese & Ledbetter 1991). Due to quality management and risk management having a clear impact on a number of defects, further research into quality management is believed to be necessary.

The fourth objective is to synthesize the list of trades that are suitable for the research project. After synthesizing the list of trades deemed suitable for the research project a survey will be conducted to understand the nature of trade-based risk focusing on defects and strategies will be identified for managing high-risk trades.

### 1.3 Problem Statement

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Although there have been studies conducted relating to the cost, cause and magnitude of defects, but there has been minimal to non-research into quantifying the risk factor of the various trades involved in residential construction. Defective work is a recurrent issue within the residential building industry. The expense of redressing has been observed to be 4% of the contract value; this rectifying value can skyrocket by the inclusion of all intangible but real costs such as project delays, proceeding cost, and disturbance in contract relationships (Evans & Love 2008). Queensland Building and Construction Commission (QBCC) has been issuing the list of ten most common defects each year in its annual report. Many of these issues have been repeating every year as the top ten common defects, yet there has been little to non-research has been done, to quantify the risk factor of trades involved in residential construction and to minimise or eradicate

them nor has QBCC provided any suggestion on how to eradicate them or to minimise them in their report.

## 1.4 Potential Implication and Consequential Effects of this Project

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As stated within chapter 1.3 of this research project, there has been minimal research into quantifying the risk factor of the various trades involved in residential construction. Therefore, by finding solutions to the primary objective of the project certain trades may be exposed as hugely troublesome trades. A possible exposure of this magnitude could create repercussions for subcontractors involved with this certain trade. With the main focus of the research project being data gathering for purely academic use an issue like this should optimistically be avoided.

If the conclusions made by this research project were made publicly available and the troublesome trades for residential defects became common knowledge, then there would most likely be benefits for builders, subcontractor and homeowners. The main benefit would be the knowledge of the troublesome trades themselves. With this knowledge, potential mitigation techniques could be implemented in construction to assist in minimising defects. The conclusions obtained by this research could also be beneficial to future researchers wishing to investigate into similar research areas.

## Chapter 2 Literature review

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### 2.1 Introduction

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The literature review examines the nature of residential construction in Australia more specifically residential construction in Queensland. The literature review also examines the common method of construction in Australia and various stages of construction in order to understand the various trades that are required in the residential construction of single and double story houses. Further, the literature review examines the regulatory mechanism of residential construction in Australia more specifically to Queensland to get a brief understanding of various acts, regulations, codes and building approvals that can impact residential construction. Furthermore, to understand their impact on defects and its management. The literature review also examines different types of defects seen in residential construction and their cause and effects. Analysis of QBCC top ten-defect list is carried out to see if these defects list really represent the actual defects occurring in Queensland residential construction. Furthermore, various management approaches for managing defects and their consequences are examined to get a better understanding.

### 2.2 Nature of the Construction Sector

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The Construction industry is the third largest industry in Australia with only behind mining and finance. Thus, it is safe to say construction industry is one of the key components of the Australian economy. It comprises 8% of Gross Domestic Product (GDP) and employs more than one million people, which is almost 9% of the total workforce (AI Group 2015). The construction industry operates in both the private and public sector (AI Group 2015) Furthermore, construction is mainly divided into three broad areas (AI Group 2015). Three broad areas of the construction industry are:

- Engineering construction (infrastructures like road, highways, dams, mining projects, etc.)
- Non-residential building (shops, hotels, offices, etc.)
- Residential building (single/ double story houses, townhouses, etc.)

A diverse range of products and services are provided by the construction industry. It comprises of 330,000 businesses Australia wide, but due to its nature of subcontracting and licenced trade specialisation, this industry is comprised of many small businesses. Almost 98% of construction businesses employees less than 20 people, while 82.2% of these businesses are trade based such as plumber, electrician, masonry, carpentry, etc. (AI Group 2015).

#### 2.2.1 Residential Building Construction

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The Australian Bureau of Statistics (ABS) cited in (BIS Shrapnel 2015) defines residential building as

“A dwelling or residential building as a rigid, fixed and permanent structure which has a

roof and whose intended purpose is primarily to house people and as such, has a self contained suite of rooms, including cooking and bathing facilities and is intended for long-term residential use.”

Residential building can generally be divided into three density segments (BIS Shrapnel 2015):

Low-density Segment: Single or double storey houses

Medium-density Segment: Townhouses, semi-detached terrace houses, duplexes, villas, etc.

High-density Segments: Flats, units, apartments of four floor or higher

This research topic is solely focused in low-density Segment i.e. single or double storey houses. Section 2.3 provides more detail on the common method of building low-density segments and its stages of construction.

## 2.2.2 Volume of Work

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The residential building sector has been performing comparatively better than Engineering construction and non-residential building as mining investment has dropped from its peak, resulting in a decline of mining-related construction projects (AI Group 2015). According to AI Group (2015), the value of work done by the building and construction industry was \$204.5 billion in 2014. Of this, Residential building works comprised of 26.6%, which is the increment of 11.4% by the first quarter of 2015. The escalation in building approvals, low interests and strong population growth were the key elements for solid performance of residential building (Master Builders 2016). According to Queensland Building and Construction Commission (2016b) the Queensland residential building sector is looking solid, as the number of building approvals forecasted for 2016 is as high as 46,000, an increase of 6.1% from 2014-15. Figure 2.1 below shows the dwelling approvals and the forecast for Queensland up to the year 2017.

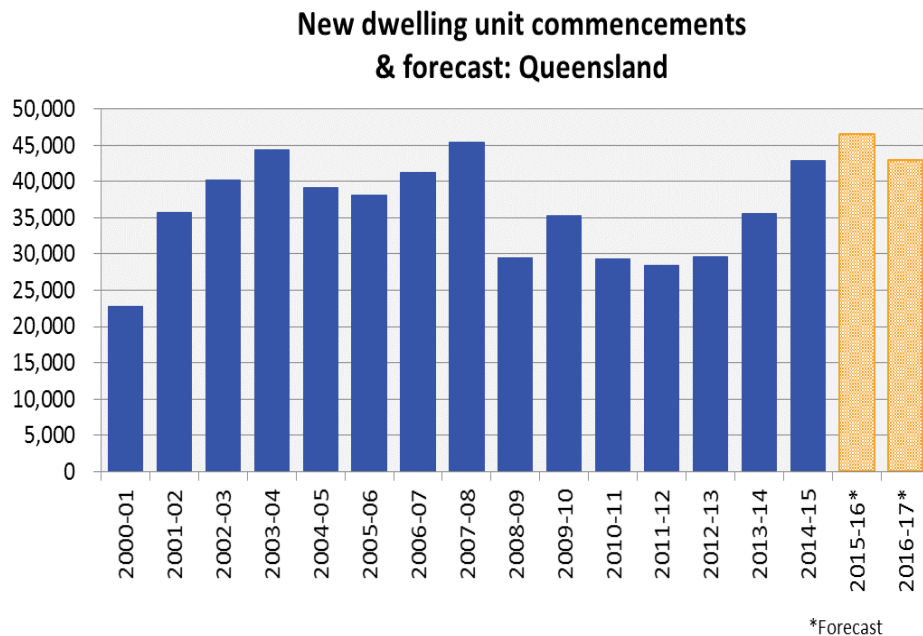


Figure 2.1: New dwelling units' commencement and forecast.  
Source: (Master Builders 2016)

## 2.3 Common Residential Construction Method in Australia

Home ownership has long been the great Australian dream. It is often the biggest investment an individual will make. The housing industry of Australia alone exceeds more than 4% of the country's gross domestic product, but little is known about this industry (Dowling 2005). The great Australian dream can turn into a nightmare due to various defects and rework required. It would, however, be unrealistic to assume that houses would be free of defects and built to perfection as in reality defects do occur due to a number of reasons. This project's aim is to minimise the defects by identifying the most problematic trades. In order to take the trade based approach to manage defects, it is important to understand how typical Australian residential houses are made and its stages of construction where various trades are required.

According to Staines (2007) the four traditional construction method are:

1. Timber Frame weatherboard
2. Brick veneer
3. Cavity Brick
4. Hollow concrete block masonry

### 2.3.1 Timber Frame Weatherboard Construction Method:

The timber frame construction method is commonly used in many developed countries. Timber frame construction is a well-proven and versatile method of building residential houses. Standardised and prefabricated timber wall panels and floors are used with



advanced breathable membrane and vapour control layers to improve durability with careful detailing. Termite, fire, thermal and acoustic requirements of building regulation are all integrated into the timber frame design (Staines 2007).

Table 2.1: Stages of construction for timber frame weatherboard method

Foundation and footing with sanitary drainage under the slab are constructed.	Internal walls and ceilings are lined
Concrete floor is laid	Plumbing finished off
Wall frames with plumbed and braced are erected	Cupboards throughout kitchen are installed, bath shower is installed
Roof framing, fascia, and barge board are constructed	Internal doors and moulding are fitted
Roof sarking and cladding are attached	Plumbing completed
Exteriors doors and windows are mounted	Painting and decoration carried out
Soffits lining and external wall cladding are applied	Floor sanded, carpet laid if required
Ceiling battened or nogged	Electrical work completed
Plumbing and electrical works are carried out	

Source: (Staines 2007)

### 2.3.2 Brick Veneer Construction Method

In this construction method bricks are used as external cladding, façade and as well as the insulator for the house. Brickwork is anchored to the timber or steel frame that bears the structural load and supports the roof, ceiling, and internal wall lining. Brick Veneer houses are considered as a cost effective method and are very low maintenance. It can be constructed using slab on ground in relatively level sites (Staines 2007).

Table 2.2: Stages of construction for Brick veneer construction method

Foundation and footing with sanitary drainage under the slab are constructed.	Plumbing and electrical works are carried out
Brick base to floor level	Internal walls and ceilings are lined
Concrete or timber floor is laid	Internal doors, moulding, bath shower are fitted
Wall frames with plumbed and braced are erected	Tiling
Roof framing, sarking, and tiles are installed	Plumbing completed
Exteriors doors and windows frames are mounted	Painting and decoration carried out
Bricks wall are laid	Electrical work completed
Soffits framed and lined	Floor sanded, carpet laid if required

Source: (Staines 2007)

### 2.3.3 Cavity Brick (double brick)

The cavity brick method is built by two brick walls standing side by side tied together with brick ties and separated by a cavity. It can either be built on a concrete or timber slab with the walls left exposed or treated with render finish. Brick walls provide the structural support as well as support internal and external lining.

Table 2.3 Stages of Construction for Cavity Brick Method

Footings with reinforcement are laid, and sanitary drainage installed	Internal partition is done.
Bricks are laid up to slab floor level	Roof erected
The Floor is laid	Interior lining, doors attached. Finishing work can be carried out at the same time outer brick leaf can be built.
The inner wall is built with the windows and exterior doors built-in	

Source: (Staines 2007)

### 2.3.4 Hollow Concrete Block Masonry

Hollow concrete blocks are filled with concrete and reinforcement that provides the structural support. The block work also acts as façade as well as and best suited for sites requiring retaining walls.

Table 2.4: Stages of Construction for Hollow Concrete Block Masonry

Footings	Roof sarking and cladding are attached
Blocks below slab are laid	Render walls if required
Slab is laid with sanitary drainage and plumbing services	Painting are done
Steel doorframes are set up into plumb to alignment.	Install windows and door panel
Block work is constructed with plumbing and electrical services installed	Batten and line ceilings, install bath and shower
Concrete grout is poured	Install cupboards, internal doors, mouldings, tiles, etc.
Fix top plates to block walls if required; internal partition is done then roof framing and eaves	

Source: (Staines 2007)

In order to complete the various stages of construction as mentioned above, a builder or main contractor requires various subcontractors and trades. Different jobs mean many subcontractors. According to a Housing market index survey cited in Emrath (2015), 70% of builders use around 11 to 30 subcontractors to build the average single family home. An average of 22 different subcontractors was identified by the survey to build the average single family home (Emrath 2015). In this scenario, it would be beneficial to further investigate into building trades and identify the list of trades required for

residential construction.

## 2.4 Regulatory Mechanism in Queensland

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### 2.4.1 Principle Building Act, Regulation, and Code in Queensland

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*“If a builder builds a house for someone and does not construct it properly and the house which he built falls down and kills its owner, then the builders shall be put to death.” Cited in (Van der Heijden 2008)*

The above quote is derived from the earliest known building code from 2000 BC, which is also known as the code of Hammurabi. The code of Hammurabi is evident that the duties and responsibilities of builders towards their client were regarded highly since the 19<sup>th</sup> century (Van der Heijden 2008). In the present context, the construction industry is highly regulated, as anyone involved in the building and construction industry is subject to various laws, codes and regulations. Although there are a number of acts, regulations, and codes, some of the principle acts, regulation and code are discussed below.

The principle legislation governing the Development in Queensland is The Sustainable Planning Act (SPA). Sustainable Planning Act (2009) includes five activities and one of which is ‘building work’. Sustainable planning regulation 2009 is a subordinate of the SPA, which provides details of authorities that need to be consulted for various types of development and establishes their respective jurisdictions (Department of Housing and public works 2010). The building work principle authorities are (Department of Housing and public works 2010):

- Building Act 1975
- Building Regulation 2006
- Building Code of Australia
- Queensland Development Code
- Australian Standards

#### **The Building Act 1975**

All building works in Queensland is governed by the Building Act 1975. The act itself does not contain any technical regulations but provides administrative tools necessary to give effect to the laws (Department of Housing and public works 2010).

#### **Building regulation 2006**

The building regulation 2006 gives effect to the provision of the Building Act. It defines competent persons and their Functions. Contains details about building inspections and includes the general provision about the certificates (Department of Housing and public works 2010).

## The Building Code of Australia (BCA)

The Building Code of Australia (BCA) provides technical provisions for the design and construction of buildings and other structures throughout Australia. Australian Building Code Board (ABCB) reviews and amends the BCA every year to include various technical and regulatory changes (Department of Housing and public works 2010).

## Queensland Development Code (QDC)

Queensland Development Code contains additional provision specific to Queensland. The Department of Infrastructure and Planning administers QDC. If any conflict arises between BCA and QDC, the later takes the precedence (Department of Housing and public works 2010). The regulatory framework for Queensland building work is shown in figure 2 below.

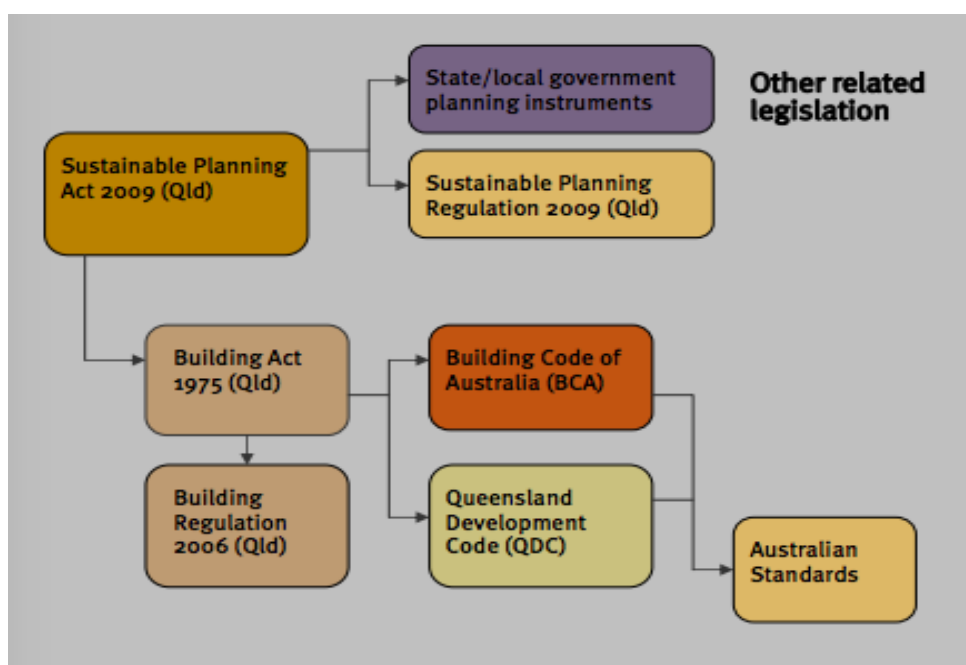


Figure 2.2: Queensland's building regulatory framework (Department of Housing and public works 2010).

Besides the aforementioned principle Building Acts, regulations and codes, there are numerous other Acts and regulations that can impact building environment. Some of the relevant acts and regulations (but not limited to) can be found in Table 2.5.

Table 2.5: Acts, Regulations and Codes impacting Residential building

Acts	Regulations	Codes
Fair Work Act 2009	Fair Work Regulation 2009	Small Business Fair Dismissal Code
Queensland Building and Commission Act 1991	Queensland Building and Construction Commission	

	Regulation 2003	
Subcontractor's charges Act 1974		
Work Health and Safety Act 2011		
Payments Act 2004		
Domestic Building Act		

Source: (Department of Housing and public works 2010)

### 2.4.2 Building Regulatory Body in Queensland

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The Queensland Building and Construction Commission (QBCC) is the statutory regulatory body for Queensland's Building Industry. It was established under the QBCC Act 1991. QBCC is the independent body consisting of an organisational Board controlled under the commissioner.

The Primary responsibilities of QBCC are:

- Providing licensing for building contractor and trades
- Provides dispute resolution services
- Provides remedies for defective work
- Undertake compliance and enforcement
- Provide statutory home warranty insurance

(Queensland Building and Construction Commission 2015)

### 2.4.3 Licensing of Contractors and Trades

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In Queensland, QBCC requires individuals and companies to hold a licence for any building work valued over \$3,300 or building work valued over \$1,100 involving Hydraulic Services (Queensland Building and Construction Commission 2016b). Furthermore, they are required to hold a license for any value of building work involving drainage, plumbing, gas fitting, termite management, fire protection, building inspection, building design-low rise, medium rise and open and Site classification (Queensland Building and Construction Commission 2016b).

### 2.4.4 Licensing for Building Certifiers

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QBCC is the licensing body for building certifiers. QBCC provides three grades of licence for building certifiers and their set of responsibilities are:

- Building Certifier Level 1: Are able to perform building certification on all classes of building and structures.
- Building Certifier Level 2: Only able to perform building certification on building and structure that is no more than three storeys and 2000m<sup>2</sup>. Level 2

certifiers can help assess and inspect all types of buildings under the supervision of Level 1.

- Building Certifier Level 3: Level 3 certifiers are only able to certification class 1 and class 10 buildings and structures.

(Queensland Building and Construction Commission 2016a)

## 2.4.5 Contractor's Associations

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### **Master Builders**

Master Builders is one of the oldest industry associations consisting of 33,000 members including national and international contractors, residential and commercial builders as well as various subcontractors. The purpose of this association is to provide a broad range of services to its members such as:

- Training
- Legal services
- Industrial relations
- Building codes and standards
- Industry economics and international relations

(Master Builders 2015)

### **Housing Industry Association (HIA)**

HIA is the official body of Australia's building industry. The purpose of the HIA is to support its members including residential builders, trade contractors, manufacturers and suppliers. All HIA members are bound by the National Code of Ethics to provide their services with aptitude, impartiality, value, morality and integrity. Some of the services provide by HIA are:

- Manage workplace safety
- Provides training and professional development programme
- Legal and technical assistance
- Advice on building regulations
- Help apprentices

(Housing Industry Association 2016)

In this section 2.4 various building acts, regulations, licensing of various trades and certifiers and contractors associations are discussed. While these acts, regulations and codes assist people to in protecting from unfair practices and maintains the standard of work, it also helps to prevent problems but in the case of its occurrence provides avenues to resolve them. Industry Associations provide training, professional development programs, legal and technical assistant to builders and trades, which is beneficial to minimise defects, but despite all these, buildings are still being completed with defects and the numbers are still increasing. It is evident from the annual report produced by QBCC as the value of claims approved for the 2013-14 financial year was \$82,806,370

for the year and increased by 16 % to \$96,358,403 for 2014-15 financial year (Queensland Building and Construction Commission 2015). This is perhaps not a very satisfactory situation, and there is a need to investigate as to how this situation can be arrested.

## 2.5 Building Approval

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Construction method and its various stages of construction help to identify key construction process involved in various construction methods. During the construction of residential houses various, inspections and certification are required in order to ensure the house is constructed to required standards as specified by building regulations. Independent building certifiers could carry out these inspections. Some of the key functions of building certifier are (Department of Local Government and Planning 2011):

- Determines building applications and provides decision on building approvals
- Conducts building inspection to ascertain they meet building standards
- Informs builder for any non-compliance in minimum standard and building approvals
- Enforces builders to attain compliance with the standards and building approval.

Building approval decision notice provides inspection stages required during the various construction process. These inspections are mandatory and set out in Standard Building Regulation 1993. The mandatory stages of inspection are:

1. Foundations and excavation (footings) – prior to concrete footings poured
2. Slab – before pouring of concrete
3. Frame – prior cladding or lining is fixed, or brick/block started
4. Final inspection – when all aspects of building work completed

• Note: Additional mandatory council plumbing inspections may also be needed for any drainage or plumbing work.

(Smith, Smith & Mitchell 2013)

The stages of inspection could vary depending on the construction method and style of construction. A typical Timber/steel frame, brick veneer house constructed on a slab on the ground has five key stages where Standard Building Regulation 1993 requires inspections (Smith, Smith & Mitchell 2013).

Stage 1- Site: site inspection is done to ensure that everything is according to the approved plans and services are located according to the council plans. At this stage, a land surveyor might have positioned building footprint to ensure setback distances as well.

Stage 2- Footings: At this stage excavation and reinforcement that supports the building are inspected. This inspection is carried out before the concrete is poured to ensure the

size and depth of the footings are correct and right size reinforcements with required spacing is maintained.

Stage 3- Slab: slab inspection is carried out after footings have been poured. At this stage reinforcement, plastic membrane, compaction of soil, lagging of horizontal plumbing penetration are inspected.

Stage 4- Frame: At this stage, the framework will be assessed according to residential timber framed standards (Australian Standard AS1684.2-2010 – Residential Timber Framed Construction) or engineer’s design for timber or steel frame. Items such as tie downs, bracing, truss installation and sizes of the structural member are inspected.

Stage 5- Final- depending upon the dwelling types various item needs to be inspected at this stage such as termite protection, weather and vermin proofing, site drainage, stairs, smoke alarm, etc.

A study conducted by Smith, Smith and Mitchell (2013) on 109 houses in south-east Queensland found that the maximum number of minor defects was detected at the final stage of inspection. Table 2.6 below shows the number of houses affected by minor defects and the stages they were detected.

Table 2.6: Number of house affected by minor defects at various stages.

Approval stages	1. Footing	2. Slab	3. Frame	4. Final
No. of incidents in 109 houses	4	3	49	563
Total houses affected (percentage)	3.70	2.80	45	51.50

Source: (Smith, Smith & Mitchell 2013)

A high number of defects have been detected during the final stage. Smith, Smith and Mitchell (2013) suggest that the key reason behind this is the involvement of a higher number of trades, more activities and work sections. Despite vigorous inspections at various stages, defects are still found in the newly built houses during the defect liability period. Such defects could cause inconvenience and dissatisfaction to the homeowner as well as the reputation and image of the builder being hampered. However, a lack of coordination with subcontractors, the pressure to deliver the building on a certain time frame to the homeowner, and a lack of inspections may result in defects still been found after the buildings handover.

## 2.6 Building Trades

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As already mentioned in section 1 construction industry is comprised of large number of small businesses. According to AI Group (2015), 98.6% of construction business employs less than 20 employees, interestingly 60% are sole operators with no employees. In the Australian construction industry, 82.2% of businesses are trade based which highlights the fact that the construction industry is based on subcontracted work performed by various licenced trades. According to Pratt (2011) in residential projects almost 80% of work is performed by subcontractors and often most of the on-site work is carried out by the sub-trades, leaving the main builders as the co-ordinator of various sub-



trades. In this project subcontractor, subbies or trade contractor is used interchangeably implying the same meaning subcontracted trade works. The fact various trades and subcontractors carry out that majority of building works, they are pervasive and economically significant to the main builders and the home building industry itself. It is vital for successful homebuilders to maintain a good relationship with subcontractors, schedule large numbers of trades in order to complete projects on time and most importantly maintaining control over quality for the works carried by various trades and subcontractors.

Table 2.8 below lists the number of trades listed in Australian method of measurement of building works, New Zealand Standard method of measurement of building works, National association of housing builders US and QBCC.

Table 2.7: Lists of trade for building work in US, Australia and New Zealand

<b>Australian method of measurement of building works</b>	<b>New Zealand Standard method of measurement of building works</b>	<b>National association of housing builders US</b>	<b>QBCC Trade lists</b>
Demolitions	Demolition	Security system	Air Handling Duct Installation
Groundwork	Excavation	Carpeting	Brick and Segmental Paving
Piling	Underpinning	HVAC	Bricklaying and Blocklaying
			Cabinet making
Concrete	Piling	Electrical wiring	Carpentry
Masonry	Concrete work	Plumbing	Drainage
Stonework	Sprayed concrete	Technology	Drainage- On-site Sewerage
Structural steel	Precast concrete	Fireplace	Floor Finishing and covering (hard sector)
Metalwork	Reinforcing steel	Foundations	Foundation work (piling and Anchors
Woodwork	Structural steel	Drywall	Gasfitting
Glazing	Mastic asphaltting and similar treatment	Masonry work	Glass, Glazing and aluminium
Hardware	Brickwork	Concrete flatwork	Irrigation
Access floors	Blockwork	Roofing	Joinery
Partitions	Stone masonry	Kitchen countertops	Metal fascias and Gutters
Roofing	Metalwork	Ceramic tiles	Non-structural metal fabrication and installation
Suspended ceilings	Metal windows and doors	Flooring (except carpet and tiles)	Painting and decorating
Windows	Carpentry	Painting and wall covering	Plastering drywall
Doors	Laminated timber	Landscaping	Plastering solid
Finishes	Joinery	Kitchen cabinets	Plumbing and drainage
Paintings	Proprietary partitions	Exterior doors and	Refrigeration, air

		windows	conditioning and mechanical services including unlimited design
Furniture	Insulating panel system	Framing	Roof and wall cladding
Hydraulics	Roofing	Exterior siding	Roof tiling
Drainage	Plumbing and gas fitting	Interior doors	Site classifier
Electrical installations	Drainage	Finished carpentry	Sheds, carports and garages
Exterior elements	Mechanical services		Shopfitting (trade)
	Fire protection		Steel fixing
	Lifts and escalators		Stone masonry (trade)
	Electrical services		Structural landscaping (trade)
	Solid plasters		Structural metal fabrication and erection
	Plasterboard linings		Swimming pool construction, installation, and maintenance
	Grid suspended ceilings		Termite management (chemical)
	Tiling		Termite management (physical)
	Terrazzo work		Wall and floor tiling
	Floor coverings		Waterproofing
	Painting and specialists finishes		
	Glazing		

Source: (Australian Institute of Quantity Surveyors 1973; Emrath 2015; Queensland Building and Construction Commission 2016b; Standards Association of New Zealand 1972)

There were 24 trades identified by the Australian standard method of measurement of building work, 36 trades from the New Zealand standard method of measurement and 23 trades by the National Housing Industry Association of US. While due to time and resource limitation carrying out the research project with all the trade list mention above will be difficult. This project will narrow down the trade lists to a manageable portion by conducting a further literature review. It is also deemed that trade list provided by the QBCC is suitable for this project as it is based on the specific location this project is based on.

### 2.6.1 Classification of Building Trade and Scope of Work

Australian and New Zealand Standard Industrial Classification (ANZSIC) (1993)

classifies Construction trade services into four subdivision:

#### 2.6.1.1 Site Preparation Services

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Site preparation services include work such as demolition, land clearing, levelling of the construction site, excavating foundations, trench digging, etc.

#### 2.6.1.2 Building Structure Services

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Building Structure services include services such as:

##### **Concreting Services**

Services such as concrete pumping, concreting footpaths, kerb and guttering, foundation, and other concrete structural products

##### **Bricklaying service**

Services such as bricklaying, concrete block laying, and stonework are included in this services

##### **Roofing Services**

Services such as metal roof fixing, roof painting, spraying or coating, roof tilings are included in roofing services. Installation of insulating materials, roof guttering and wooden roof trusses are not included in this category.

##### **Structural steel Services**

Services such as reinforcing steel erection, truss or joist steel erection, metal storage tank erection, etc. are included in structural steel services.

#### 2.6.1.3 Installation Trade Service

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Installation trade service includes:

##### **Plumbing services**

Units mainly engaged in plumbing or drainage excluding sewerage or stormwater drainage system is included. The primary activities covered are gas plumbing, guttering roof, hot water installation, water recycling equipment, and solar hot water installation, etc.

##### **Electrical service**

Units engaged in the installation of electrical wiring or fittings. Activities like installation of electric lights, wiring, television antennae or cables, satellite dish, switchboards, circuit breakers, telecommunication cable or wire are included.

### **Air Conditioning and Heating services**

Units involved in air conditioning equipment, heating equipment refrigeration equipment. Primary activities are air conditioning duct installation, air conditioning equipment installation, heating equipment installation, etc.

### **Fire and Security Alarm installation**

Units engaged in installation of fire protection, detection and control system; installing a security system. Primary activities are surveillance system installation, fire alarm and sprinkler installation, security and smoke detector installation system.

### **Other building services**

Building services excluded elsewhere, such as blind or shutter installation, curtain installation, flywire screen installation and insulation material installation.

#### **2.6.1.4 Building Completion Services**

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Building completion services include:

#### **Plastering and ceiling services**

Units involved in plastering, plater fixing or finishing. Primary activities include cement rendering of building, decorative plaster fixing, fibrous plaster finishing, plasterwork and plasterboard fixing or finishing

#### **Carpentry Services**

Units involved carpentry work or the fixing of wooden formwork on building projects. Primary activities include carpentry work, joinery work, wooden roof truss, wooden flooring, wooden formwork erection, and wooden kitchen cabinet installation.

#### **Tiling and Carpeting services**

Units involved in laying carpet and setting wall or floor tiles. Primary activities include carpet laying, floor covering laying, floor sanding, floor tiling (ceramic, concrete or stone tiles), slate flooring, terrazzo lying, wall tiling (ceramic, concrete or stone tiles).

#### **Painting and decorating services**

Units involved in painting, decorating or wallpapering. Primary activities are house-painting, spray painting, wallpapering.

#### **Glazing Services**

Units involved in glazing, services such as glazing, window frame installation, window installation and window insulation fixing.

### 2.6.1.5 Other Construction Services

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#### **Landscape Construction services**

Units engaged in building landscapes, including retaining walls and paths, decks, fences, ponds, garden planting or installation of sprinkler/drainage system.

#### **Other Construction services**

Services not included elsewhere, such as metal wall cladding fixing for the building, sand blasting or steam of building exteriors, scaffolding, waterproofing of building.

Abeysekera and Soysa (2012) have also classified building trades in three categories that are shown in Table 2.8 below. As suggested by Smith, Smith and Mitchell (2013) most defects are detected during the final stage of building approvals, suggesting mid, and backend trades are more problematic than frontend trades thus there is a need to investigate as to how this situation can be arrested.

Table 2.8: list of frontend, mid, and backend trades

<b>FRONTEND TRADES</b>	<b>MID TRADES</b>	<b>BACKEND TRADES</b>
Demolition	Metal windows & doors	Solid Plaster/ Cladding
Excavation	Carpentry	GIB Fix & Stop
Piling	Joinery	Suspended Grid Ceilings
Concrete work	Roofing	Floor coverings
Pre-cast concrete	Plumbing & Gas	Paintings and special finishes
Reinforcement steel	Mechanical services	
Structural steel	Fire Protection	
Brick & block work	Electrical Services	
Drainage		

Source:(Abeysekera & Soysa 2012)

## 2.7 Defects

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Oxford English Dictionary defines a defect as “a shortcoming or failing short in the performance of a building element”. This definition provided by Oxford dictionary has also been validated by the case of Schuller AG v. Wickman Machine Tools Sales Ltd Dorter and Sharkey cited in (Georgiou, Love & Smith 1999). The case CIB W86 (1993) also additionally substantiate the above by defining a defect as “a situation where one or more elements do not perform its/their intended function(s)” (Georgiou, Love & Smith 1999).

These imperfections in residential construction have also been described by words such as “failure”, “fault”, and “defect” in variously reviewed literature. The word “defect” has been preferred throughout this project, although all three words “failure”, “fault”, and “defect” suggest that the client involve has had an unsatisfactory solution. The majority of building defects are not major and dramatic collapses, but rather far less newsworthy mechanical, structural or serviceability issues such as minor cracking, roof drainage,

movement of floor tiles, etc. Although these are not major issues, but they are still capable of causing serious consequences for the project (Ilozor et al. 2004).

The Australian Building Codes Board (ABCB) has produced a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia known as The Building Code of Australia (BCA). In Queensland, Queensland Building and Construction Commission (QBCC) provides Home warranty insurance for residential construction work valued over three thousand and three hundred dollars. It aims to provide homeowners protection for up to six years against non-completion, defective work and subsidence (Queensland Building and Construction Commission n.d). Despite the fact that residential builders are bound by the Building Code of Australia and QBCC compulsory warranties to ensure that all residential buildings meet fundamental requirements with respect to functionality, safety, structure, insulation, habitability, etc. defects in residential buildings have been a pervasive problem. QBCC alone received 2,180 complaints in regards to defective and incomplete work for the period of 1 December 2013 to 30 June 2014. The figure 2.3 below shows insurance claim approval type over the past five years within the state of Queensland only.

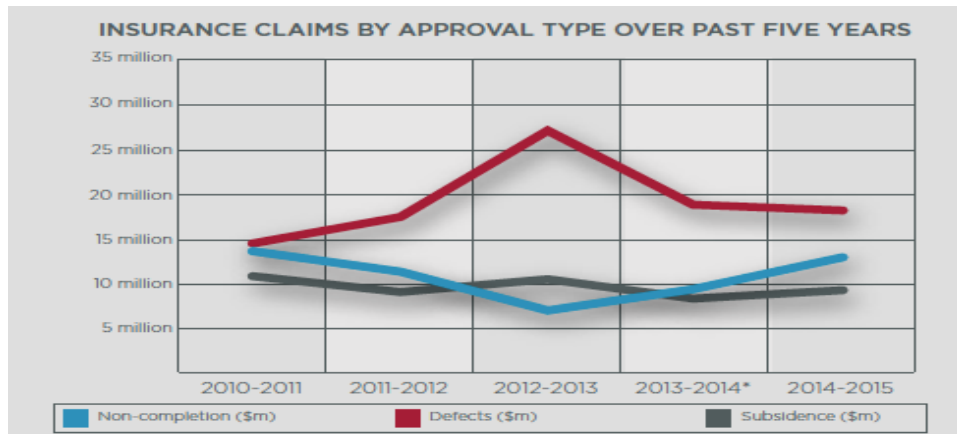


Figure 2.3: Insurance claims by approval type over past five years.  
Source: (Queensland Building and Construction Commission 2015)

Various studies have suggested that the cost of rectifying defects in residential construction can be up to 3.4% to 6.2% of the contract value. Some studies have even suggested rework cost as high as 12% (Karim, Marosszeky & Davis 2006). While there have been studies that are focused on identifying costs, causes and magnitude of the defects but there is very limited studies and action to eradicate these issues. Most importantly, less focus has been given to subcontractors, although various subcontractors undertake 80%-90% of the residential construction work (Karim, Marosszeky & Davis 2006).

### 2.7.1 Structural and Non-structural Defects

Any defects seen in structural elements of the building or defects that are likely to cause defects in the structural element of the building are classified as structural defects (Northern Territory Government 2013). Foundation, load bearing walls, roof, columns and beams are the structural elements of the building, any defect on these elements or any

defect that can cause damage to these elements are structural defects. For example, defective waterproofing on the bathroom floor, external walls or roof can cause defects on structural elements of the building so it can be classified as the structural defects or category 1 defects. QBCC allows the homeowner to lodge a complaint within 6 years and 3 months after the completion of the work or within 12 months of identification of the defect.

Any defects occurred in non-structural element of the building that does not impact the structural integrity of the building are non-structural defects or category 2 defects. Defects like brickwork, plasterwork, and plasterboard are non-structural defects (Bagdiya & Wadalkar 2015). Residential builders are bound to provide 6-month statutory warranty from the practical completion date for any non-structural defects. Contract condition for new home construction compels builders to fix any defects that arise during the warranty period within 6 months and if not owners can lodge the complaint to QBCC within 12 months of the practical completion date.

### 2.7.2 Latent and Patent Defect

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Defects that are identified during the occupancy stage are commonly known as latent defects, although these defects are identified after the construction process, but their origin is usually from the design or the construction stages (Chong & Low 2006). Due to the time frame that these defects appear, they are normally hard to detect and eliminating them is difficult. Most of the latent defects go unnoticed unless it causes major problems to the occupants to file a complaint to the authorities. According to Chong and Low (2006), while most latent defects originate from the design stage, various other factors such as managerial errors, workmanship, materials, specification, etc. could cause latent defects.

Defects that are generally detected during the construction phase are termed as patent defects. Patent defects are generally detected during the inspection process and are rectified before the practical completion (Sommerville & McCosh 2006). Since the practical completion certificate is only issued after the rectification of a patent defect, most contractual contracts do not include patent defects clauses into the defect liability period (Sommerville & McCosh 2006).

### 2.7.3 Serial Defects

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If more than 20% of the same part of the work is affected by the same root cause, it is known as serial defects (Patterson 2013). It usually occurs in components produced by the manufacturer and delivered on-site to incorporate into the facility. Interestingly contractual clause like AS4000 and QBCC are silent in this matter. According to Patterson (2013), contractors can protect themselves by reserving the right to claim these cost back if the defects were not their responsibility.

As mentioned earlier defects are inevitable and are a prevalent issue in construction. Almost half of the defects in buildings are due to incorrect design, whereas 40% of the defects are caused during the construction process, which may be due to various reasons such as lack of supervision, poor construction practices, poor workmanship, etc. the remaining 10% defects are originated due to incongruous materials and equipment (Evans

& Love 2008). Josephson and Hammarlund cited in (Evans & Love 2008) suggested that 45% of the defects generally occurs due to simply carelessness and forgetfulness of either main contractor, design team or the subcontractor. Therefore, in general, defects could originate throughout the life cycle of residential construction. Defects are usually seen during the construction process or after the practical completion either by the main contractor or by the client after the house has been deemed ready for occupancy (Sommerville & McCosh 2006).

Sommerville and McCosh (2006) classify defects into three categories i.e.

1. Technical (mostly related to workmanship, material and design team)
2. Omission (parts and features that are simply neglected)
3. Aesthetic (appearances of the house is maltreated)

Defects can cause severe consequences depending on its severity. Health and safety of the occupants and significant economic consequences can be the result of a major defect in the technical category, whereas, defects in the aesthetic category can cause significant economic ramification but less likely to affect the health and safety of the occupants. According to Georgiou, Love and Smith (1999) problem with categorizing the defect severity into major and minor defects is that there are no accepted definitions. In order to classify the difference between major and minor defects Georgiou, Love and Smith (1999) uses the following classification:

Major defect

- Affecting the health and safety or if not fixed can cause major consequent damages
- Costing more than \$800.00 (1994 costs to repair)

Any defects that do not match both of the above-mentioned criteria are considered to be minor defects.

While builders, main priority in terms of providing quality house may be assuring the technical category, such as foundation and structural integrity, but not so much on Aesthetic categories such as paintwork. However, clients predominantly rely on aesthetic or appearance of the house. At initial stage, presentation, look and feel of the house is what impacts the clients (Forcada, Macarulla & Love 2012). Thus clients, builders and subcontractors may have different interpretations and perception of defects and quality of work.

#### 2.7.4 Causes of Defects:

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Aljassmi and Han (2014) state, “ A cause is a reason for the existence of an undesired results”. Defect is an undesired result and Aljassmi and Han (2014) distinguishes between the root cause and the direct cause of the defect. Root cause describes the fundamental reasons for defective work and the direct cause can primarily be attributed to individuals who are influenced by these conditions.

Often, demands from clients for earlier completion, contractor involvement in various other projects and various other reasons, the construction process is commenced without



complete design documentation to fast track the process, which increases the probability of occurrence of defects during the construction stage. Due to the nature of construction projects i.e. complex and carried out by various trades, various tasks are often overlapped to optimise the project schedule, resulting in less control over communication flow and action of various trades (Aram & Noble 1999). Decision made on one part of the project can trigger unpredictable events on other interrelated project elements. Eventually, people working on the basis of tentative knowledge, unclear goals and objectives can cause defects and these causes are the root cause of defects or latent condition.

Although root cause is the fundamental cause of defects, detailed observations of project systems and people's behaviour provides insight into the actual mechanics in which defects occur (Aljassmi & Han 2014). Reason (1990) classifies direct causes of defects into errors and violations.

### **Error**

When an outcome is worse than the expectation, but not solely to chance or circumstances, and involves some element of surprise than the act is considered as error (Aljassmi & Han 2014). Errors occur unintentionally but are caused by psychological or cognitive limitation (Love et al. 2009). Love et al. (2009) further summarizes the reason for errors as follows:

- Mistakes- occurs due to ignorance of correct task or method. It is either rule-based or knowledge-based.
- Slips and lapses of attention- occur due to forgetfulness, habit or similar psychological issues. Normally occurs at the level of execution and when tasks are routine.

### **Violation**

When an individual carries out the task without following the clear instructions deliberately, the act is considered a 'violation'. Violation is the intentional act and hard to eliminate, on the other hand, errors could be prevented by removing root causes or latent conditions. The act of violation could be the result of low motivation, moral or lack of supervision (Love et al. 2009).

Aljassmi and Han (2014) has further identified nine defective acts clusters and their occurrence as follows:

- Poor workmanship (20%): Errors that can be traced back to particular trades such as a carpenter or concreter are workmanship errors (Love & Josephson 2004). Poor workmanship is concerned with skilled-based error meaning it is concerned with the quality of skill held by trades to do a particular work. A study conducted by Georgiou in Australia cited in (Aljassmi & Han 2014) found that in each sample 38% to 77% defects were due to the cause of poor workmanship. The study conducted by Aljassmi and Han (2014) also found poor workmanship to be the predominant cause of defects.
- Impaired material use (20%): Due to unsuitable, damaged or unfitting materials defects could arise. In many developing countries like Nepal, Pakistan, and Turkey impaired materials are the major cause of construction defects. It could be a knowledge-based error or a rule-based error.

- Task sequence omission (15%): Failing to carry out the required steps during the execution accounts for 38% of rework costs (Aljassmi & Han 2014). Omission generally occurs due to a violation or knowledge-based error. In some circumstances contractors or tradies were unaware if the procedure was necessary or not, while in some cases tradies just neglected the procedure. For example, carrying out formwork prior to casting without proper cleaning or not curing concrete.
- Deviation from intended dimension (13%): defects that occur due to inadequate measurements. This is again skill-based error triggered by tradies' inaccuracy or on rare occasion violation may be the cause.
- Instruction contravention (10%): any sorts of information upon which builders or subbies carry out the execution are instruction. It can be in the form of drawing, written guidelines or vocal instruction. Error occurs when these instructions are not followed. Generally occurs due to violation although rule-based error may originate these defects.
- Professional principles/conventions noncompliance (9%): Any tasks performed by the professionals, non-confirming to the established practices are conventions non-compliance. Lack of technical knowledge, under qualification, inexperience is the major causes of such errors.
- Official rule noncompliance (7%): Non-complying to the statutory requirements is considered to be the defects. It could be due to the unintentional error (rule-based error) or sometimes contractor or subbies intentionally violates them for their own interest.
- Items interdependence disregard (4%): lack of coordination between interdependent tasks or units involved causes defects to occur. For example, if scaffoldings are removed before the concrete has reached sufficient strength defect could arise. It could cause by either rule-based error or knowledge-based error.
- Adoption of misleading instruction (2%): A knowledge-based error, where misleading instructions are followed. For example design and drafting errors are misleading instruction and if they were not detected during execution would yield defects. Thus adopting faulty instructions is itself a defective work.

The study conducted by Aljassmi and Han (2014) categorises defective acts into 9 clusters, as mentioned above, and identifies the error type associated with each cluster i.e. skill-based error, knowledge-based or violation. The defective acts in many clusters categorised are directly linked to the various trades required for building a house, which is further evident that this project's aim to identify the troublesome trades could be beneficial for the building industry, main contractor and even to the subcontractor and the homeowners.

## 2.8 Analysis of QBCC Top Ten Common Defects

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QBCC has been issuing the list of ten most common defects each year in its annual report. Many of these issues have been repeating every year as the top ten common defects, yet there has been little to non-research, to identify the root cause of it and to minimise or eradicate them nor has QBCC provided any suggestion on how to eradicate them or to minimise them in their report.

Table 2.9: Top ten defects approved by QBCC

<b>Top ten common defects (2011-2012)</b>	<b>Top ten common defects (2012-2013)</b>	<b>Top ten common defects (2013-2014)</b>	<b>Top ten common defects (2014-2015)</b>
Roof drainage	Fire separation	Roof cladding	Joinery
Wall/ceiling plasterboard	Roof drainage	Plaster board	Tiling (floor)
Waterproofing shower recess	Wall/ceiling internal plasterboard	External waterproofing membrane	Roof cladding
Ceramic floor tiling	Shower screen recess	Joinery-aluminium door/ window	Painting
Concreting driveway	Steel sheet (roof cover)	Floor tiling	Wet areas waterproofing membranes (internal)
Footings	Decks	Joinery timber door/window	Drainage
Steel sheet (roof cover)	Aluminium window/ door installation	Waterproofing shower recess	Wall cladding
Timber window/ door installation	Timber window/ door installation	Painting internal	Driveways and paths
External cement render	Ceramic floor installation	Fascia, gutters and downpipes	Timber framing
Aluminium window/ door installation	External cement renders	Painting approvals	Waterproofing membranes (external)

Source:(Building Services Authority 2012, 2013; Queensland Building and Construction Commission 2014, 2015)

The annual reports provided by QBCC are a clear indication that there are some troublesome trades. The recurrence of some of the defects every year is the clear indication of these. The recurrence of these defects is also evident that very little action has been done to eliminate or lessen these issues. Rather it seems the Australian building industry and the builders have accepted these defects as obvious. Instead of trying to eradicate them, they are accepting it rather. Analysing the report produced by QBCC for the last four years, defects types such as plasterboard, waterproofing, tiling, aluminium doors/ windows, timber doors/windows have repeated in several years. The table 2.11 below has been prepared by linking the top ten defects of previous four years to its respective trade. For example defect type ‘timber doors/ windows installation’ is related to the trade ‘Carpentry’. Similarly, all defect type produced in last four years top ten list are linked to their respective trades. The left-hand side of the table shows the trade lists provided by the QBCC and the right-hand side shows the number of times the trade has appeared on the top ten defects list.

Table 2.10: defects appeared on QBCC top ten lists respectively to its trade

QBCC Trade lists	Defects appeared on 2011/12, 2012/13, 2013/14 and 2014/15
Air Handling Duct Installation	
Brick and Segmental Paving	
Bricklaying and Blocklaying	
Cabinet making	
Carpentry	1+1+1+1=4
Drainage	
Drainage- On-site Sewerage	
Floor Finishing and covering (hard sector)	
Foundation work (piling and Anchors)	1
Gasfitting	
Glass, Glazing and aluminium	1+1=2
Irrigation	
Joinery	1+1+1=3
Metal fascias and Gutters	
Non-structural metal fabrication and installation	
Painting and decorating	1+1+1=3
Plastering drywall	1+1+1=3
Plastering solid	1+1=2
Plumbing and drainage	1+1+1+1=4
Refrigeration, air conditioning and mechanical services including unlimited design	
Roof and wall cladding	1+1+1+1+1=5
Roof tiling	
Site classifier	
Sheds, carports and garages	1
Shopfitting (trade)	
Steel fixing	
Stone masonry (trade)	
Structural landscaping (trade)	
Structural metal fabrication and erection	
Swimming pool construction, installation, and maintenance	
Termite management (chemical)	
Termite management (physical)	
Wall and floor tiling	1+1+1+1=4
Waterproofing	1+1+1+1+1=5

Thus, from the above table trades such as waterproofing, roof and wall cladding have appeared 5 times in last four years. Trades such as plumbing and drainage, wall and floor tiling have appeared 4 times. While, some of the trades haven't appeared on the list. At this instance it appears that most troublesome trades are:

- Waterproofing- appeared 5 times
- Roof and wall cladding- appeared 5 times

- Plumbing and drainage- appeared 4 times
- Wall and floor tiling- appeared 4 times
- Carpentry- appeared 4 times
- Painting and decorating- appeared 3 times
- Plastering drywall- appeared 3 times
- Joinery- appeared 3 times

While the above list helps to narrow down the troublesome trades but there are some limitations to QBCC top ten lists. Some of the limitations are:

The lists of top ten common defects are based on frequency (number of reported complaints) rather than its consequences (its impact to the stakeholders or monetary value). In order to quantify the risk, the impact of risk is equally important as its frequency. QBCC has not mentioned impacts of that top ten defects rather produced the list on the basis of the frequency of complaints received. Another limitation of those defects list is; it is only limited to the defects that have been reported. There may be lots of defects that have not been reported to QBCC or even unknown to the clients. These defects are usually post-handover defects or latent defects that were not known or seen during the building inspection process. Defects that are seen during the construction process or by the building inspector would have been fixed and it is not accompanied by the QBCC list of top ten defects. Client's mainly complaints to QBCC if there are disputes between them and the contractor during defect liability period, meaning if no disputes occur between the client and the contractor QBCC won't be informed about the defects and the defects won't make the top ten lists. So QBCC top ten defects do not give the whole picture of defects that are actually occurring in residential construction.

A separate study conducted in Spain during the construction process and post-handover (Forcada et al. 2014; Forcada, Macarulla & Love 2012) found that during the construction process defects were mainly related to structures and foundation such as incorrect positioning of frames and incorrect length of reinforcement bars. However, during construction process defects related to roofing, insulations, water problem was minimum, which has been identified as top defects by QBCC. Due to mandatory inspections during the construction process as mention in section 2.5 building approval, defects that have been detected during the construction process are addressed before handover (Forcada et al. 2014). Both Forcada et al. (2014) and Forcada, Macarulla and Love (2012) studies conducted in Spain and study conducted by Smith, Smith and Mitchell (2013) in Southeast Queensland found that there were minimum defects detected from front-end trades, while these studies also have shown that there are more defects associated with middle and back end trades. Different interpretation and perception of quality are identified as the reason for this by (Forcada et al. 2014; Forcada, Macarulla & Love 2012). While Smith, Smith and Mitchell (2013) identify the use of a large number of subcontractors during the final stages of construction as the reason for middle and backend end trade to be problematic.

In a nutshell, QBCC top ten lists do not provide the whole picture of defects occurring in residential construction, and there is a need to identify the troublesome trades in order to minimise or eradicates defects from residential construction.

The fact that QBCC has recently performed legislative reform in order to shift the accountability for defective work from the main contractor to the subcontractor also highlights the importance of identifying the troublesome trades. The reformed defect

policy ensures subcontractors are held accountable for defective works performed by them. After the policy change QBCC can direct the subcontractors to rectify the defective work if main contractor is not willing to fix the problem caused by the subcontractor, saying that main contractor cannot escape from their responsibility of supervision and if held accountable for not properly supervising the work of subcontractor will be subject to disciplinary action (Duffy 2015).

## 2.9 Defect Management

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The construction industry has adopted several practices to manage defects. According to Abeysekera (2015) some of the practices used in the construction industry for defect management are:

- Forms of contracts
- Contractual clauses
- Statutory requirements
- Integration of Quality management procedure with payment procedure
- Operational procedure for quality management
- Insurances
- Subcontracting
- Training education, licencing

However, the residential sector seems to be less committed towards defect management as the Standard form of contracts includes very few clauses on defect management (Abeysekera 2015). Surprisingly standard form of contracts introduced by Master Builders, Housing Industry Association or QBCC are silent on defect management. There is a lack of contract form for design and build residential projects, and contractual clauses are minimum compared to commercial contracts. However, QBCC's contract states that 'it is the responsibility of the owner and contractor to work together that the dwelling is constructed to an acceptable standard of quality and finish'. Domestic Building Contracts Act (Qld) also imposes contractors to exercise 'skill, care and competence' but they all lack in mentioning about good building practice (Abeysekera 2015). Statutory Inspection and certificates are mandatory. QBCC provides home warranty insurance for new dwellings. Defects documents are to be provided at the practical completion. Domestic Building Contracts Acts 2000 requires owner to be provided with defect documents at practical completion and is required to (Abeysekera 2015):

1. Provide agreed list of defects
2. State the time frame for rectification
3. List the defects only the homeowner believes to exist
4. Be signed by the homeowner and contractor

Defects are an issue that correlates with both quality and risk. Thus Quality management and risk management are both integral part of defect management. Perkins (2011) states that risk is the future of quality. Quality management process assists to deliver the product and services effectively (meet or exceed expectation), efficiently (without wasting resources) and economically (generate revenue) in other words being free from defects by meeting the expectation of the clients. Now if we look at the risk perspective, the definition of quality becomes the risk of defects, the risk of clients' dissatisfaction or

the risk of failing to achieve the objective.

## 2.10 Quality Management in Construction Industry

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### 2.10.1 Introduction to Quality Management

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Total quality management (TQM) has been a proven philosophy in the manufacturing and service industry, but there is a lack of commitment to adopt TQM in the construction industry, especially in the residential construction (Burati Jr, Matthews & Kalidindi 1991). Conventionally quality management principle and tools were not the integral part of the construction industry. Demands from clients for improved quality, service, faster building and innovations in technology have made the construction industry perform like a manufacturing industry. Thus the construction industry is slowly adopting quality management to solve quality problems. Due to the nature of construction industry where many parties are involved, implementing TQM principles are difficult but necessary (Hoonakker, Carayon & Loushine 2010). In the construction industry, the large amount of money and time are spent on reworks thus in order to prevent this, the level of quality management need to rise to prevent the defect from occurring.

A study conducted by Neese and Ledbetter (1991) on nine construction projects found that poor quality in construction projects is the major cause of reworks. Hoonakker, Carayon and Loushine (2010) states that involvement of various subcontractors, trades and suppliers in construction projects as a barrier for implementing TQM. Many subcontractors are small businesses that do not implement quality management. Poor performance from one trade will affect the next trade. Thus quality performance is difficult to measure. Abdul - Aziz (2002) also concluded in his study that due to the fact that in the majority of cases, contractors and subcontractors are selected on the basis of competition often on costs, thus implementing TQM principles is a daunting task for these small construction businesses. Many small businesses perceive TQM as an extra cost, but what they do not realise is the cost incurred by not achieving quality is higher than implementing TQM. If the work is non-conformance to quality the associated cost such as rework, correcting errors, responding to customer complaints, missing deadlines could be much higher for both contractors and the subcontractors.

### 2.10.2 Application of Quality Management

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Quality control is the important aspect of quality management. Historically quality control was only carried out by the inspection of goods and services just before the sale. Along with industrial revolution quality management also evolved to meet the high standard demands (Rumane 2016). In present days quality concept has evolved from just an inspection to quality control, quality assurance to reach the total quality management concept (Rumane 2016).

Quality Control (QC): QC is an important part of quality management that deals with operational techniques and activities to ensure competence and performance meet the requirement for quality (QualityGurus 2015). Quality control is associated with product, reactive, line function, find the defect, walk through and testing checkpoint review.

Through various tools and techniques, it helps to find and eliminate the cause for quality problems.

Quality Assurance (QA): QA is a systematic activities planned to implement within the quality system. It evaluates performances and services against a system, standard or specified requirement for customers. QA is associated with the process, pro-active, staff function, prevent the defect, quality audits, defining process, selection tools and training (QualityGurus 2015).

### 2.10.3 Quality Control Tools

There are varieties of quality control tools available. Seven basic quality tools are described briefly below:

- Cause and Effect Diagrams: Cause and effect diagram also known as Ishikawa or Fishbone chart helps to identify potential causes for particular quality problems. The head of the fish represents the quality problem, and head is connected to the spine, which is connected to the smaller bones that represent the causes such as suppliers, workers, machines, environment, process and materials. These causes can again be connected to the smaller bones that address the specific issues. For example, issues with workers could be connected to training, poor workmanship, supervision, etc.

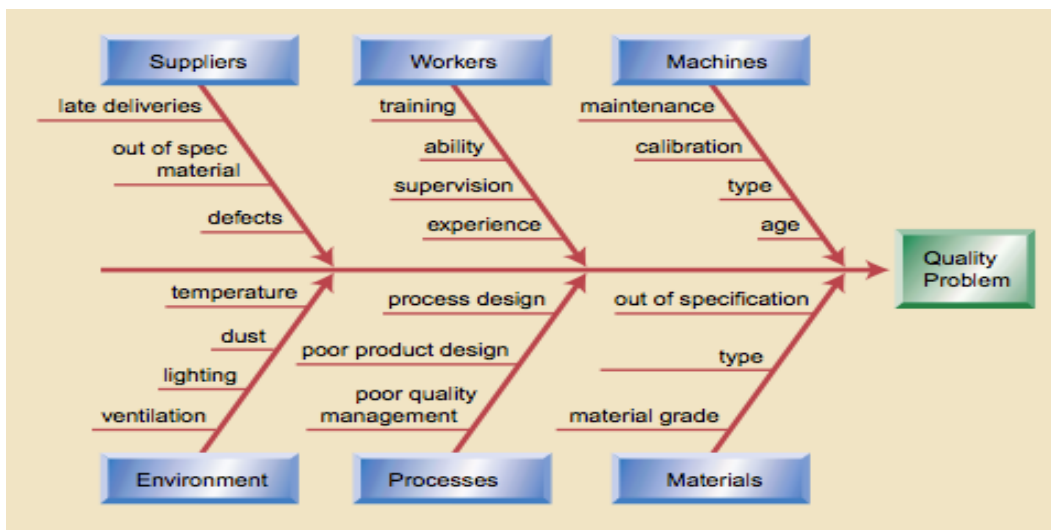


Figure 2.4: Example of fishbone diagram  
Source: (Chapter 5: Total Quality Management 2016)

- Flowchart: Flowchart provides a visual tool showing the steps or process involved in a project. It provides a clear picture of operational work and helps to identify where problems could arise.
- Checklist: Checklist provides lists of common defects and the frequency of these defects. Checklists allow management to focus on problematic areas by identifying them.
- Control charts: Control charts are used to study how process changes over time.



- Scatter diagram: Scatter diagrams are graphs used for detecting correlation or degree of linear relationship between two variables.
- Pareto Analysis: It is a technique used to show which factors are more significant and its degree of importance.
- Histograms: Histograms are used to show frequency distribution of observed values or occurrence of different values in a set of data.

#### 2.10.4 Consequences of not Implementing Quality Management

The poor quality performance of subcontractor's or main contractors can impact their reputation and has consequences in financial, operational, insurance, and legal matters. The table 2.12 below presents some of the consequences of defective work and the risk associated with it (Beyer 2012).

Table 2.11: Consequences of poor quality or defective work

<b>Consequences</b>	<b>Primary Risk</b>	<b>Secondary Risk</b>
Lessen productivity due to rework	Operational	Financial
Lessen profit due to rework	Financial	Reputation
Delayed turnover of completed projects	Operational	Reputation
Clients dissatisfaction	Reputation	Financial
Liquidated damages from hindered completion time	Financial	Legal
Higher deductibles, increased premiums, and/or lower limits for liability insurance	Insurance	Financial
Legal costs to defend against defect claims	Financial	Insurance/Legal
Damaged partnerships	Reputation	Operational
Fewer opportunities to bid or negotiate for future work due to damaged reputation	Financial	Reputation
Type and size of projects limited for future work due to lowered surety bond credit line	Financial	Reputation
Surety bond default and company survival threatened due to decreased corporate profitability	Financial	Reputation

Source: (Beyer 2012)

#### 2.11 Relevance of Risk Management to Defect Management

The concept of risk management is used in almost all industries from manufacturing, IT, service to the construction industry. It is one of the nine critical parts of project commissioning (Gajewska & Ropel 2011). However it important for a project manager to realise that risk management is not a tool that confirms success rather it is the tool, which increases the probability for achieving success if utilised correctly. It is a proactive concept rather than a reactive measures (Gajewska & Ropel 2011). Defects are of great risks for the construction industry. It can affect various parties such as clients, main

contractors or subcontractors, and not to mention the economic side of reworks. Thus, it is important to treat defect as a risk and implement proactive measures for its prevention rather than waiting for reactive action.

### 2.11.1 Introduction to Risk Management

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Although risk management is a broad topic and defining risk depends on the profession, project or industry. For this project, anything that challenges a project's success or obstacles to achieve the set goals (specifically related to defects) can be termed as risk (Gajewska & Ropel 2011). The concept of time, cost and quality are important for project's success and defects could impact all of these dimensions if not acted promptly. Quite often projects fail to meet deadlines, cost and quality targets due to the nature of construction industry it suffers from more risk and uncertainty than any other industries (Liu, Flanagan & Li 2003). Typically in the construction industry, any events that can affect the project goals of achieving cost, time and quality can be considered risks. Construction risk is varying in nature, such as some risk are easily predictable and identifiable while others are totally unpredictable. Although project success or failure is much more complex than just controlling or not being able to manage the risk, but the record shows that companies that have included risk as an integrated part of the project control and quality system have improved project success (Liu, Flanagan & Li 2003). Thus, the application of risk management can help stakeholders avoid failures in the construction industry.

Profit of construction industry can decrease with the inefficient and careless handling of risk. Thus, there is a need to improve the quality of risk management in the construction industry to arrest the ever-increasing defect trend. Risk management process involves three major component people, process and technology.

### 2.11.2 Risk Management Process

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The risk management process generally involves four major steps:

#### **Risk identification**

The purpose of risk identification is to eliminate them or to have control over them. If risks are identified before any consequences risk management is more effective and risk could be transferred to opportunities like profitability, competitive advantage, etc. for example, if causes of most defects are identified earlier in the project, than the cost of rework is drastically reduced, increasing profitability as well as improve competitive advantage. An experienced project manager with knowledge of critical elements that has been identified in previous projects, can keep track and see the early warnings signs of any of the targets time, cost and quality are not satisfied (Gajewska & Ropel 2011). While the consequences of poor quality or defective works are associated with various risk. According to Beyer (2012), the above-mentioned consequences of poor quality of work or defective works with risk, such as:

- Operational risk
- Financial risk
- Reputation risk

- Insurance risk
- Legal risk

### **Risk assessment/ analysis**

Risk analysis is the second step of the risk management process. It helps to find the impacts of each risk identified in the first step. Risk analysis assesses the risks and helps to prioritise the risks for necessary actions required. The risk assessment tool allows to (PERSEUS 2012):

- Emphasis on greatest risk and helps to make decision to allocate limited resources
- Helps to raise ‘what if’ question for potential managerial action
- Facilitate explicit identification of environmental values of concern
- Helps to prioritise future research by identifying knowledge gaps

Gajewska and Ropel (2011) states two methods for analysis of identified risk:

**Qualitative method:** Qualitative method is based on a descriptive scale that describes the likelihood and impact of risk. This method is much simpler than the quantitative method and used in a small or medium project where quick assessment is needed. When there is a lack of exact numerical data and lack of resources, but projects need to identify major impacts, this method suits the best. Some of the qualitative methods for risk analysis are; Risk Probability and impact assessment, Probability/impact risk rating matrix, Risk Urgency Assessment (Gajewska & Ropel 2011). Qualitative risk assessment basically calculates the magnitude of potential consequences (impact) and the frequency (probability) of these consequences to occur. Therefore, the risk is the product of impact and frequency, higher the probability of worse impact greater the risk (PERSEUS 2012). However, an event can have multiple consequences and capacity to impact multiple objectives, which should be taken into account (Australia/New Zealand Standard 2004).

**Quantitative method:** Quantitative method is a more precise method of quantifying risk, though it requires specific numerical data, which may not be readily available or requires in-depth analysis. Quantitative analysis usually requires complex software and skill personnel as well as correct data. The techniques such as Monte Carlo analysis, sensitivity analysis, Fault tree analysis, etc. can be used for quantitative analysis.

### **Risk Response**

The third step of risk management is taking necessary action. Depending on the risk, various strategy and approach could be chosen. Common strategies for risk treatment are (Australia/New Zealand Standard 2004):

- Avoiding the risk (discontinue the activity that gives rise to the risk)
- Create opportunity (taking or increasing the risk in order to pursue and opportunity)
- Remove the source
- Change the likelihood
- Change the consequences
- Share the risk
- Retain the risk by informed decision

## **Risk Monitoring**

All information related to identifying risks is collected and monitored in this step. Through this step new potential risks are identified and repeated throughout the project, overall project status is monitored. Discussion and sharing of experience of different risk's owners are also the part of this step. According to Australia/New Zealand Standard (2004) risk monitoring and review process should ensure:

- Control measures are effective and efficient throughout the process
- Obtain additional information to improve risk assessment
- Lessons are learned from near misses, changes, trends, success and failures
- Detect changes in both internal and external context
- Identify emerging risks

Typical risk associated with the construction industry as stated by Edwards (1995) include;

Client risks, supplier/subcontractor risks, constructional plant risks, direct contractor risks, financial risk, third party risks, overseas risks and litigation/arbitration risks. As this research project is taking a trade-based approach, the research will focus on the subcontractor risks. Edwards (1995) identifies some of the risk associated with the subcontractor or trade contractors are:

- Delay start by the nominated subcontractor
- Poor performance
- Quality of materials and workmanship
- Delivery of information
- Insolvency of nominated subcontractor

The main contractor isn't just letting subcontractor do their work but are responsible for the subcontracted work. In many occasions, default by a subcontractor could impact the project far beyond the value of work carried out by a subcontractor (Baartz et al. 2003).

Interestingly, many studies have been conducted implying defects as a risk, whereas this project has taken a trade-based approach meaning treating those troublesome trades as a risk. Through the literature review, it has been identified that one of the main causes of defects originates from the subcontractor that has performed the work. According to Bateson and Komidar (2008) opportunities could be created through risk management, reducing disputes and handling risks pays off in various ways:

- Reducing the bottom line: Rectification of defect incurs costs such as labour, materials and overheads. Overhead expenses include a large portion of insurance cost. These insurance costs could be kept low by avoiding or resolving defects quickly as possible. As insurance companies are more willing to provide insurance to construction companies with a fewer record of claims. As also mention in section 2.10.4 Consequences of not implementing quality management, reducing the bottom line is linked with financial risk, operational risk, and insurance.
- Increasing customer value: buying a house is one of the biggest investment in one's life and nobody wants problems associated with one's biggest investment it

just paid to have built. Handling of defects and complaints can have an impact on customer's satisfactions and negative word of mouth tales could have huge impacts on potential clients. Thus, contractors need to pay attention to quality as well as handle complaints promptly to keep the customer satisfied and spread positive word of mouth tales. This section relates to reputational risk and legal risk as mentioned in section 2.10.4 of consequence of not implementing quality management.

- Growing profitability: Reduction of defects opens opportunities for contractors and subcontractors. Profitability could be greatly increased by the reduction of unexpected cost and reputation for delivering value could enhance even further. This section relates to financial as well as reputational risk, as mentioned in section 2.10.4 of consequence of not implementing quality management.

Whether, its consequences of not implementing quality management or not having a proper risk management system, the risk associated with it are:

- Financial risk
- Operational risk
- Reputational risk
- Legal risk
- Insurance risk

## 2.12 Literature Summary

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The Construction industry is the third largest industry in Australia. It comprises 8% of Gross Domestic Product (GDP) and employs more than one million people, which are almost 9% of the total workforce (AI Group 2015). 82.2% of these businesses are trade based such as plumber, electrician, masonry, carpentry, etc. (AI Group 2015). However, despite trade contractors being the specialist on specific area defects are yet very much common and surprisingly it is increasing in number and value claimed (Queensland Building and Construction Commission 2015).

Through literature review, it has been identified that tradesman ship issues, whether it be knowledge-based, skill-based or violation can trigger defective work. Defects can either be seen during the construction process (patent defects) or may be seen during the defect liability period (latent defects). Patent defects are usually rectified before practical completion. Since the practical completion certificate is only issued after the rectification of a patent defect (Sommerville & McCosh 2006). While some latent defects are seen during the defect liability period, which contractors and subcontractors are obliged to fix. But not all defects are rectified without any disputes. Some defects lead to disputes requiring clients to make a formal complaint to the construction industry regulatory body, Queensland building and Construction Commission (QBCC) is the regulatory body in Queensland.

QBCC has been producing the list of top ten common defects each year in its annual report, but due to its limitations such as; 1. List of top ten defects released by QBCC is only based on frequency; QBCC has not provided the impacts of those defects. 2. Top ten lists are only limited to the defects that have been reported to QBCC. 3. Top ten lists do not include defects rectified during the construction process or during the defect liability period without disputes.

Thus, through literature review, it was deemed that QBCC top ten lists do not provide the whole picture of defect actually occurring in the Queensland residential construction. Thus, it was not sufficient to identify the troublesome trades by using this list. A more detailed study was deemed to be necessary which accompanies both frequency and impact to identify the troublesome trade.

Despite various construction acts, regulations, standards, codes, licensing regimes, building approvals and certification, other quality management approaches, buildings are still handed with defects. In developed countries such as Australia, subcontractors do most of the on-site work. According to Pratt (2011) in residential projects almost 80% of work is performed by subcontractors and often most of the on-site work is carried out by the sub-trades, leaving the main builders as the co-ordinator of various sub-trades. However, defects are still increasing in number and in monetary value. Thus, effective management of defect is a necessity. Some of the current practices as described by Abeysekera (2015) forms of contracts, contractual clauses, statutory requirements, integration of quality management procedures, insurances, subcontracting, training education and licensing. Despite these measures for managing defects, Defects are still seen, and disputes are still occurring in the construction industry. Non-conformance to quality standards gives rise to defects and occurrences of defects, risk the success of the project. Thus, quality management and risk management are an integral part of managing defects.

Through literature review, it has been identified that the consequences of not implementing quality management are:

1. Lessen productivity due to rework
2. Lessen profit due to rework
3. Delayed turnover of completed projects
4. Client's dissatisfaction
5. Liquidated damages from hindered completion time
6. Higher deductibles, increased premiums, and/or lower limits for liability insurance
7. Legal costs to defend against defect claims
8. Damaged partnerships
9. Fewer opportunities to bid or negotiate for future work due to damaged reputation
10. Type and size of projects limited for future work due to lowered surety bond credit line
11. Surety bond default and company survival threatened due to decreased corporate profitability

While the consequences of poor quality or defective works are associated with various risk. According to Beyer (2012), the above-mentioned consequences of poor quality of work or defective works with risk, such as:

- Operational risk
- Financial risk
- Reputation risk
- Insurance risk
- Legal risk

Above mentioned risk are not just capable of hampering contractors but capable of impacting all other stakeholders. Thus, these risks need to be tackled implementing proactive measures rather than waiting for reactive action. Risk management is the proactive measures and one of the critical aspects of project commissioning (Gajewska & Ropel 2011). Risk management process generally involves four major steps (Gajewska & Ropel 2011):

- Risk identification
- Risk assessment/ analysis
- Risk response
- Risk monitoring

Through proactive measures to identify risk, assessing the risk, responding to the risk and monitoring them, opens the door of opportunities. Some of the benefits are:

Operational- With proactive risk management, operational risk such as work halt, delays, could be minimised or eliminated.

Financial- Profitability could be greatly increased by the reduction of unexpected cost associated with defects.

Reputation- With fewer disputes between stakeholders, customer satisfaction increases and spread positive word of mouth tales.

Insurance- insurance companies are more willing to provide insurance to construction companies with fewer records of claims. Decrease insurance premium increases competitive advantage

Legal -With fewer risks, it is less likely to occur disputes ending in legal actions.

Interestingly many studies have been conducted implying defects as a risk, whereas this project has taken a trade-based approach meaning treating trades as a risk. Through the literature review, it has been identified that one of the main causes of defects originates from a subcontractor or trades that has performed the work. While some of these trades are riskier (causes more defects) than others, but there is a lack of enough research and literature to identify the riskier trades. Thus, this project aims to identify the risky trades that cause a significant amount of defects and strategies could be implemented to manage these risky trades.

## Chapter 3 Methodology

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### 3.1 Introduction

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Any research projects involve various numbers of sequential steps that generally begins with finding the research area, investigating the area for knowledge gap and formulating the research questions to fulfil the knowledge gap. Further, appropriate investigation method is chosen along with research design and data collection techniques. After vigorous analysis and the interpretation of the collected data conclusions are drawn (Gajewska & Ropel 2011).

Gathering of data requires a research method. Various instruments such as self-completion survey, structured/ semi-structured/ unstructured interviews, case study, etc. are available for data collection, but the selection of appropriate technique is vital. For the purpose of this dissertation, a qualitative research method has been chosen to gather the experience of selected samples. According to Noor (2008), people's experiences are captured through qualitative research method that is based on the socially constructed facts rather than objectively. Also, according to Bryman and Bell (2015) when theories are generated from the collected data it is an inductive approach of qualitative research method. Thus qualitative research method is the most suitable method for this dissertation as it uses people's experience. Participant's experience of various trades in relation to the likelihood and impact of having defects will be captured through the research design. Thus, qualitative risk analysis approach was undertaken to understand the level of performance risk of various trades. As well as strategies for managing troublesome trades will be captured through the research design.

In order to understand the level of performance risk of various trades and strategies to manage them in the residential construction sector, the questionnaire survey was chosen as a research method. The questionnaire survey was divided into two stages. The first stage was conducted to identify the level of performance risk in terms of defects for each trades listed. Second stage survey was to identify the strategies to manage most troublesome trades identified by the first stage of the survey. Google form was used to create both sets of the questionnaire and the link to the questionnaire was distributed to the participants electronically along with the information sheet.

### 3.2 Research Method

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Various methods for data collection was considered at the initial stage such as self-completion questionnaire, structured interview, observation, in- depth interviews, focus groups, case study, Delphi method, etc. For the first stage survey of this dissertation, there were 34 trades listed. For each trade, there were 3 questions thus interviews and Delphi technique that was considered at the initial stage of the dissertation deemed inappropriate as there were a large number of questions that were not suitable for interviews as well as gathering participant for two stages was not viable due to difficulty of organising industry professionals for multiple times. Similarly, a focus group was also ruled out due to difficulty in organising multiple professionals at the same time for two stages of the survey. A case study approach was also rejected as case studies have very



little basis for scientific generalisation (Zainal 2007). Generally case study include very small numbers of the subject, often just one, in this case, it would be inadequate to generalize the overall tendencies in Queensland from just a single case.

### 3.2.1 Selected Method

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The questionnaire survey was deemed to be the most appropriate method of data collection for the purpose of this dissertation. Questionnaire survey allows large amounts of information to be collected from a large number of people with limited effects on its validity and reliability. Likely, results of the questionnaire can be quantified quickly and easily by the researcher or by the use of the software package (University of Surrey 2016). Finally, an online questionnaire survey was deemed most appropriate due to both financial and time constraints. There were no extra costs associated with the online survey, Google form was used which is available for free. Another advantage of using online survey was distribution and collection of the survey was instant. Through an online questionnaire survey, a large number of participants could be reached in a very short period of time that could be completed by the participants in their own time. Once the survey was completed, responses were collected instantly in the Google drive, which is not possible in face-to-face interviews and other techniques. Although the disadvantage of questionnaire survey is the possibility of a low response rate, which will be overcome by sending the questionnaire to a large number of related organisations and industry professionals as possible, as low response rate is expected.

### 3.3 Survey Design

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The questionnaire survey was designed for the purpose of highlighting the general consensus amongst Queensland residential construction industry professionals on the relevant issues such as; identifying the level of performance risk of various trades and strategies for managing troublesome trades.

The first stage of the survey utilises 34 trades listed by the QBCC. Each trade has the same set of 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.

Second stage survey will only utilise 4 trades that are identified as most troublesome through the first stage of the survey. Waterproofing, Concreting and Swimming pool construction, maintenance and installation were identified as the high-risk trade. Although the Painting and decorating trade was identified as the moderate risk trade, it was identified as fourth most troublesome trade in the first stage survey but due to its appearances in several years in the QBCC top ten defects lists and only falling short to high-risk trade by a very little margin in the first stage survey, it was decided to include this trade for the second stage survey. The second survey will require the participant to select top three approaches out of 8 approaches provided to minimise defect in the particular trade. The first question will be in the format of the multiple-choice where various management strategies identified through the literature review are listed and

Participants were asked to select rank 1 strategy to minimise defects. Then the participants are asked to indicate the acceptability and implementability of those strategies using a linear scale format as well as comment on the implementability and acceptability on short answer format. The same set of questions is repeated for rank 2 and rank 3 strategies. Finally, participants are asked to recommend any other strategies that could be used to minimise defects for the troublesome trades identified.

### 3.4 Data Sample

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The sample consists of the people who participate in the dissertation study through voluntary time, energy, and information (Sumerson 2013). The selection of participant requires careful consideration about who will be the best people to help answer the research question. For the purpose of this dissertation, which is specific to the state of Queensland the requirement for the companies to be included in the selection processes is that they operate within the state of Queensland or individual participants that have worked in Queensland residential industry. In the survey questionnaire, participants are specifically asked that their response should relate to the experience within Queensland.

It was also deemed that roles such as Site Supervisor, Foreman, Building Certifier, Managing Director (building firm), Architect (project management), Project Manager (residential construction) within the residential construction industry are the reliable people to help answer the research question. The above mention roles within the industry are such that they have to work with various trades either directly or indirectly and have the knowledge of likelihood and impact of defect that arises during the residential construction and most importantly they are at the position where they have to manage those trades, or they are at the position where they can provide information on necessary measures to minimise defects in residential construction sector.

The distribution of initial survey questionnaire was decided to be released on Monday as the research conducted by (Zheng 2011) found that the survey invitations set out on Monday received highest response rate than any other day. According to Zheng (2011) surveys sent on Mondays collected 13% more responses than the average response rate. The first reminder for completing the survey was sent to the participants after a week, and the last reminder was sent after two weeks of the initial release. Both reminders were sent to all participants, as a participant who has responded to the survey could not be identified as survey being anonymous.

### 3.5 Ethics Approvals

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Survey questionnaire are often regarded as an easy research approach. However, in reality as with any other research approach conducting a good quality and real value survey requires time and effort and thought full considerations (Kelley et al. 2003). Any researcher involved in collecting data has an ethical duty to respect participants' autonomy. Participant's rights to confidentiality were always respected and any legal requirements on data protection were adhered to. Survey questionnaire was distributed only after the acceptance from the University of Southern Queensland Human Research and Ethics Committee. The acceptance from Human Research and Ethics Committee ensured that no participants were subjected to any potential physical or psychological risk. All participants were provided with the information sheet that provides detail

information about the project and the aim of the survey. Participant's consent was obtained in the tacit method.

Clicking on the 'Submit' button at the end of the questionnaire was accepted as an indication of participants consent to participate in this project.

### 3.6 Resource Requirement

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The project requires minimal to non-experimental work as it is mostly based on theoretical knowledge, which requires extensive research and manipulation of information. The major resource required outside the theoretical knowledge is the input from the industry professionals. Input from the industry professionals will be collected in the form of answers to the survey questionnaire. It is also required to obtain ethical clearance in order to conduct surveys and interviews; approval from the related faculty will be obtained before conducting any surveys and interviews.

Resources such as computer/laptop, notebook, the Internet, office software, Endnote and printer are required which are readily available at no extra costs.

### 3.7 Data Analysis

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Once required amount of responses were collected for the first stage of the survey, a thorough investigation was applied and responses from the industry professionals were summarised. Use of Google Form enables all responses to be transferred to Google sheet directly, which is very helpful to analyse the data. Each trade listed in the survey questionnaire were analysed separately. The formula ( $\text{Risk} = \text{Likelihood} * \text{Impact}$ ) was used to determine the risk factor for each trade. Once the analysis was carried out, the list of high-risk trades was identified by comparing the risk score of each trade to the risk matrix adopted from Project Management Institute (2000) body of knowledge. For the second stage of the survey only high-risk trades were used to identify the suitable management strategies. A detailed analysis of the data is presented in Chapter 4.

## Chapter 4 Results and Data Analysis

### 4.1 Introduction

As mentioned in Chapter 3, in the first stage survey, to identify the troublesome trade, an online questionnaire was sent out to the related professionals. The main goal was to identify the troublesome trades by conducting a qualitative risk analysis. The participants were asked to weigh the likelihood of having defects for the particular trade as well as the impact of having defects for that particular trade. The scale used for this assessment was on the scale of 1 to 5 where 1 being very low and 5 being very high. After getting required number of responses average rating of likelihood and impacts was calculated to the nearest number. Then the likelihood and impact were multiplied together in order to get the results. The result is then compared with the risk matrix provided in Table 4.3. The risk matrix is adopted from the Project Management Institute (2000) Body of Knowledge. Risk matrix table below shows the level of the risk. The risks marked with red colour in the upper right corner are the high risk. On the other hand, risks marked with yellow colour in the lower left corner are the low risks. The remaining risks in the middle section of the matrix are classified as moderate risk. In order to compare the results, likelihood and impact scale used in the online questionnaire are converted as shown in Table 4.1 and Table 4.2. This conversion was necessary so as to compare the result with risk matrix provided from Project Management Institute (2000) Body of Knowledge.

Table 4.1 Conversion of likelihood 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 4.2 Conversion of impact scale

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

Table 4.3 Risk Matrixes

Risk Score for a Specific Risk					
Likelihood	Risk Score = Likelihood*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				

## 4.2 Survey Distribution

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Approximately 500 surveys were distributed including Builders, Architects and building certifiers. Approximately 300 builders, 125 architect and 55 building certifiers were emailed either to their direct email or through the organisation's email. Unfortunately, responses rate were very low. Only 24 responses were received for the first stage survey. Participant's role and number of responses are as follows

1. Site supervisor-6
2. Foreman-2
3. Building certifier-1
4. Managing director- 2
5. Architect- 4
6. Project manager- 4
7. Quantity Surveyor-1
8. Customisation officer-1
9. Consultant-2
10. Contract administrator-1

The experience of respondents varies from 2 years to 41 years in residential construction industry. 22 respondents had 5 years or over experience in the industry. Since most of the respondent were highly experience in the industry reliability of the responses is expected to be high.

## 4.3 Responses for First Stage Survey

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Responses are analysed separately for each trade and a summary will be provided at the end of this section.

### **Trade 1 Concreting**

The first question in Concreting requested respondent to indicate the likelihood of having defects in this trade. Figure 4.1 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

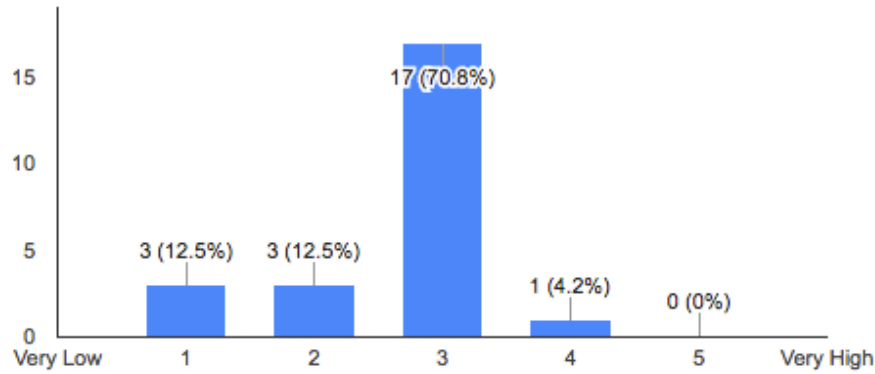


Figure 4.1: Response summary for likelihood of having defect (Concreting)

24 responses were received for the likelihood of having defects in concreting. 73.3% respondent rated the likelihood as 3.

Table 4.4 Analysis of likelihood of having defect in Concreting

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$3(1)+3(2)+17(3)+1(4)+0(5)=64$	3	0.5

The figure within the bracket is rating and number before relates to the number of responses for that rating.

The second question requested respondent to indicate the impact of having defects in Concreting. Figure 4.2 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

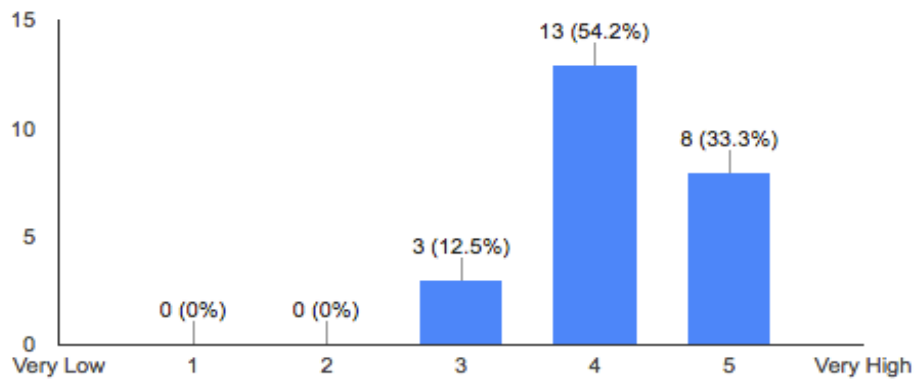


Figure 4.2: Summary of responses for Impact (Concreting)

24 responses were received. 54.2% respondent rated 4 and 33.3% respondent rated 5 for the impact of having defects for this trade.

Table 4.5 Analysis of impact of having defect in Concreting

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	0(1)+0(2)+3(3)+13(4)+8(5)=101	4	0.40

The figure within the bracket is rating and number before relates to the number of responses for that rating.

Table 4.6 Risk score for Concreting

Trade	Likelihood	Impact	Risk=L*I
Concreting	0.5	0.4	0.2

Comparing risk score for concreting with the risk matrix table 4.3, it falls under high-risk trade.

## Trade 2 Brick and Segmental Paving

The first question in Brick and Segmental Paving trade requested respondent to indicate the likelihood of having defects in this trade. Figure 4.3 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(24 responses)

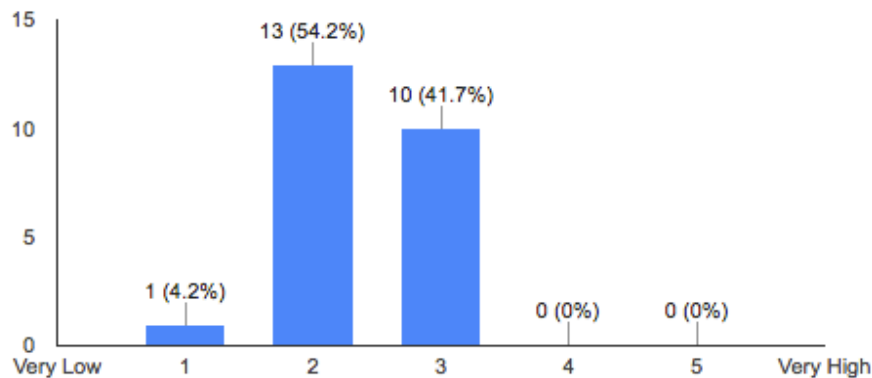


Figure 4.3: Response summaries for likelihood (Brick and Segmental Paving)

24 responses were received. 54.2% rated 2 and 41.7% rated 3 for the likelihood of having defects in brick and segmental paving.

Table 4.7 Analysis of likelihood of having defect in Brick and segmental Paving

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	1(1)+13(2)+10(3)+0(4)+0(5)=57	2	0.3

The figure within the bracket is rating and number before relates to the number of responses for that rating.

The second question in this trade requested respondent to indicate the impact of having defects. Figure 4.4 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

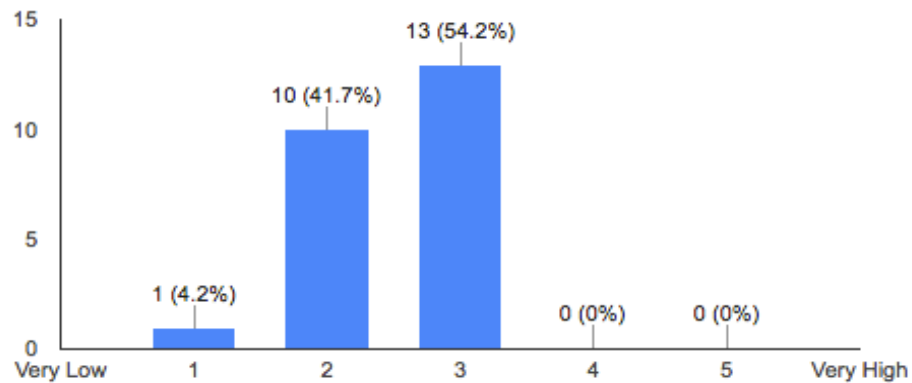


Figure 4.4: Responses summary for Impact (Brick and Segmental Paving)

24 responses were received. 41.7% rated 2 while 54.2% percentage rated 3 for the impact of having defects in this trade.

Table 4.8 Analysis of impact of having defect in Brick and segmental Paving

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	1(1)+10(2)+13(3)+0(4)+0(5)=60	3	0.10

The figure within the bracket is the rating and the number before relates to the number of responses for that rating.

Table 4.9 Risk score for Brick and segmental Paving.

Trade	Likelihood	Impact	Risk=L*I
Brick and segmental paving	0.3	0.20	0.06

Comparing risk score for Brick and segmental paving with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 3-Bricklaying and Blocklaying**

The first question in Bricklaying and Blocklaying trade requested respondent to indicate



the likelihood of having defects in this trade. Figure 4.5 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**

(24 responses)

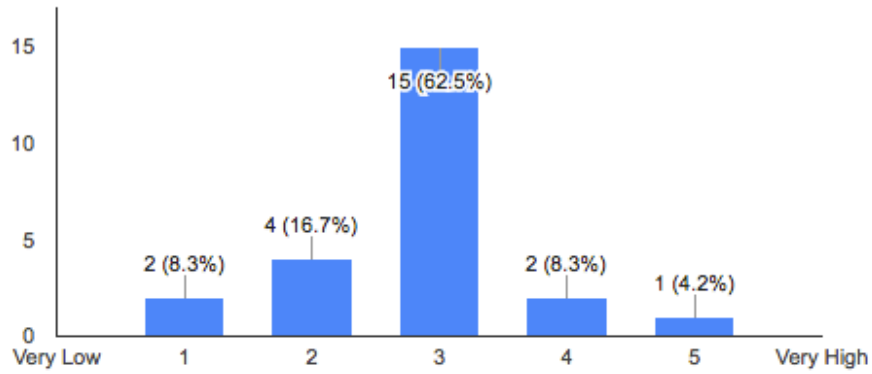


Figure 4.5: Responses summary for likelihood (Bricklaying and Blocklaying)

24 responses were received. 62.5% respondent rated 3 and 16.7% rated 2 for the likelihood of having defects in this trade.

Table 4.10 Analysis of likelihood of having defect in Bricklaying and Blocklaying

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$2(1)+4(2)+15(3)+2(4)+1(5)= 68$	3	0.5

The figure within the bracket is the rating and the number before relates to the number of responses for that rating.

The second question in this trade requested respondent to indicate the impact of having defects. Figure 4.6 provides the summary of the responses for this question.

## Please indicate the impact of having defects in this Trade.

(24 responses)

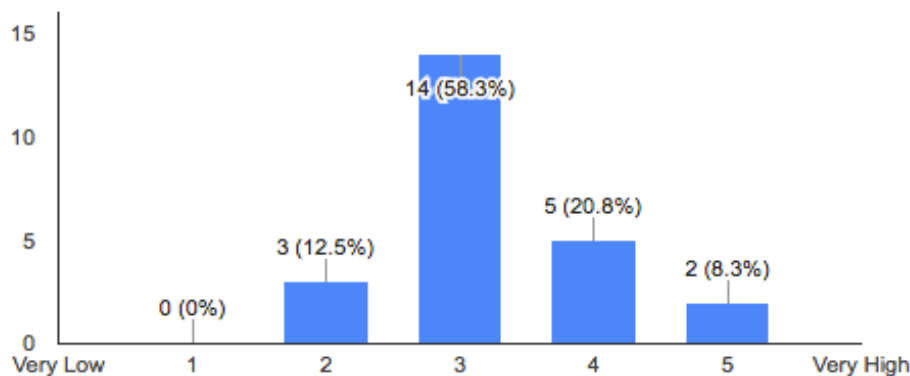


Figure 4.6: Responses summary for Impact (Bricklaying and Blocklaying)

24 responses were received. 58.3% respondent rated 3 while 20.8% rated 4 for the impact of having defects in this trade.

Table 4.11 Analysis of impact of having defect in Bricklaying and Blocklaying

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$0(1)+3(2)+14(3)+5(4)+2(5)= 78$	3	0.20

Table 4.12 Risk score for Bricklaying and Blocklaying

Trade	Likelihood	Impact	Risk=L*I
Bricklaying and Blocklaying	0.5	0.20	0.10

Comparing risk score for Bricklaying and Blocklaying with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 4- Cabinetmaking

The first question in Cabinet making requested respondent to indicate the likelihood of having defects in this trade. Figure 4.7 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

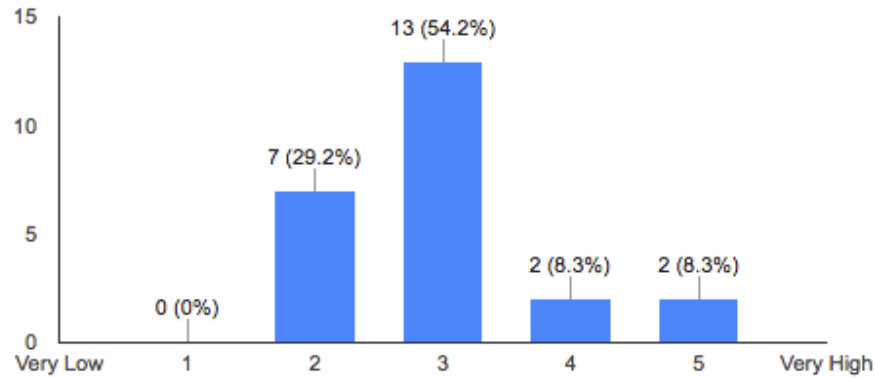


Figure 4.7: Response summaries for likelihood of having defect (Cabinetmaking)

24 responses were received for the likelihood of having defects in cabinetmaking. 54.2% respondent rated the likelihood as 3 while 29.2% rated 2.

Table 4.13 Analysis of likelihood of having defect in Cabinetmaking

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$0(1)+7(2)+13(3)+2(4)+2(5)=71$	3	0.5

The Second question requested respondent to indicate the impact of having defects in Cabinetmaking. Figure 4.8 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

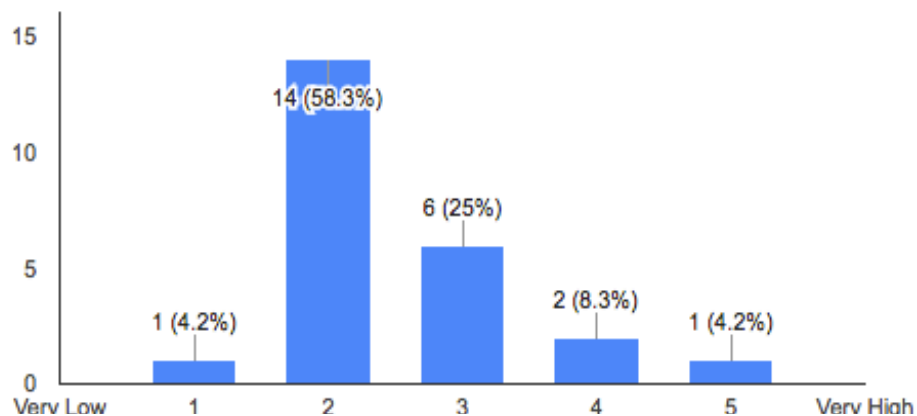


Figure 4.8: Response summaries for Impact (Cabinetmaking)

24 responses were received. 58.3% respondent rated 2 and 25% respondent rated 3 for the impact of having defects for this trade.

Table 4.14 Analysis of impact of having defect in Cabinetmaking

Number of respondent	Sum of Ratings	Average Rating	Conversion
15	1(1)+14(2)+6(3)+2(4)+1(5)= 60	3	0.20

Table 4.15 Risk score for Cabinetmaking

Trade	Likelihood	Impact	Risk=L*I
Concreting	0.5	0.20	0.1

Comparing risk score for Cabinetmaking with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 5- Air Handling and Duct installation

The first question in Air Handling and Duct installation requested respondent to indicate the likelihood of having defects in this trade. Figure 4.9 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(23 responses)

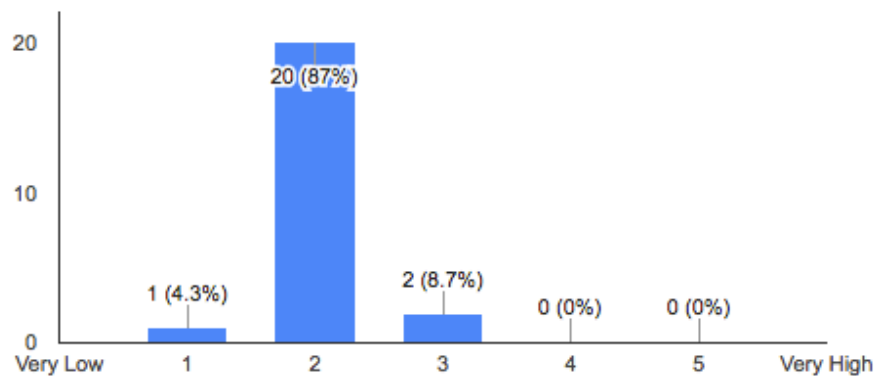


Figure 4.9: Response summary for likelihood of having defect (Air Handling and Duct Installation)

23 responses were received for the likelihood of having defects in Air Handling and Duct Installation. 87% respondent rated the likelihood as 2.

Table 4.16 Analysis of likelihood of having defect in Air Handling and Duct Installation

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
23	0(1)+20(2)+2(3)+0(4)+0(5)= 47	2	0.3

The second question requested respondent to indicate the impact of having defects in Air

Handling and Duct Installation. Figure 4.10 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(23 responses)

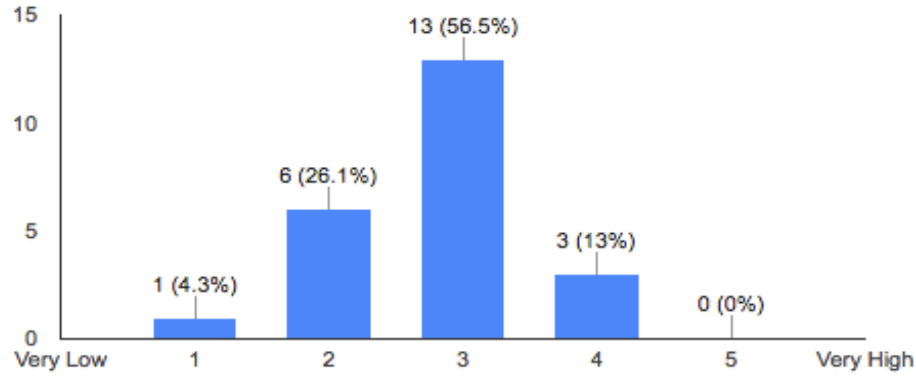


Figure 4.10: Response summary for Impact (Air Handling and Duct Installation)

23 responses were received. 56.5% respondent rated 3 and 26.1% respondent rated 2 for the impact of having defects for this trade.

Table 4.17 Analysis of impact of having defect in Air Handling and Duct Installation

Number of respondent	Sum of Ratings	Average Rating	Conversion
23	$1(1)+6(2)+13(3)+3(4)+0(5)= 64$	3	0.20

Table 4.18 Risk score for Air Handling and Duct Installation

Trade	Likelihood	Impact	Risk=L*I
Air Handling and Duct Installation	0.3	0.20	0.06

Comparing risk score for Air handling and Duct installation with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 6- Carpentry**

The first question in Carpentry requested respondent to indicate the likelihood of having defects in this trade. Figure 4.11 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

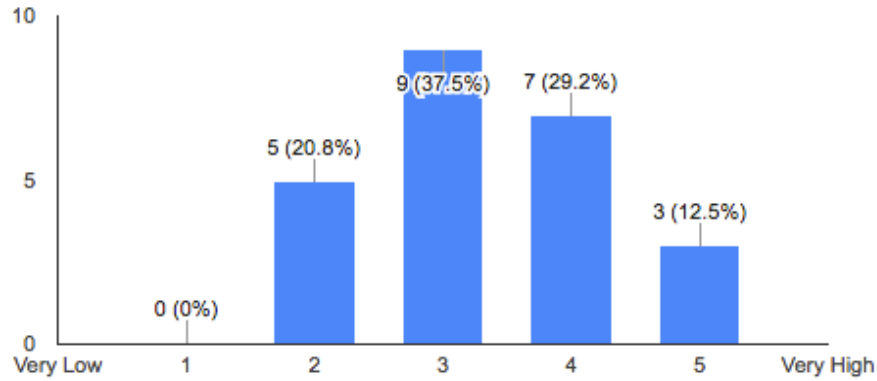


Figure 4.11: Response summary for likelihood of having defect (Carpentry)

24 responses were received for the likelihood of having defects in Carpentry. 37.5% respondent rated the likelihood as 3 and 29.2% rated 4.

Table 4.19 Analysis of likelihood of having defect in Carpentry

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$0(1)+5(2)+9(3)+7(4)+3(5)=80$	3	0.5

The second question requested respondent to indicate the impact of having defects in Carpentry. Figure 4.12 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

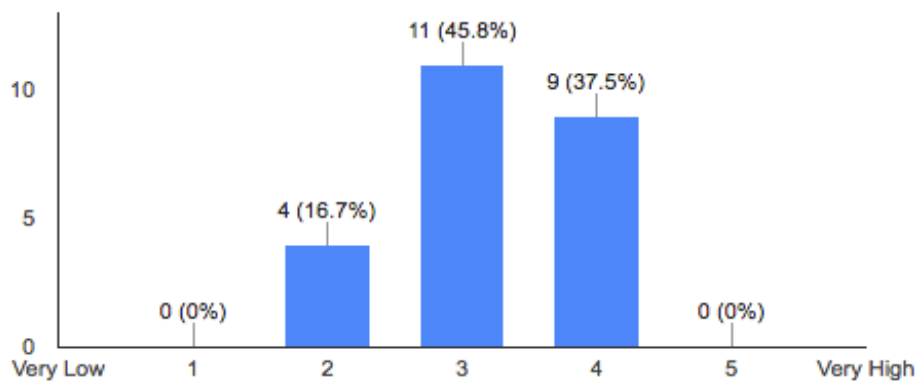


Figure 4.12: Response summary for Impact (Carpentry)

24 responses were received. 45.8% respondent rated 3 and another 37.5% respondent

rated 4 for the impact of having defects for this trade.

Table 4.20 Analysis of impact of having defect in Carpentry

Number of respondent	Sum of Ratings	Average Rating	Conversion
24	$0(1)+4(2)+11(3)+9(4)+0(5)= 77$	3	0.20

Table 4.21 Risk score for Carpentry

Trade	Likelihood	Impact	Risk=L*I
Carpentry	0.5	0.20	0.1

Comparing risk score for concreting with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 7- Drainage

The first question in Drainage requested respondent to indicate the likelihood of having defects in this trade. Figure 4.13 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

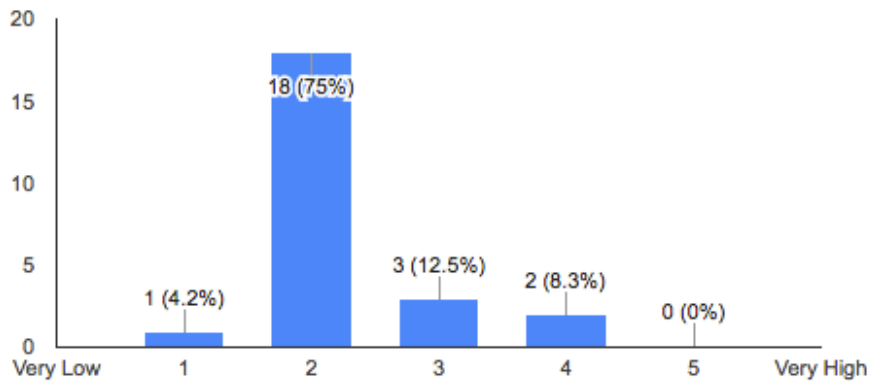


Figure 4.13: Response summary for likelihood of having defect (Drainage)

24 responses were received for the likelihood of having defects in Drainage. 75% respondent rated the likelihood as 2.

Table 4.22 Analysis of likelihood of having defect in Drainage

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+18(2)+3(3)+2(4)+0(5)= 54$	2	0.3

The second question requested respondent to indicate the impact of having defects in Drainage. Figure 4.14 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

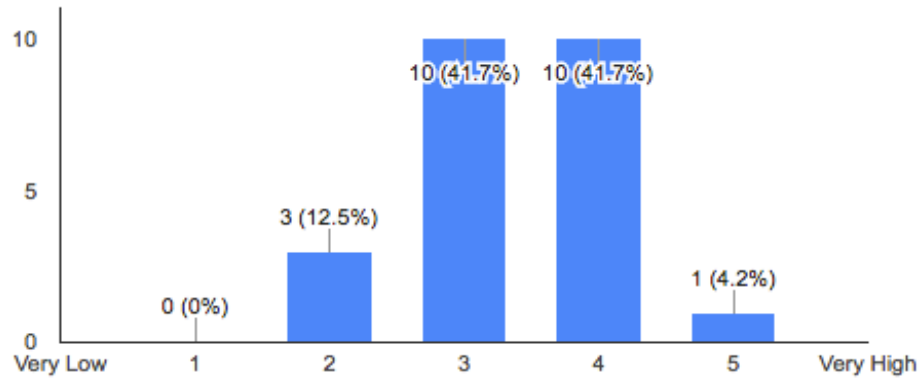


Figure 4.14: Response summary for Impact (Drainage)

24 responses were received. 41.7% respondent rated 3 and another 41.7% respondent rated 4 for the impact of having defects for this trade.

Table 4.23 Analysis of impact of having defect in Drainage

Number of respondent	Sum of Ratings	Average Rating	Conversion
24	$0(1)+3(2)+10(3)+10(4)+1(5)= 51$	3	0.20

Table 4.24 Risk score for Drainage

Trade	Likelihood	Impact	Risk=L*I
Drainage	0.3	0.20	0.06

Comparing risk score for Drainage with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 8- Drainage-On-site Sewerage**

The first question in Drainage-Onsite Sewerage requested respondent to indicate the likelihood of having defects in this trade. Figure 4.15 provides the summary of the responses for this question.



**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

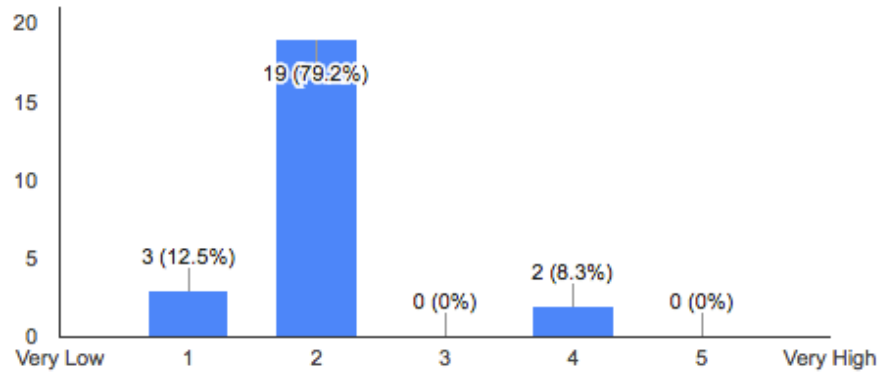


Figure 4.15: Response summary for likelihood of having defect (Drainage-On-site Sewerage)

24 responses were received for the likelihood of having defects in Drainage-On-site Sewerage. 79.2% respondent rated the likelihood as 2.

Table 4.25 Analysis of likelihood of having defect in Drainage-On-site Sewerage

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$3(1)+19(2)+0(3)+2(4)+0(5)= 49$	2	0.3

The second question requested respondent to indicate the impact of having defects in Drainage-On-site Sewerage. Figure 4.16 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

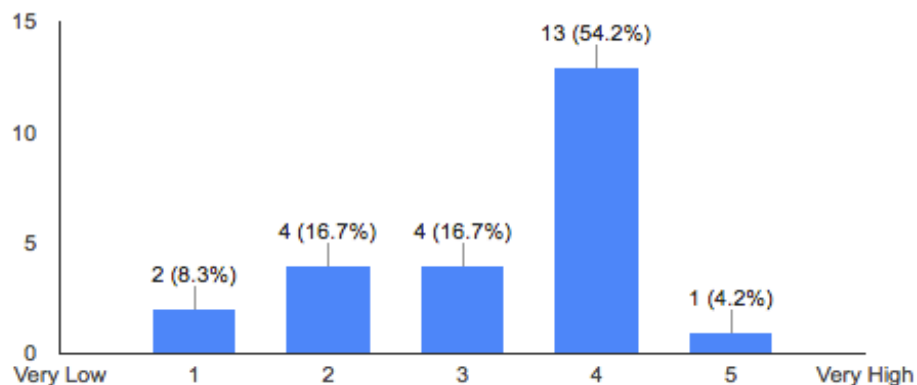


Figure 4.16: Response summary for Impact (Drainage-On-Site Sewerage)

24 responses were received. 54.2% respondent rated 4 and another 16.7% respondent rated 2 and 3 for the impact of having defects for this trade.

Table 4.26 Analysis of impact of having defect in Drainage-On-site Sewerage

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$2(1)+4(2)+4(3)+13(4)+1(5)=79$	3	0.20

Table 4.27 Risk score for Drainage-On-site Sewerage

Trade	Likelihood	Impact	Risk=L*I
Drainage-On-site Sewerage	0.3	0.20	0.06

Comparing risk score for Drainage-On-site Sewerage with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 9- Floor Finishing and Covering (hard sector)

The first question in Floor finishing and Covering (hard sector) requested respondent to indicate the likelihood of having defects in this trade. Figure 4.17 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

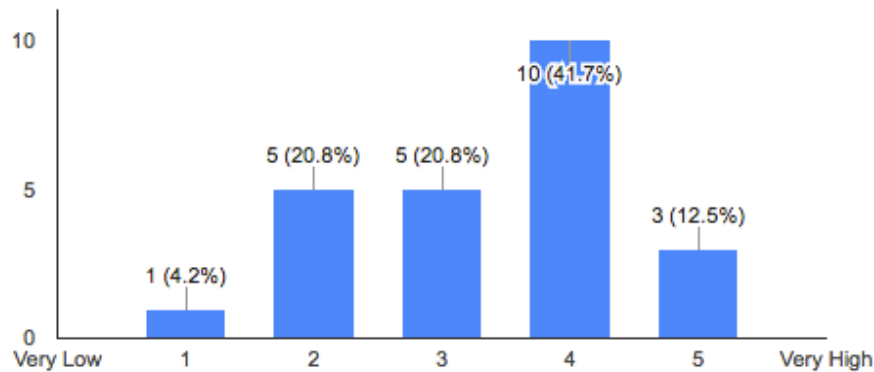


Figure 4.17: Response summary for likelihood of having defect (Floor Finishing and Covering (hard sector))

24 responses were received for the likelihood of having defects in Floor finishing and Covering (hard sector). 41.7% respondent rated the likelihood as 4 while 20.8% rated 2 and 3.

Table 4.28 Analysis of likelihood of having defect in Floor Finishing and Covering (hard sector)

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+5(2)+5(3)+10(4)+3(5)=81$	3	0.5

The second question requested respondent to indicate the impact of having defects in Floor Finishing and Covering (hard sector). Figure 4.18 provides the summary of the

responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

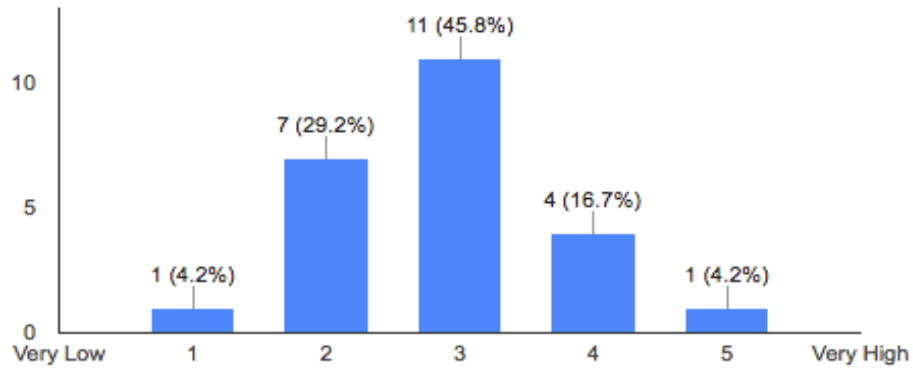


Figure 4.18: Response summary for Impact (Floor Finishing and Covering (hard sector))

24 responses were received. 45.8% respondent rated 3 and another 29.2% respondent rated 2 for the impact of having defects for this trade.

Table 4.29 Analysis of the impact of having defects in Floor Finishing and Covering (hard sector).

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$1(1)+7(2)+11(3)+4(4)+1(5)= 69$	3	0.20

Table 4.30 Risk score for Floor Finishing and Covering (hard sector).

Trade	Likelihood	Impact	Risk=L*I
Floor Finishing and Covering (hard sector)	0.5	0.20	0.1

Comparing risk score for Floor finishing and Covering (hard sector) with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 10- Foundation work (Pilling and Anchors)**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.19 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

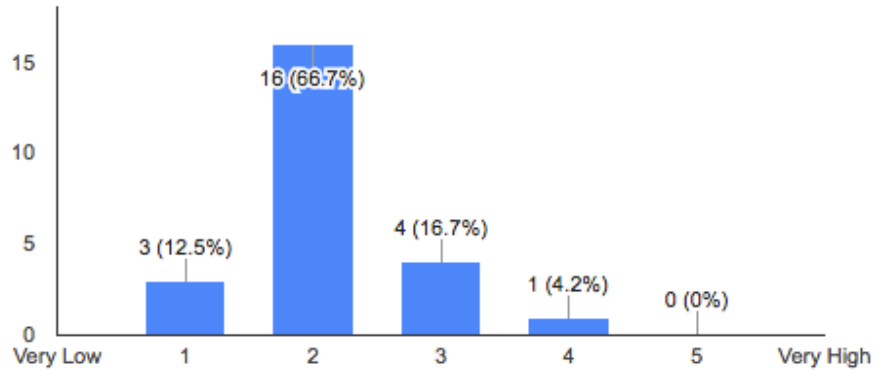


Figure 4.19: Response summary for likelihood of having defect (Foundation work (Piling and Anchors))

24 responses were received for the likelihood of having defects in Foundation work (Piling and Anchors). 66.7% respondent rated the likelihood as 2.

Table 4.31 Analysis of likelihood of having defect in Foundation work (Piling and Anchors)

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$3(1)+16(2)+4(3)+1(4)+0(5)=51$	2	0.3

The second question requested respondent to indicate the impact of having defects in this Trade. Figure 4.20 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

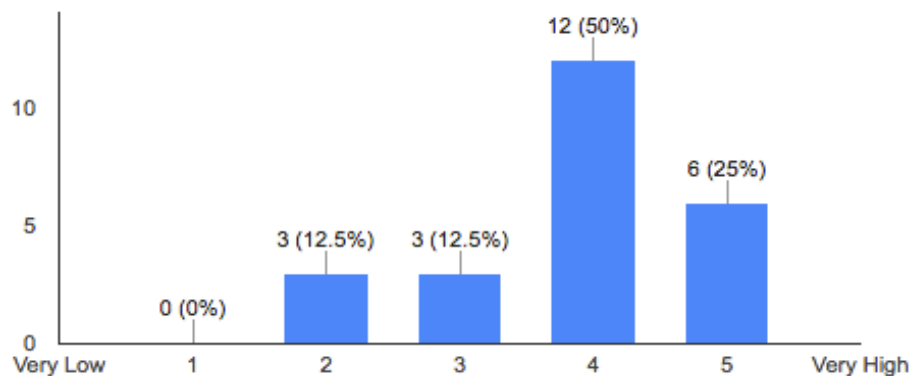


Figure 4.20: Responses summary for Impact (Foundation work (Piling and Anchors))

24 responses were received. 50% respondent rated 4 and another 25% respondent rated 5

for the impact of having defects for this trade.

Table 4.32 Analysis of the impact of having defects in Foundation work (Piling and Anchors).

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+3(2)+3(3)+12(4)+6(5)= 93$	4	0.40

Table 4.33 Risk score for Foundation work (Piling and Anchors).

Trade	Likelihood	Impact	Risk=L*I
Foundation work (Piling and Anchors)	0.3	0.40	0.12

Comparing risk score for Foundation work (Piling and Anchors) with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 11- Gasfitting

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.21 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(23 responses)

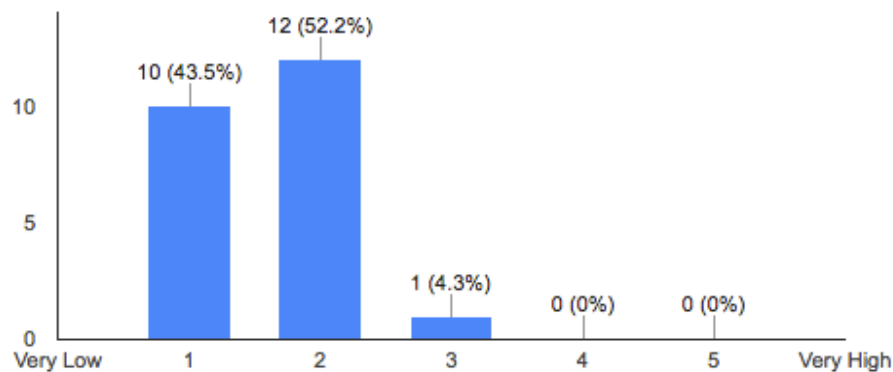


Figure 4.21: Response summary for likelihood of having defect (Gasfitting)

23 responses were received for the likelihood of having defects in this trade. 52.2% respondent rated the likelihood as 2 while 43.5% rated 1.

Table 4.34 Analysis of the likelihood of having defects in Gasfitting.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
23	$10(1)+12(2)+1(3)+0(4)+0(5)=37$	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.22 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(23 responses)

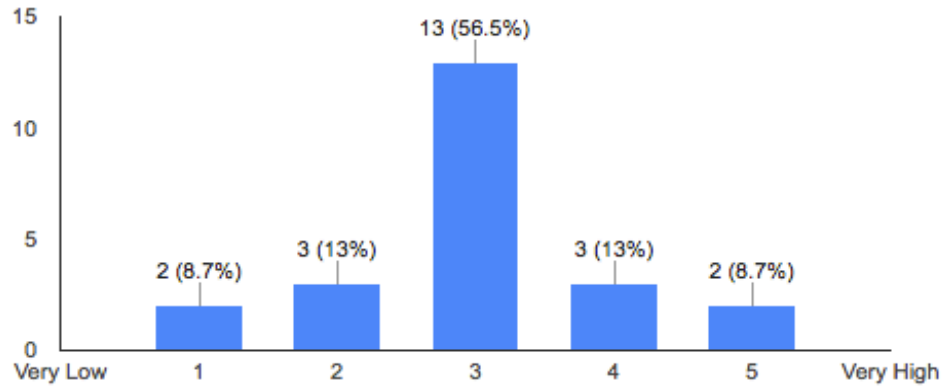


Figure 4.22: Response summary for Impact (Gasfitting)

23 responses were received. 56.5% respondent rated 3 for the impact of having defects in this trade.

Table 4.35 Analysis of the impact of having defects in Gasfitting.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
23	$2(1)+3(2)+13(3)+3(4)+2(5)= 69$	3	0.20

Table 4.36 Risk score for Gasfitting.

Trade	Likelihood	Impact	Risk=L*I
Gasfitting	0.3	0.20	0.06

Comparing risk score for Gasfitting with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 12- Glass, Glazing and Aluminium**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.24 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

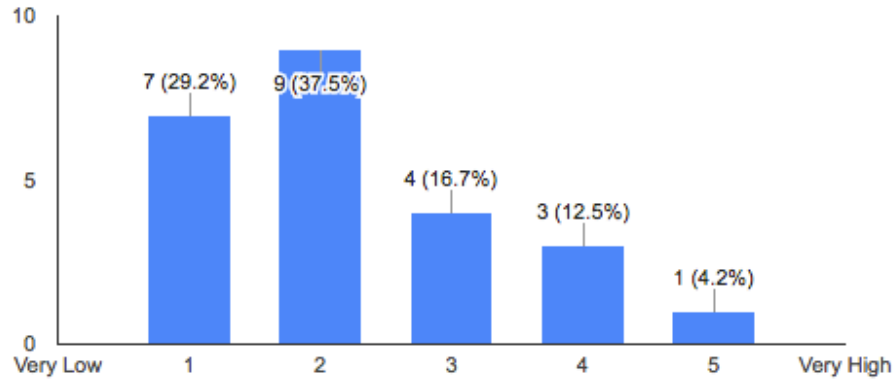


Figure 4.23: Response summary for likelihood of having defect (Glass, Glazing and Aluminium)

24 responses were received. 37.5% respondent rated the likelihood as 2 while 29.2% rated 4.

Table 4.37 Analysis of the likelihood of having defects in Glass, Glazing and Aluminium

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$7(1)+9(2)+4(3)+3(4)+1(5)= 54$	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.24 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

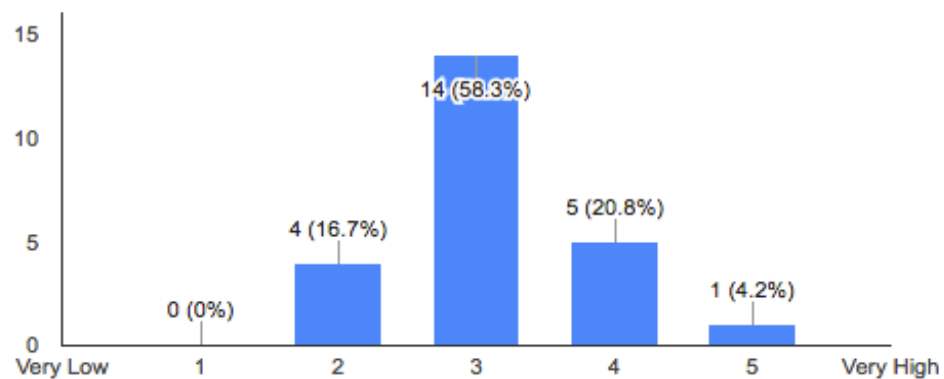


Figure 4.24: Response summary for Impact (Glass, Glazing and Aluminium)

24 responses were received. 58.3% respondent rated 3 and another 20.8% respondent rated 4 for the impact of having defects for this trade.

Table 4.38 Analysis of the impact of having defects in Glass, Glazing and Aluminium.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+4(2)+14(3)+5(4)+1(5)= 75$	3	0.20

Table 4.39 Risk score for Glass, Glazing and Aluminium.

Trade	Likelihood	Impact	Risk=L*I
Glass, Glazing and Aluminium	0.3	0.20	0.06

Comparing risk score for Glass, Glazing and Aluminium with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 13- Irrigation

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.25 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(24 responses)

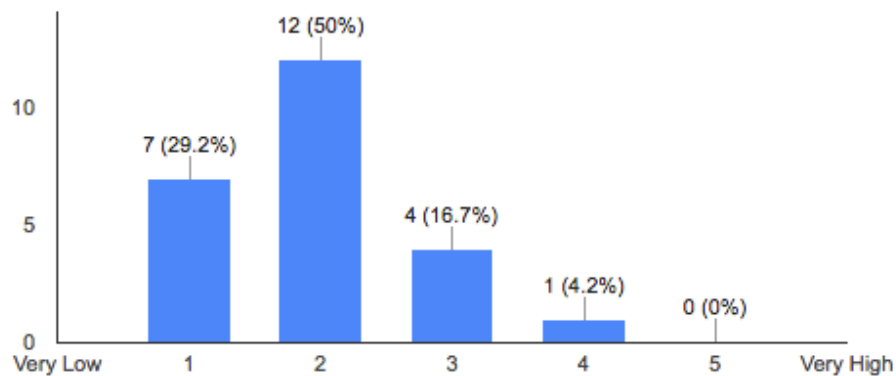


Figure 4.25: Response summary for likelihood of having defect (Irrigation)

24 responses were received. 50% respondent rated the likelihood as 2 while 29.2% rated 1.

Table 4.40 Analysis of likelihood of having defect in Irrigation

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$7(1)+12(2)+4(3)+1(4)+0(5)= 47$	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.26 provides the summary of the responses for this question.



## Please indicate the impact of having defects in this Trade.

(24 responses)

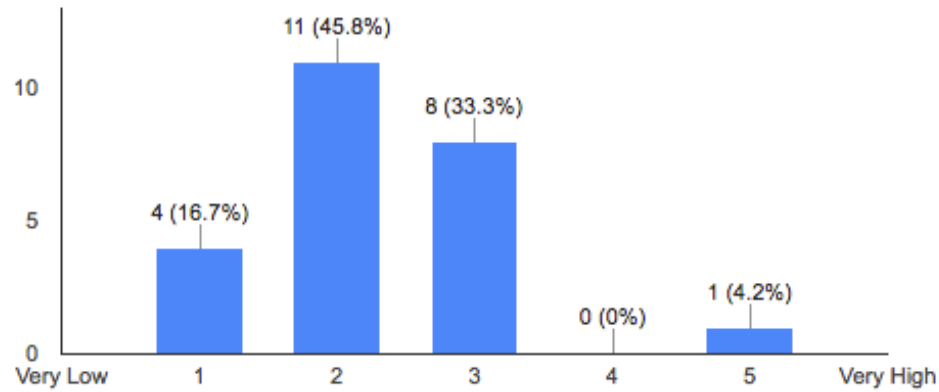


Figure 4.26: Response summary for Impact (Irrigation)

24 responses were received. 45.8% respondent rated 2 and another 33.3% respondent rated 3 for the impact of having defects in this trade.

Table 4.41 Analysis of the impact of having defects in Irrigation.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$4(1)+11(2)+8(3)+0(4)+1(5)= 55$	2	0.10

Table 4.42 Risk score for Irrigation.

Trade	Likelihood	Impact	Risk=L*I
Irrigation	0.3	0.10	0.03

Comparing risk score for Irrigation with the risk matrix table 4.3, it falls under low-risk trade.

### Trade 14- Joinery

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.27 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(23 responses)

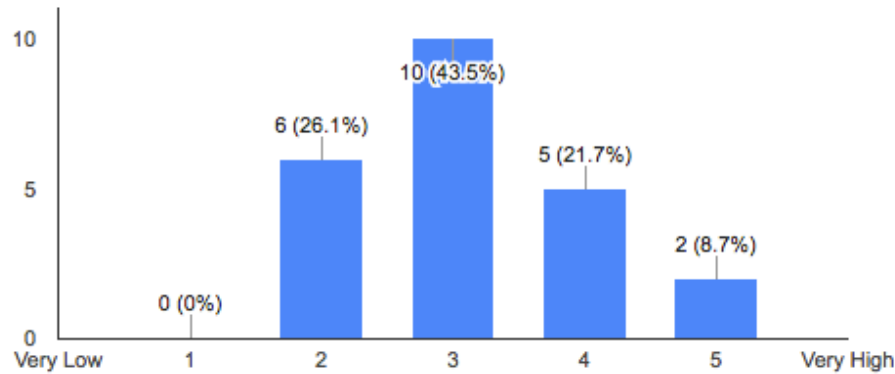


Figure 4.27: Response summary for likelihood of having defect (Joinery)

24 responses were received. 43.5% respondent rated the likelihood as 3 while 26.1% rated 4.

Table 4.43 Analysis of the likelihood of having defects in Joinery.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$0(1)+6(2)+10(3)+5(4)+2(5)= 72$	3	0.5

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.28 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(23 responses)

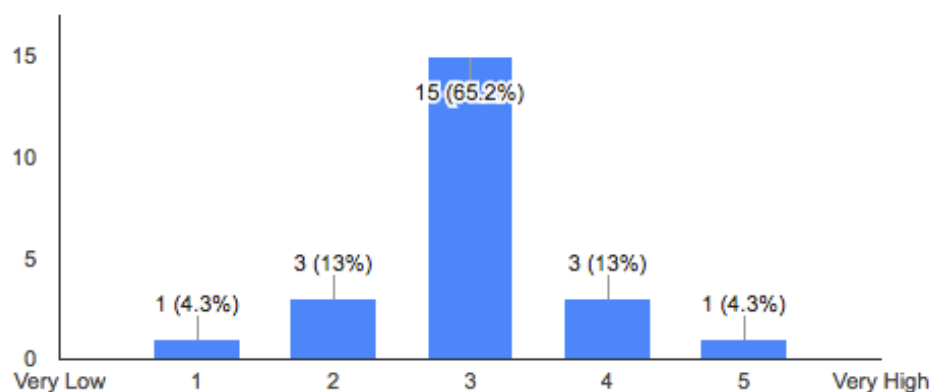


Figure 4.28: Response summary for Impact (Joinery)

24 responses were received. 65.25% respondent rated 3 while 13% respondent rated 2 for

the impact of having defects in this trade.

Table 4.44 Analysis of the impact of having defects in Joinery.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$1(1)+3(2)+15(3)+3(4)+1(5)= 69$	3	0.20

Table 4.45 Risk score for Joinery.

Trade	Likelihood	Impact	Risk=L*I
Joinery	0.5	0.20	0.10

Comparing risk score for Joinery with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 15- Metal fascias and Gutters

The First question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.29 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

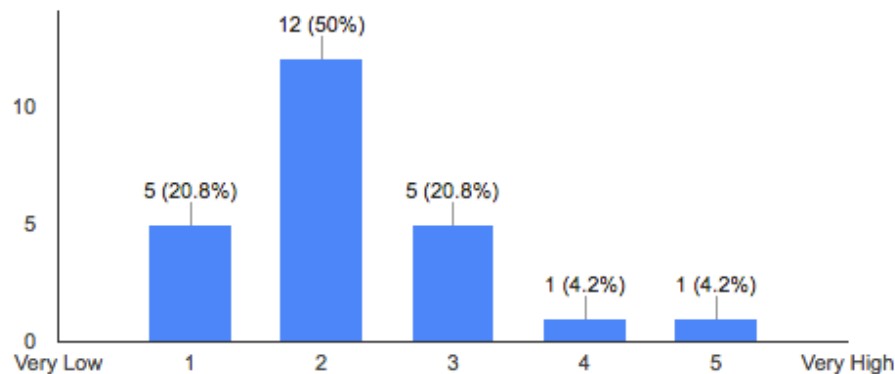


Figure 4.29: Response summary for likelihood of having defect (Metal fascias and Gutters)

24 responses were received. 50% respondent rated the likelihood as 2, while 20.8% respondents rated 1 and 3.

Table 4.46 Analysis of the likelihood of having defects in Metal fascias and Gutters

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$5(1)+12(2)+5(3)+1(4)+1(5)= 53$	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.30 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

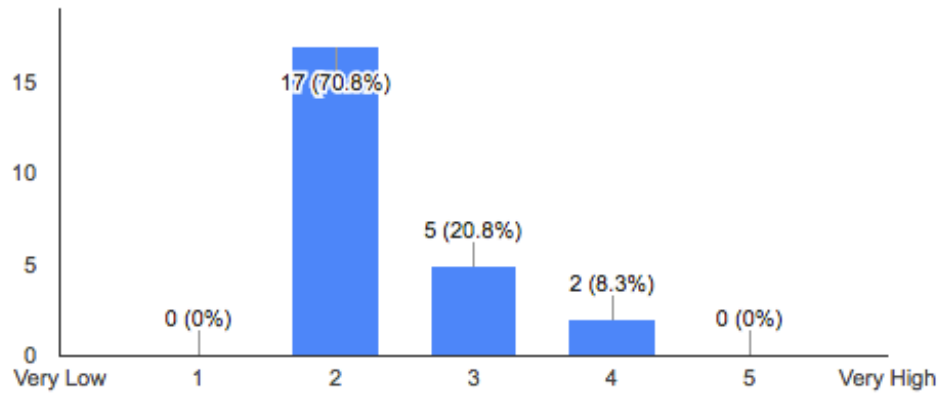


Figure 4.30: Responses summary for Impact (Metal fascias and Gutters)

24 responses were received. 70.8% respondent rated 2 and another 20.8% respondent rated 3 for the impact of having defects in this trade.

Table 4.47: Analysis of the impact of having defects in Metal fascias and Gutters.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+17(2)+5(3)+2(4)+0(5)= 57$	2	0.10

Table 4.48: Risk score for in Metal fascias and Gutters.

Trade	Likelihood	Impact	Risk=L*I
Metal fascias and Gutters	0.3	0.10	0.03

Comparing risk score for Metal fascias and Gutters with the risk matrix table 4.3, it falls under low-risk trade.

**Trade 16- Non-Structural metal fabrication and installation**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.31 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**

(24 responses)

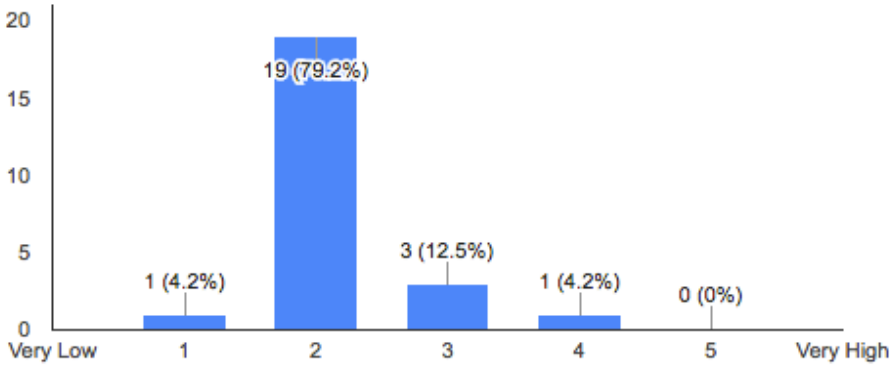


Figure 4.31: Response summary for likelihood of having defect (Non-Structural metal fabrication and installation)

24 responses were received. 79.2% respondent rated the likelihood as 2.

Table 4.49: Analysis of likelihood of having defect in Non-Structural metal fabrication and installation

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+19(2)+3(3)+1(4)+0(5)= 52$	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.32 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(24 responses)

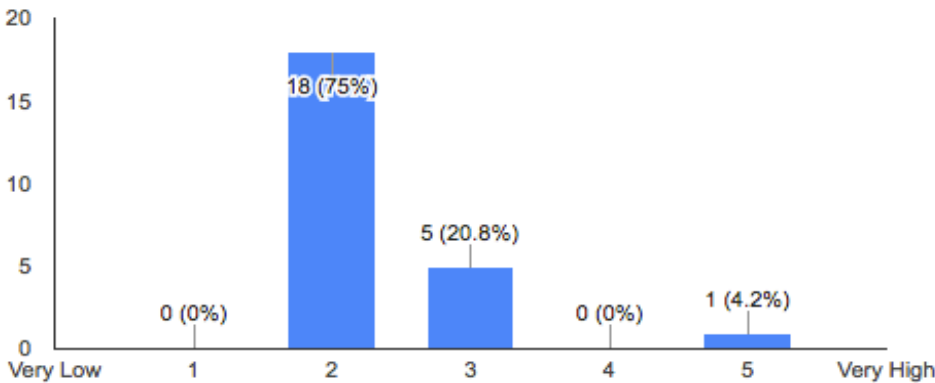


Figure 4.32: Responses summary for Impact (Non-Structural metal fabrication and installation)

24 responses were received. 79.2% respondent rated 2 and another 12.5% respondent rated 3 for the impact of having defects in this trade.

Table 4.50: Analysis of the impact of having defects in Non-Structural metal fabrication and installation.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	0(1)+18(2)+5(3)+0(4)+1(5)= 56	2	0.10

Table 4.51: Risk score for Non-Structural metal fabrication and installation.

Trade	Likelihood	Impact	Risk=L*I
Non-Structural metal fabrication and installation	0.3	0.10	0.03

Comparing risk score for Non-Structural metal fabrication and installation with the risk matrix table 4.3, it falls under low-risk trade.

### Trade 17- Painting and Decorating

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.33 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

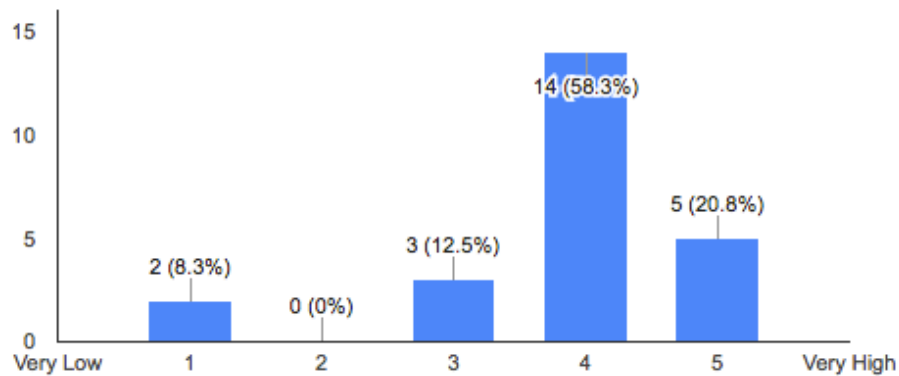


Figure 4.33: Response summaries for the likelihood of having defects (Painting and Decorating).

24 responses were received. 58.3% respondent rated the likelihood as 4 and 20.8% responded as 5.

Table 4.52: Analysis of likelihood of having defects in Painting and Decorating.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	2(1)+0(2)+3(3)+14(4)+5(5)= 92	4	0.70

The second question requested respondent to indicate the impact of having defects in this

trade. Figure 4.34 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

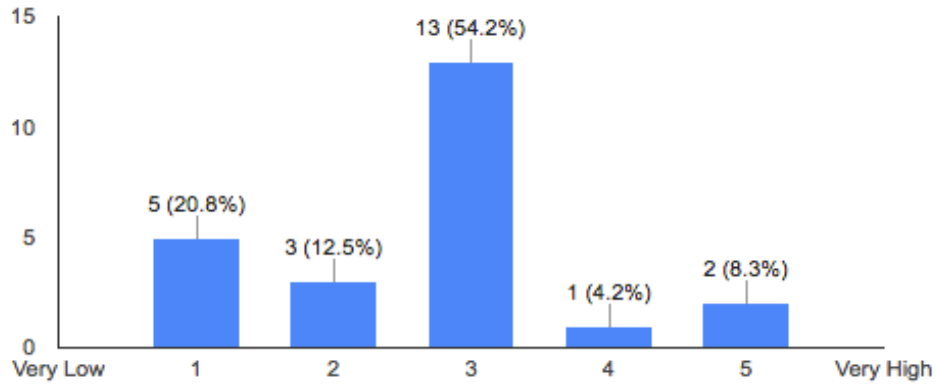


Figure 4.34: Responses summary for Impact (Painting and Decorating)

24 responses were received. 54.2% respondent rated 3 and another 20.8% respondent rated 1 for the impact of having defects in this trade.

Table 4.53: Analysis of the impact of having defects in Painting and Decorating.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$5(1)+3(2)+13(3)+1(4)+2(5)= 64$	3	0.20

Table 4.54: Risk score for Painting and Decorating.

Trade	Likelihood	Impact	Risk=L*I
Painting and Decorating	0.70	0.20	0.14

Comparing risk score for Painting and Decorating with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 18- Plastering Drywall**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.35 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

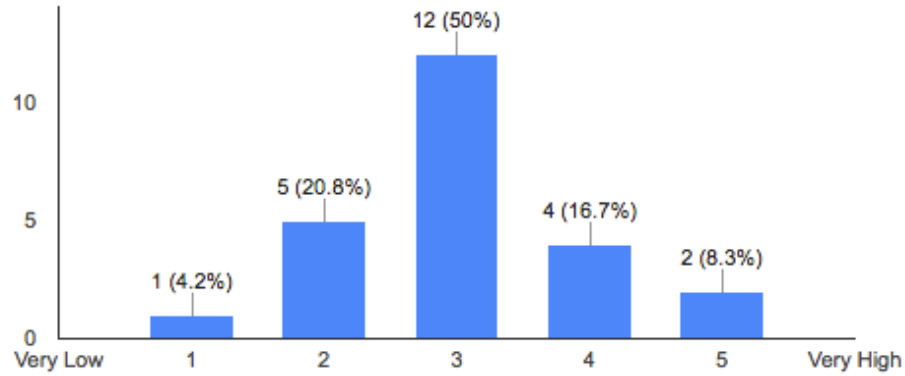


Figure 4.35: Response summaries for likelihood of having defect (Plastering Drywall)

24 responses were received. 50% respondent rated the likelihood as 3 and 20.8% responded as 2.

Table 4.55: Analysis of likelihood of having defects in Plastering Drywall.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+5(2)+12(3)+4(4)+2(5)= 73$	3	0.5

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.36 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

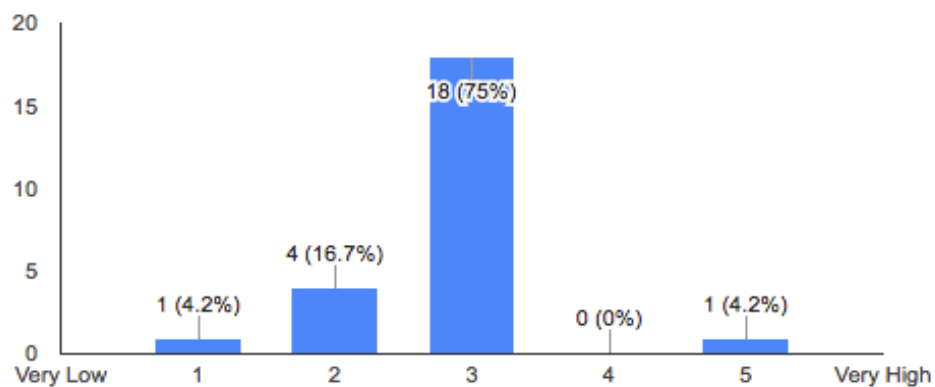


Figure 4.36: Responses summary for Impact (Plastering Drywall)

24 responses were received. 75% respondent rated 3.



Table 4.56: Analysis of the impact of having defects in Plastering Drywall.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$1(1)+4(2)+18(3)+0(4)+1(5)= 68$	3	0.20

Table 4.57: Risk score for Plastering Drywall.

Trade	Likelihood	Impact	Risk=L*I
Plastering drywall	0.50	0.20	0.1

Comparing risk score for Plastering Drywall with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 19- Plastering Solid

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.37 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(24 responses)

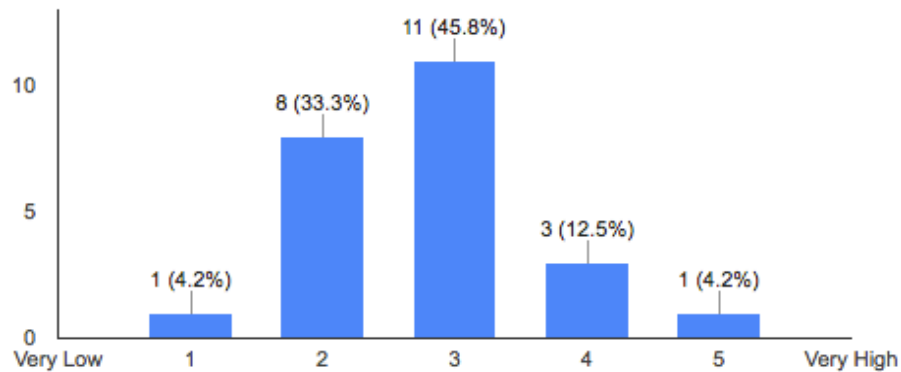


Figure 4.37: Response summaries for likelihood of having defect (Plastering Solid)

24 responses were received. 45.8% respondent rated the likelihood as 3 and 33.3% responded as 2.

Table 4.58: Analysis of the likelihood of having defects in plastering solid.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+8(2)+11(3)+3(4)+1(5)= 67$	3	0.5

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.38 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

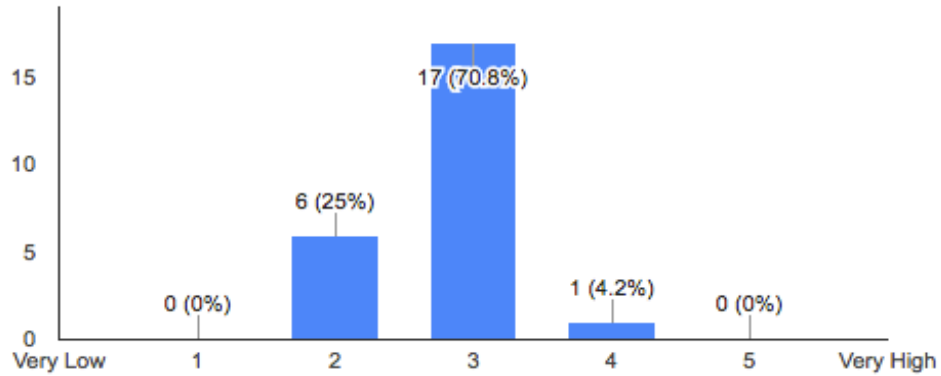


Figure 4.38: Responses summary for Impact (Plastering solid)

24 responses were received. 70.8% respondent rated 3 and 25% rated 2.

Table 4.59 Analysis of the impact of having defects in Plastering solid.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+6(2)+17(3)+1(4)+0(5)= 67$	3	0.20

Table 4.60: Risk score for Plastering solid.

Trade	Likelihood	Impact	Risk=L*I
Plastering solid	0.50	0.20	0.1

Comparing risk score for Plastering solid with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 20- Plumbing and drainage**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.39 provides the summary of the responses for this question.

## Please indicate the likelihood of having defects in this Trade.

(24 responses)

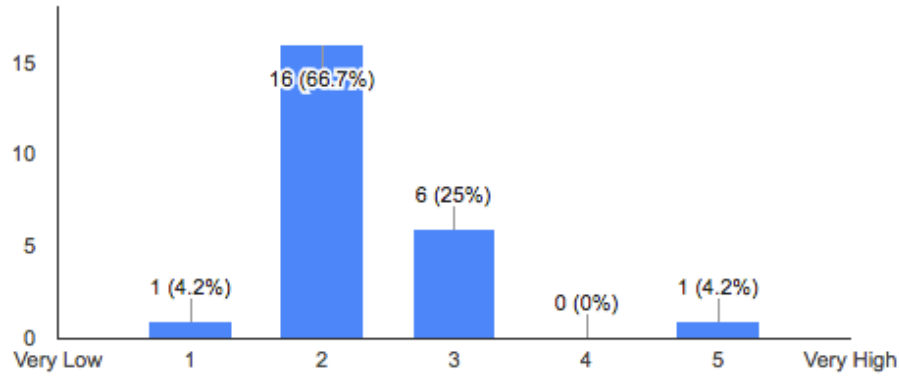


Figure 4.39: Response summaries for likelihood of having defect (Plumbing and drainage)

24 responses were received. 66.7% respondent rated the likelihood as 2 and 25% responded as 3.

Table 4.61: Analysis of the likelihood of having defects in Plumbing and drainage.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+16(2)+6(3)+0(4)+1(5)= 56$	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.40 provides the summary of the responses for this question.

## Please indicate the impact of having defects in this Trade.

(24 responses)

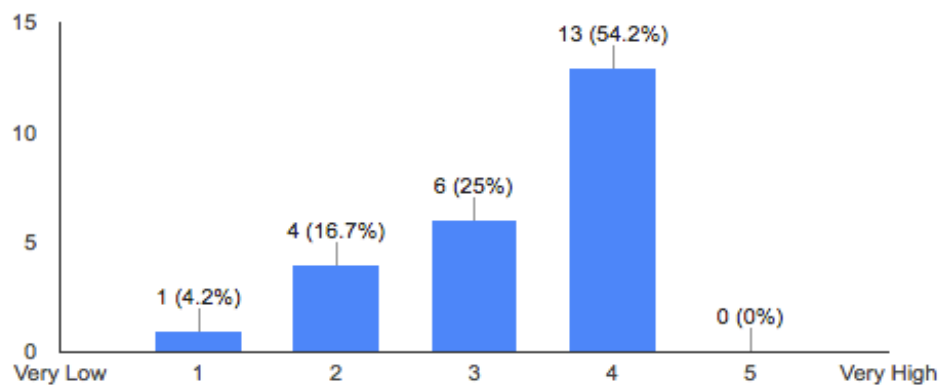


Figure 4.40: Responses summary for Impact (Plumbing and drainage)

24 responses were received. 54.2% respondent rated 4 and 25% respondent rated 3 for the impact.

Table 4.62: Analysis of the impact of having defects in Plumbing and drainage.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
15	$1(1)+4(2)+6(3)+13(4)+0(5)= 79$	3	0.20

Table 4.63: Risk score for Plumbing and drainage.

Trade	Likelihood	Impact	Risk=L*I
Plumbing and drainage	0.30	0.20	0.06

Comparing risk score for Plumbing and drainage with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 21- Refrigeration, air conditioning and mechanical services including unlimited design**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.41 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

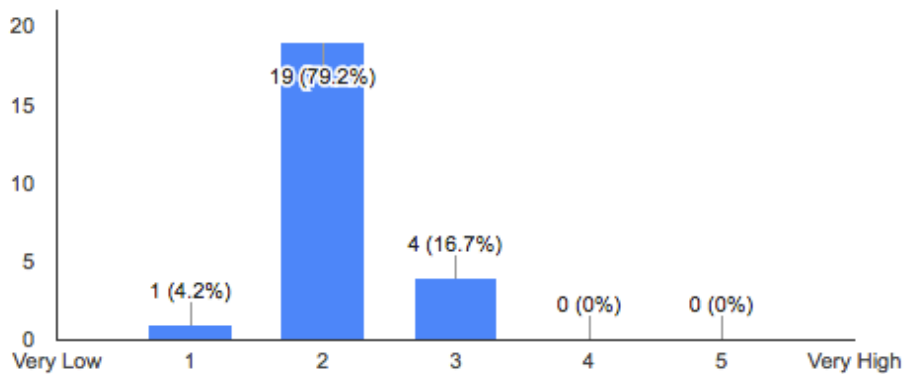


Figure 4.41: Response summaries for likelihood of having defect (Refrigeration, air conditioning and mechanical services including unlimited design)

24 responses were received. 79.2% respondent rated the likelihood as 2 and 16.7% responded as 3.

Table 4.64: Analysis of the likelihood of having defects in Refrigeration, air conditioning and mechanical services including unlimited design.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+19(2)+4(3)+0(4)+0(5)= 51$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.42 provides the summary of the responses for this question.

## Please indicate the impact of having defects in this Trade.

(24 responses)

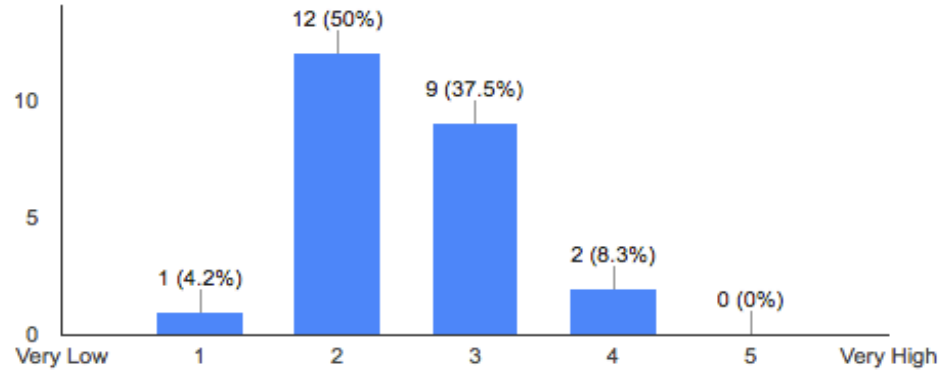


Figure 4.42: Responses summary for Impact (Refrigeration, air conditioning and mechanical services including unlimited design)

24 responses were received. 50% respondent rated 2 and 37.5% rated 3 for the impact.

Table 4.65: Analysis of the impact of having defects in Refrigeration, air conditioning and mechanical services including unlimited design.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$1(1)+12(2)+9(3)+2(4)+0(5)= 60$	3	0.20

Table 4.66: Risk score for Refrigeration, air conditioning and mechanical services including unlimited design.

Trade	Likelihood	Impact	Risk=L*I
Refrigeration, air conditioning and mechanical services including unlimited design	0.3	0.20	0.06

Comparing risk score for Refrigeration, air conditioning and mechanical services including unlimited design with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 22- Roof and wall cladding

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.43 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

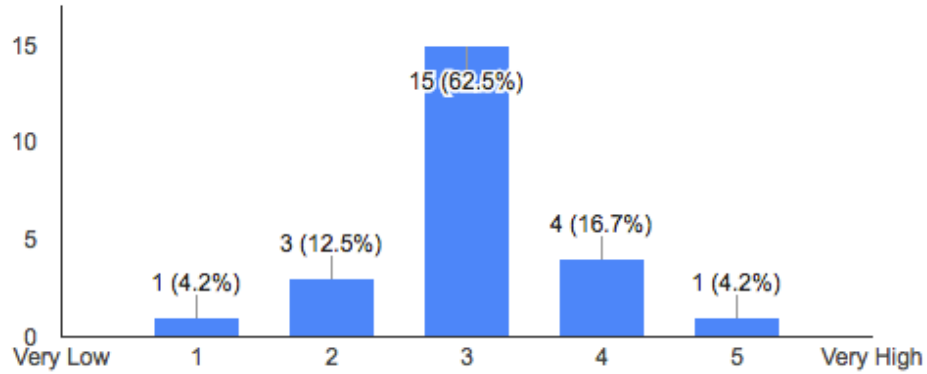


Figure 4.43: Response summaries for likelihood of having defect (Roof and wall cladding)

24 responses were received. 62.5% respondent rated the likelihood as 3 and 16.7% responded as 4.

Table 4.67: Analysis of the likelihood of having defects in Roof and wall cladding.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+3(2)+15(3)+4(4)+1(5)= 73$	3	0.50

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.44 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

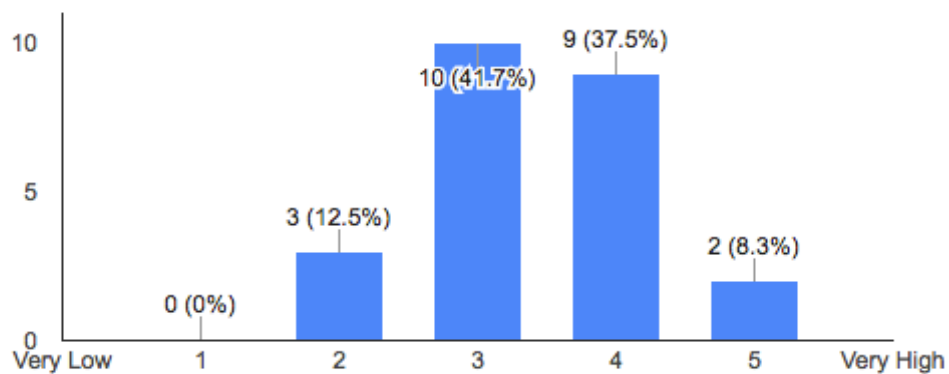


Figure 4.44: Responses summary for Impact (Roof and wall cladding)

24 responses were received. 41.7% respondent rated 3 while 37.5% respondents rated 4 for the impact in this trade.

Table 4.68: Analysis of the impact of having defects in Roof and wall cladding.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+3(2)+10(3)+9(4)+2(5)= 82$	3	0.20

Table 4.69: Risk score for Roof and wall cladding

Trade	Likelihood	Impact	Risk=L*I
Roof and wall cladding	0.5	0.20	0.1

Comparing risk score for Roof and wall cladding with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 23- Roof tiling

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.45 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(24 responses)

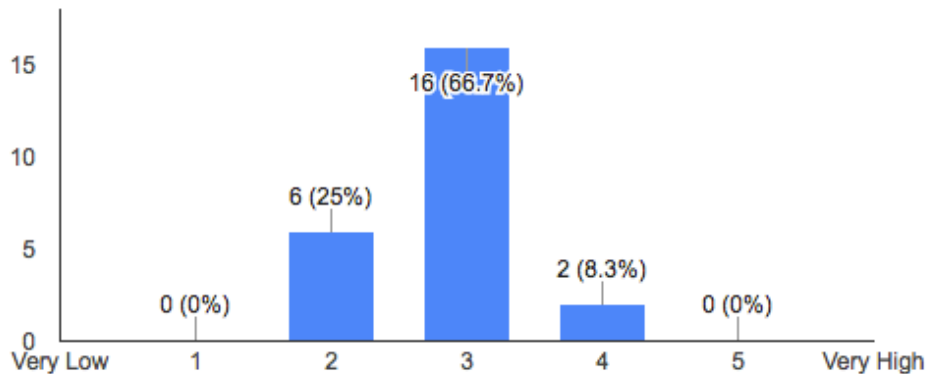


Figure 4.45: Response summaries for likelihood of having defect (Roof tiling)

24 responses were received. 66.7% respondent rated the likelihood as 3 and 25% responded as 2.

Table 4.70: Analysis of the likelihood of having defects in Roof tiling.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$0(1)+6(2)+16(3)+2(4)+0(5)= 68$	3	0.50

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.46 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

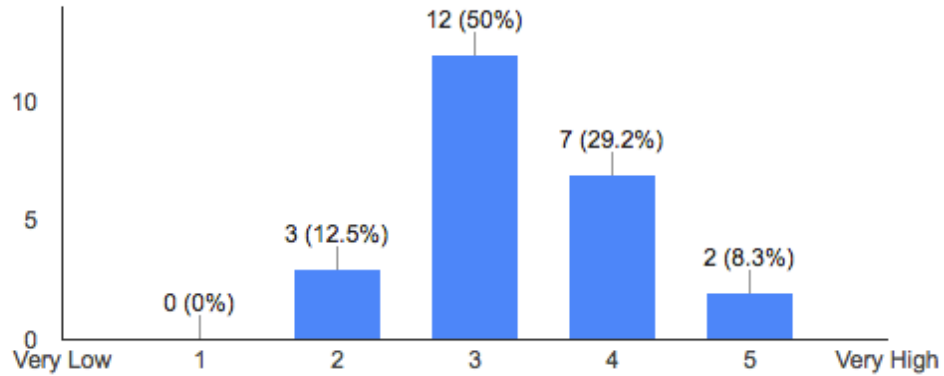


Figure 4.46: Responses summary for Impact (Roof tiling)

24 responses were received. 50% respondent rated 3, while 29.2% rated 4 for the impact.

Table 4.71: Analysis of the impact of having defects in Roof tiling.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
21	$0(1)+16(2)+4(3)+0(4)+1(5)= 80$	3	0.20

Table 4.72: Risk score for Roof tiling.

Trade	Likelihood	Impact	Risk=L*I
Roof tiling	0.5	0.20	0.1

Comparing risk score for Roof tiling with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 24- Site classifier**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.47 provides the summary of the responses for this question.



**Please indicate the likelihood of having defects in this Trade.**

(24 responses)

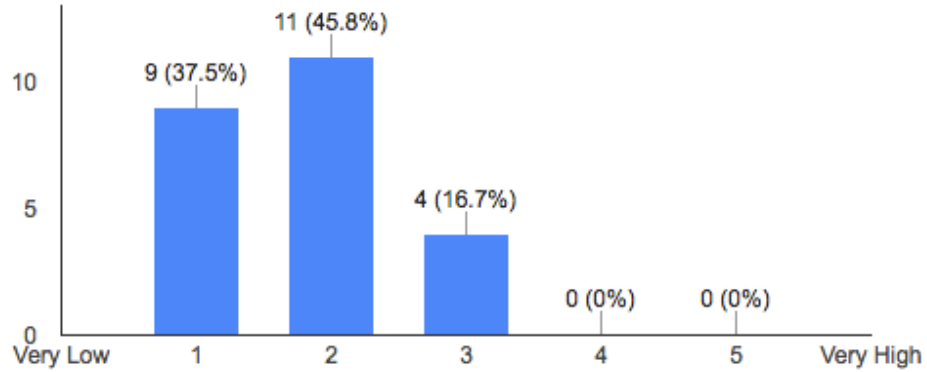


Figure 4.47: Response summaries for likelihood of having defect (Site classifier)

24 responses were received. 45.8% respondent rated the likelihood as 2 and 37.5% responded as 1.

Table 4.73: Analysis of the likelihood of having defects in Site classifier.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$9(1)+11(2)+4(3)+0(4)+0(5)= 43$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.48 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(24 responses)

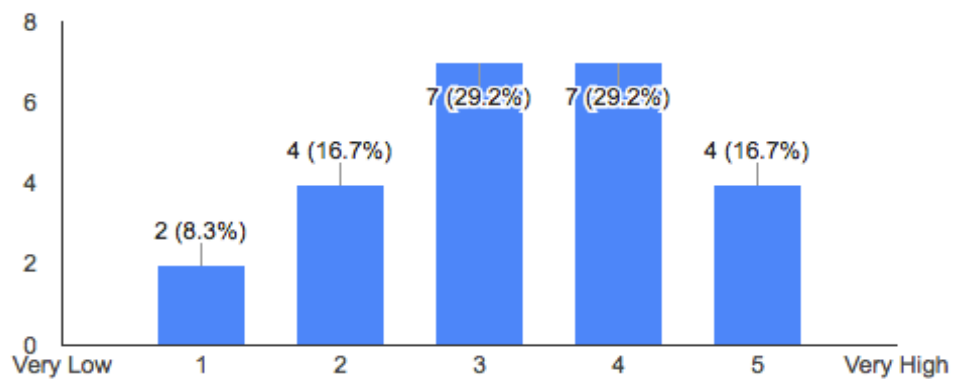


Figure 4.48: Responses summary for Impact (Site classifier)

24 responses were received. 29.2% rated the impact as 3 and the same percentage rated 4.

Table 4.74: Analysis of the impact of having defects in Site classifier.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$2(1)+4(2)+7(3)+7(4)+4(5)= 79$	3	0.20

Table 4.75: Risk score for Site classifier

Trade	Likelihood	Impact	Risk=L*I
Site classifier	0.3	0.20	0.06

Comparing risk score for Site classifier with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 24- Sheds, carports and garages

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.49 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(24 responses)

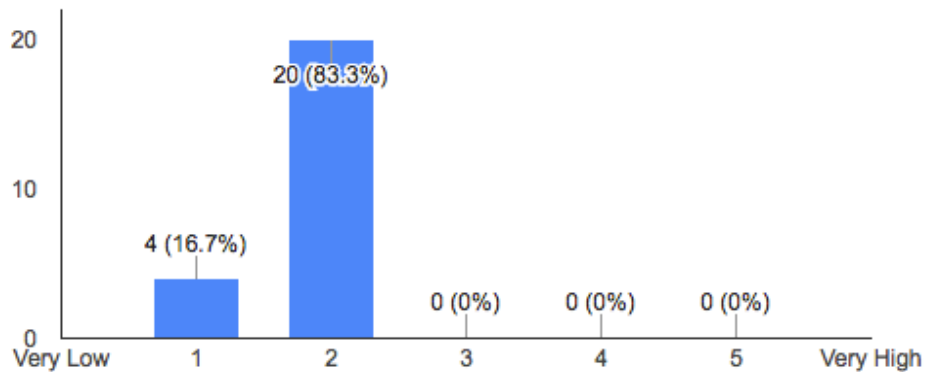


Figure 4.49: Summary of responses for likelihood (Sheds, carports and garages).

24 responses were received. 83.3% respondent rated the likelihood as 2 and 16.7% responded as 1.

Table 4.76: Analysis of the likelihood of having defects in Sheds, carports and garages.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$4(1)+20(2)+0(3)+0(4)+0(5)= 44$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.50 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

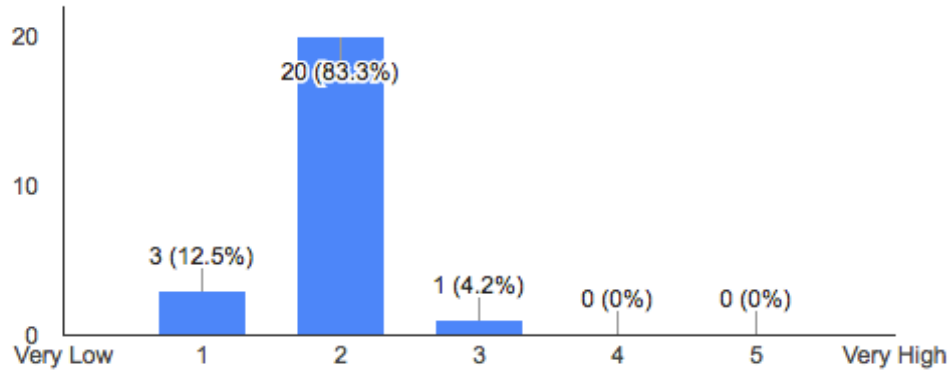


Figure 4.50: Summary of responses for Impact (Sheds, carports and garages).

24 responses were received. 83.3% respondent rated 2 for the impact.

Table 4.77: Analysis of the impact of having defects in Sheds, carports and garages.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$3(1)+20(2)+1(3)+0(4)+0(5)= 46$	2	0.10

Table 4.78: Risk score for Sheds, carports and garages.

Trade	Likelihood	Impact	Risk=L*I
Sheds, carports and garages	0.3	0.10	0.03

Comparing risk score for Sheds, carports and garages with the risk matrix table 4.3, it falls under low-risk trade.

**Trade 26- Shopfitting**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.51 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**

(24 responses)

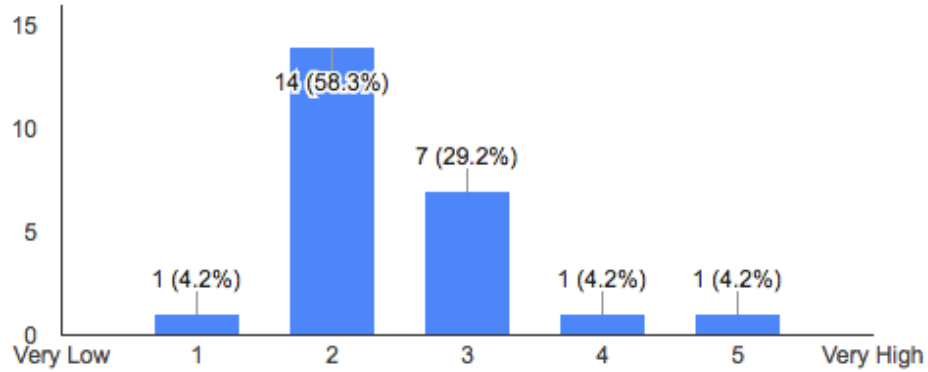


Figure 4.51: Response summaries for likelihood of having defect (Shopfitting)

24 responses were received. 58.3% respondent rated the likelihood as 2 and 29.2% responded as 3.

Table 4.79: Analysis of the likelihood of having defects in Shopfitting.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+14(2)+7(3)+1(4)+1(5)=59$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.52 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(24 responses)

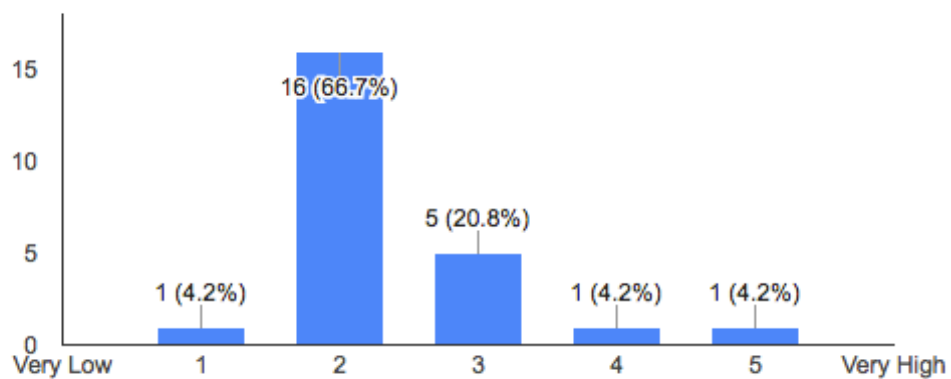


Figure 4.52: Summary of responses for Impact (Shopfitting)

24 responses were received. 66.7% respondent rated 2 and 20.8% responded 5 for the

impact.

Table 4.80: Analysis of the impact of having defects in Shopfitting.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$1(1)+16(2)+5(3)+1(4)+1(5)= 57$	2	0.10

Table 4.81: Risk score for Shopfitting.

Trade	Likelihood	Impact	Risk=L*I
Shopfitting	0.3	0.10	0.03

Comparing risk score for Shopfitting with the risk matrix table 4.3, it falls under low-risk trade.

### Trade 27- Steel fixing

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.53 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(23 responses)

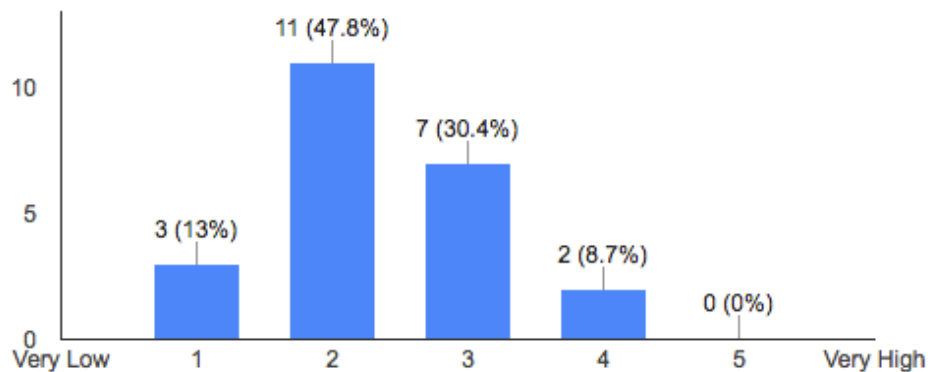


Figure 4.53: Summary of responses for likelihood of having defect (Steel fixing)

23 responses were received. 47.8% respondent rated the likelihood as 2 and 30.4% responded as 3.

Table 4.82: Analysis of the likelihood of having defects in Steel fixing.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
23	$3(1)+11(2)+7(3)+2(4)+0(5)= 54$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.54 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(24 responses)

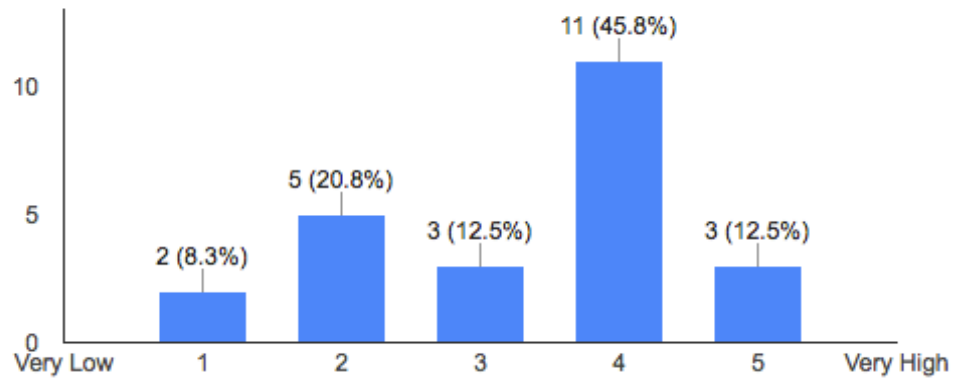


Figure 4.54: Responses summary for Impact (Steel fixing)

24 responses were received. 45.8% respondent rated 4 and 20.8% respondent rated 2 for the impact.

Table 4.83: Analysis of the impact of having defects in Steel fixing.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$2(1)+5(2)+3(3)+11(4)+3(5)= 80$	3	0.20

Table 4.84: Risk score for Steel fixing.

Trade	Likelihood	Impact	Risk=L*I
Steel fixing	0.3	0.20	0.06

Comparing risk score for Steel fixing with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 28- Stone masonry**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.55 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(23 responses)

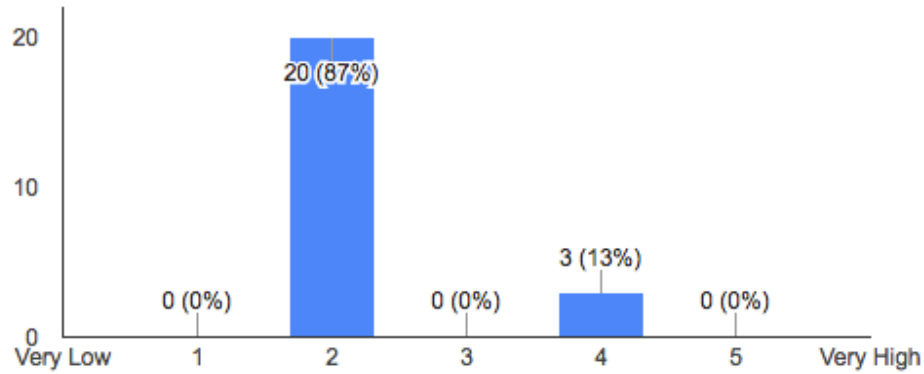


Figure 4.55: Response summaries for likelihood of having defect (Stone masonry)

23 responses were received. 87% respondent rated the likelihood as 2.

Table 4.85: Analysis of the likelihood of having defects in Stone masonry.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
23	$0(1)+20(2)+0(3)+3(4)+0(5)= 52$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.56 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(23 responses)

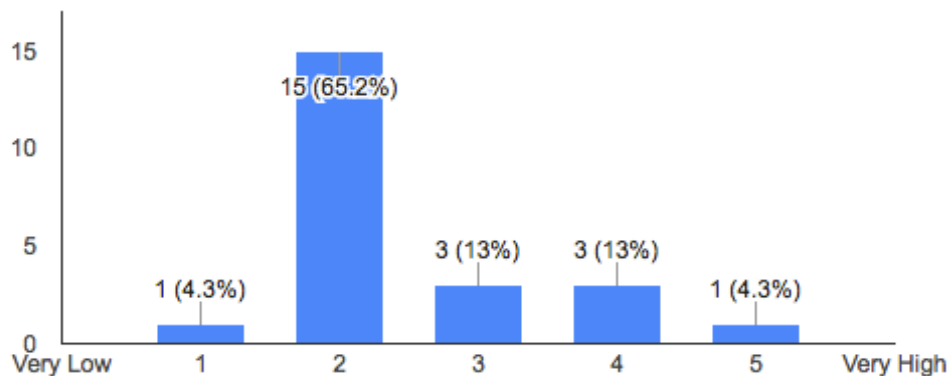


Figure 4.56: Responses summary for Impact (Stonemasonry).

21 responses were received. 76.2% respondent rated 2.

Table 4.86: Analysis of the impact of having defects in Stone masonry.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
23	1(1)+15(2)+3(3)+3(4)+1(5)= 57	2	0.10

Table 4.87: Risk score for Stone masonry.

Trade	Likelihood	Impact	Risk=L*I
Stone masonry	0.3	0.10	0.03

Comparing risk score for Stone masonry with the risk matrix table 4.3, it falls under low-risk trade.

### Trade 29- Structural landscaping

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.57 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(24 responses)

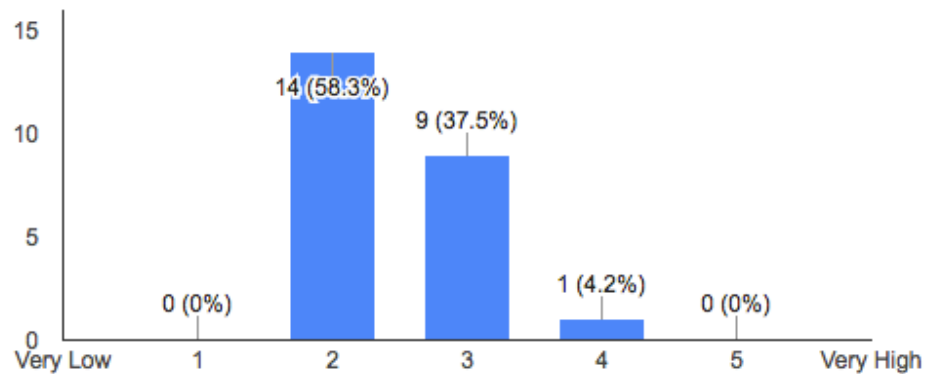


Figure 4.57: Response summaries for likelihood of having defect (Structural landscaping)

24 responses were received. 58.3% respondent rated the likelihood as 2 and 37.5% responded as 3.

Table 4.88: Analysis of the likelihood of having defects in Structural landscaping.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	0(1)+14(2)+9(3)+1(4)+0(5)=59	2	0.3

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.58 provides the summary of the responses for this question.



**Please indicate the impact of having defects in this Trade.**  
(24 responses)

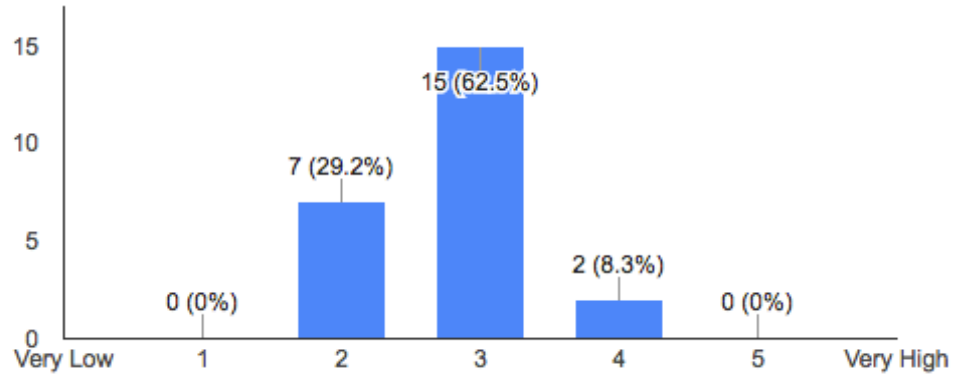


Figure 4.58: Responses summary for Impact (Structural landscaping)

24 responses were received. 76.2% respondent rated 2 and 29.2% rated 2 for the likelihood of having defects in this trade.

Table 4.89: Analysis of the impact of having defects in Structural landscaping.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+7(2)+15(3)+2(4)+0(5)=67$	3	0.20

Table 4.90: Risk score for Structural landscaping.

Trade	Likelihood	Impact	Risk=L*I
Structural landscaping	0.3	0.20	0.06

Comparing risk score for Structural landscaping with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 29- Structural metal fabrication and erection**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.59 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**

(24 responses)

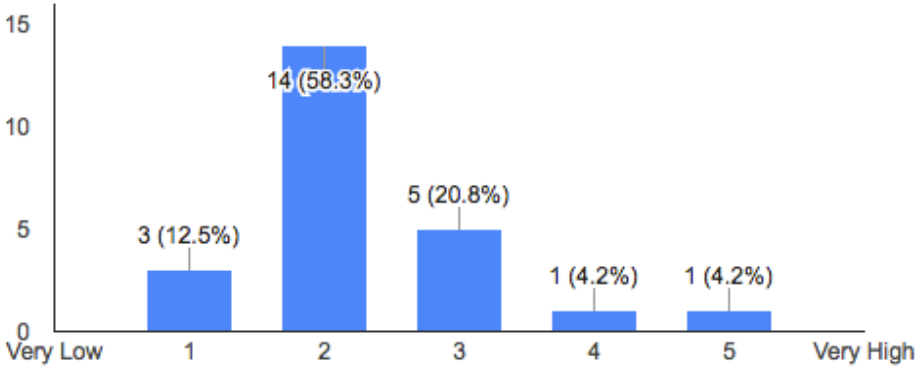


Figure 4.59: Response summaries for likelihood of having defect (Structural metal fabrication and erection)

24 responses were received. 58.3% indicated 2 and 20.8% indicated 3 for the likelihood of having defects in this trade.

Table 4.91: Analysis of the likelihood of having defects in Structural metal fabrication and erection.

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$3(1)+14(2)+5(3)+1(4)+1(5)=55$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.60 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(24 responses)

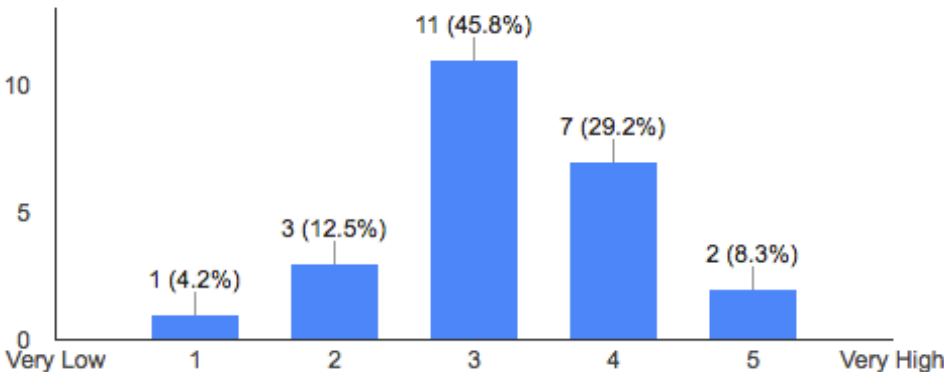


Figure 4.60: Responses summary for Impact (Structural metal fabrication and erection)

24 responses were received. 45.8% respondent indicated 3 and 29.2% indicated 7 for the

impact of having defects in this trade.

Table 4.92: Analysis of the impact of having defects in Structural metal fabrication and erection.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$1(1)+3(2)+11(3)+7(4)+2(5)= 78$	3	0.20

Table 4.93: Risk score for Structural metal fabrication and erection

Trade	Likelihood	Impact	Risk=L*I
Structural metal fabrication and erection	0.3	0.20	0.06

Comparing risk score for Structural metal fabrication and erection with the risk matrix table 4.3, it falls under moderate-risk trade.

### Trade 29- Swimming pool construction, installation and maintenance

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.61 provides the summary of the responses for this question.

## Please indicate the likelihood of having defects in this Trade.

(24 responses)

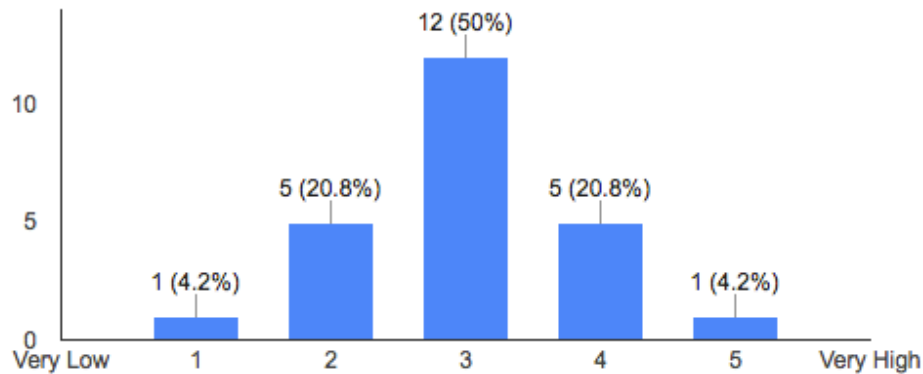


Figure 4.61: Response summaries for likelihood of having defect (Swimming pool construction, installation and maintenance)

24 responses were received. 50% respondent rated the likelihood as 3 and 20.8% responded as 3.

Table 4.94: Analysis of the likelihood of having defects in Swimming pool construction, installation and maintenance

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+5(2)+12(3)+5(4)+1(5)= 72$	3	0.50

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.62 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(24 responses)

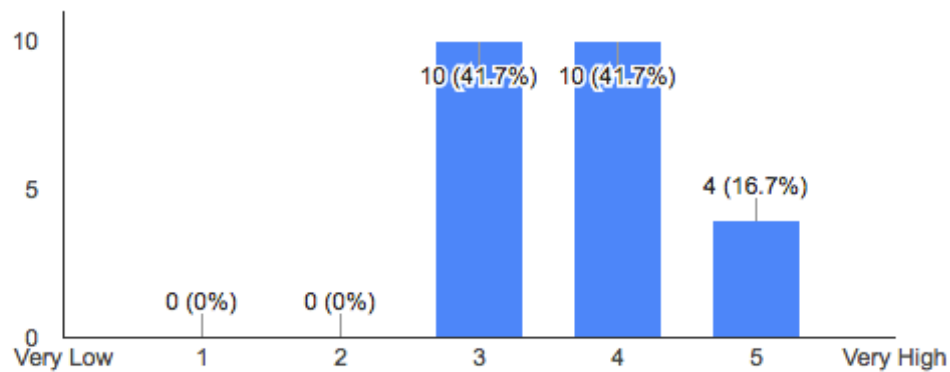


Figure 4.62: Responses summary for Impact (Swimming pool construction, installation and maintenance)

24 responses were received. 41.7% respondent rated 3 and the same percentage rated 4 for the impact of having defects in this trade.

Table 4.95: Analysis of the impact of having defects in Swimming pool construction, installation and maintenance.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+0(2)+10(3)+10(4)+4(5)= 90$	4	0.40

Table 4.96: Risk score for Swimming pool construction, installation and maintenance.

Trade	Likelihood	Impact	Risk=L*I
Swimming pool construction, installation and maintenance	0.50	0.40	0.2

Comparing risk score for Swimming pool construction, installation and maintenance with the risk matrix Table 4.3, it falls under high-risk trade.

**Trade 32- Termite management (chemical)**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.63 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**  
(24 responses)

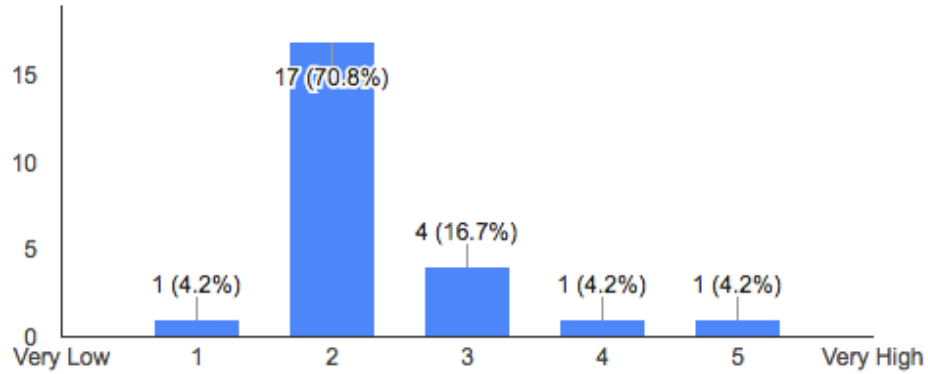


Figure 4.63: Response summaries for likelihood of having defect (Termite management (chemical))

24 responses were received. 70.8% respondent rated the likelihood as 2 and 16.7% responded as 3.

Table 4.97: Analysis of the likelihood of having defects in Termite management (chemical)

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+17(2)+4(3)+1(4)+1(5)= 56$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.64 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(24 responses)

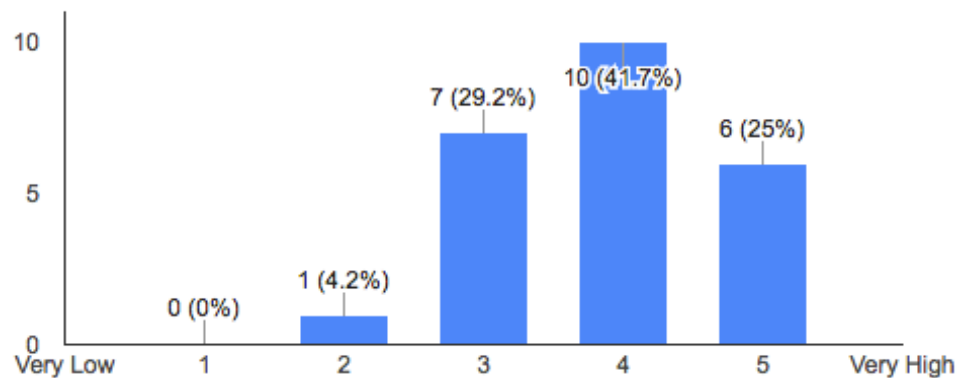


Figure 4.64: Responses summary for Impact (Termite management (chemical))

24 responses were received. 41.7% respondent rated 4, 29.2% rated 3 and 25% rated 5 for the impact of having defects in this trade.

Table 4.98: Analysis of the impact of having defects in Termite management (chemical).

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+1(2)+7(3)+10(4)+6(5)= 93$	4	0.40

Table 4.99: Risk score for Termite management (chemical).

Trade	Likelihood	Impact	Risk=L*I
Termite management (chemical)	0.30	0.40	0.12

Comparing risk score for Termite management (chemical) with the risk matrix Table 4.3, it falls under moderate-risk trade.

### Trade 33- Termite management (Physical)

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.65 provides the summary of the responses for this question.

### Please indicate the likelihood of having defects in this Trade.

(23 responses)

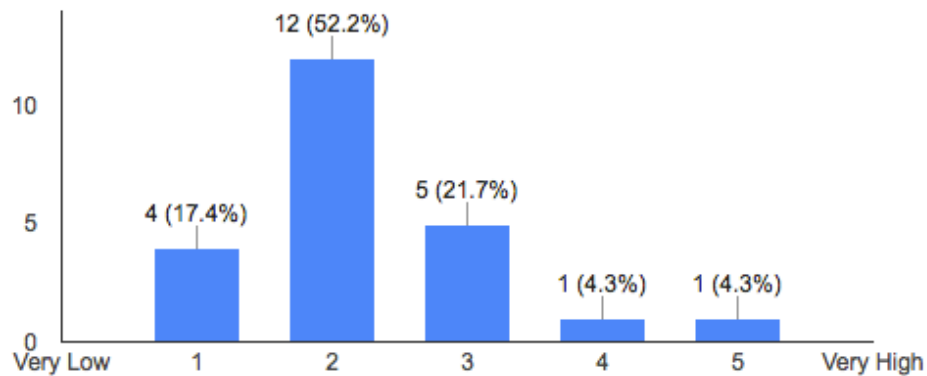


Figure 4.65: Response summaries for likelihood of having defect (Termite management (Physical))

23 responses were received. 52.2% respondent rated the likelihood as 2 and 21.7% responded as 3.

Table 4.100: Analysis of the likelihood of having defects in Termite management (physical)

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
23	$4(1)+12(2)+5(3)+1(4)+1(5)= 52$	2	0.30

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.66 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**  
(23 responses)

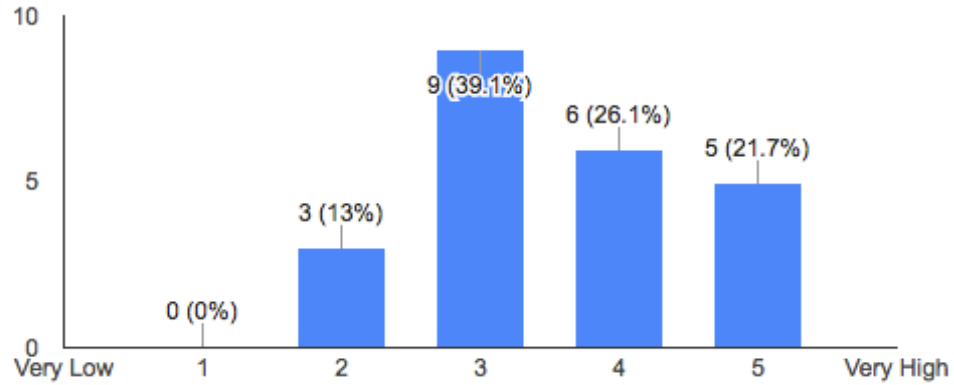


Figure 4.66: Responses summary for Impact (Termite management (physical))

24 responses were received. 39.1% respondent rated 3, 26.1% rated 4 and 21.7% rated 5 for the impact of having defects in this trade.

Table 4.101: Analysis of the impact of having defects in Termite management (physical).

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
24	$0(1)+3(2)+9(3)+6(4)+5(5)= 82$	4	0.40

Table 4.102: Risk score for Termite management (physical).

Trade	Likelihood	Impact	Risk=L*I
Termite management (physical)	0.30	0.40	0.12

Comparing risk score for Termite management (physical) with the risk matrix table 4.3, it falls under moderate-risk trade.

**Trade 34- Waterproofing**

The first question requested respondent to indicate the likelihood of having defects in this trade. Figure 4.67 provides the summary of the responses for this question.

**Please indicate the likelihood of having defects in this Trade.**

(24 responses)

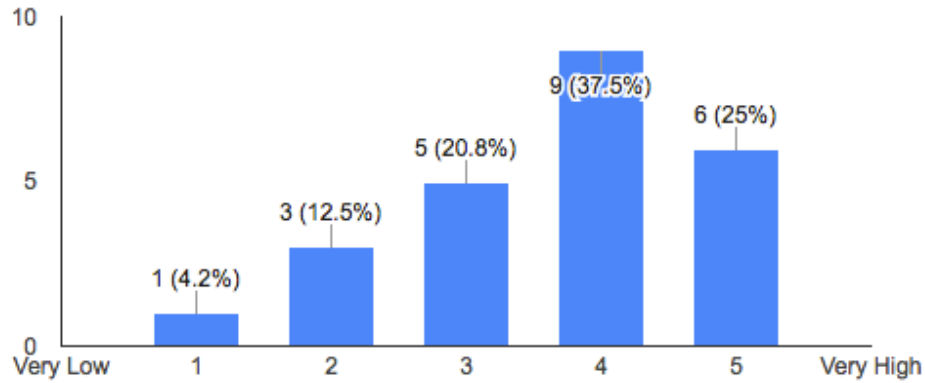


Figure 4.67: Summary of response for the likelihood of having defects (waterproofing).

24 responses were received. 37.5% respondent rated the likelihood as 4 and 25% responded 5 for the likelihood of having defects in this trade.

Table 4.103: Analysis of the likelihood of having defects in waterproofing

Number of respondent	Sum of Rating	Average	Conversion to PMI Scale
24	$1(1)+3(2)+5(3)+9(4)+6(5)= 88$	4	0.70

The second question requested respondent to indicate the impact of having defects in this trade. Figure 4.68 provides the summary of the responses for this question.

**Please indicate the impact of having defects in this Trade.**

(23 responses)

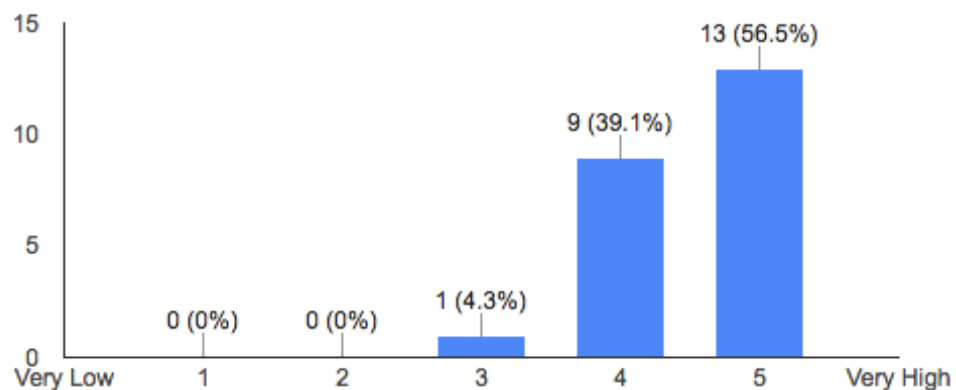


Figure 4.68: Responses summary for Impact (Waterproofing)

23 responses were received. 56.5% respondent rated 5, 39.1% rated 4 for the impact of having defects in this trade.



Table 4.104: Analysis of the impact of having defects in Waterproofing.

Number of respondent	Sum of Ratings	Average Rating	Conversion to PMI Scale
23	0(1)+0(2)+1(3)+9(4)+13(5)=104	5	0.80

Table 4.105: Risk score for Waterproofing.

Trade	Likelihood	Impact	Risk=L*I
Waterproofing	0.70	0.80	0.56

Comparing risk score for Waterproofing with the risk matrix table 4.3, it falls under high-risk trade.

## 4.4 Summary

After analysing the list of 34 trades provided by QBCC, it was found that Concreting, Swimming pool construction, installation and maintenance and waterproofing trades to be at high risk, the risk score for high-risk trade are marked with red colour in the table 4.106 below. Whereas, Brick and Segmental Paving, Bricklaying and Blocklaying, Cabinet making, Air handling and Duct installation, carpentry, Drainage, Drainage-Onsite Sewerage, Floor finishing and covering (hard sector), Foundation work (Piling and Anchors), Gasfitting, Glass, glazing and aluminium, Joinery, Painting and Decorating, Plastering Drywall, Plastering solid, Plumbing and drainage, Refrigeration, air conditioning and mechanical services including unlimited design, Roof and wall cladding, Roof tiling, Site classifier, Steel fixing, Structural landscaping (trade), Structural metal fabrication and installation, Termite management (chemical) and Termite management (Physical) to be moderate risk, risk score for moderate risk trade has been marked with orange colour in the table 4.106 below. Irrigation, Metal Fascias and gutters, Non-structural fabrication and installation, Shopfitting, Sheds carport and garages and Stone masonry trades to be the low-risk trade, the risk score for low-risk trade has been marked with yellow colour in the table 4.106 below.

Table 4.106: Risk score of 34 Trades

Number	Trade	Average Likelihood	Average Impact	Risk Score
1	Concreting	0.50	0.40	0.2
2	Brick and Segmental Paving	0.30	0.20	0.06
3	Bricklaying and Blocklaying	0.50	0.20	0.1
4	Cabinet making	0.50	0.20	0.1
5	Air Handling and Duct Installation	0.30	0.20	0.06
6	Carpentry	0.50	0.20	0.1
7	Drainage	0.30	0.20	0.06
8	Drainage- Onsite Sewerage	0.30	0.20	0.06
9	Floor Finishing and Covering (hard Sector)	0.50	0.20	0.1
10	Foundation Work (Piling and Anchors)	0.30	0.40	0.12

11	Gasfitting	0.30	0.20	0.06
12	Glass, glazing and aluminium	0.30	0.20	0.06
13	Irrigation	0.30	0.10	0.03
14	Joinery	0.50	0.20	0.1
15	Metal fascias and Gutters	0.30	0.10	0.03
16	Non-structural metal fabrication and installation	0.30	0.10	0.03
17	Painting and decorating	0.70	0.20	0.14
18	Plastering drywall	0.50	0.20	0.1
19	Plastering Solid	0.50	0.20	0.1
20	Plumbing and drainage	0.30	0.20	0.06
21	Refrigeration, air conditioning and mechanical services including unlimited design	0.30	0.20	0.06
22	Roof and wall cladding	0.50	0.20	0.1
23	Roof tiling	0.50	0.20	0.1
24	Site classifier	0.30	0.20	0.06
25	Sheds, carport and garages	0.30	0.10	0.03
26	Shopfitting	0.50	0.10	0.03
27	Steel fixing	0.30	0.20	0.06
28	Stone masonry	0.30	0.10	0.03
29	Structural landscaping (trade)	0.30	0.20	0.06
30	Structural metal fabrication and erection	0.30	0.20	0.06
31	Swimming pool construction, installation and maintenance	0.50	0.40	0.2
32	Termite management (chemical)	0.30	0.40	0.12
33	Termite management (Physical)	0.30	0.40	0.12
34	Waterproofing	0.70	0.80	0.56

#### 4.4.1 High-risk Trade

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#### 4.4.1.1 Concreting

Concreting was identified as one of the high-risk trade. Participants were asked to explain the reason if they have indicated a 4 or greater for likelihood or impact. Most respondents have replied that rectification cost for concreting as expensive. Concrete defects, particularly footing and slabs are difficult and costly to rectify. Defects in the foundation can put the whole project in jeopardy. The average likelihood rated was 3 for this trade , but the average impact was rated as 4. The figure 4.69 below provides the answers why participant has either rated likelihood or impact 4 or greater.

**If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

(12 responses)



Figure 4.69: Responses for why likelihood or impact was rated 4 or greater for Concreting.

Concreting has been a surprise inclusion in the high-risk trade, as it has not appeared on QBCC top ten lists. As discussed in chapter 2 there are limitations to QBCC top ten defect lists, as it does not take into account the impact of the defect, Concreting likelihood was rated moderate but the impact was rated high by the majority of the participants it is due to high impact, concreting has made to the high-risk trade. Also concreting is the frontend trade, any defects appeared would be rectified before handover or even before the building certifier provides the certification. Thus it may be these reasons that Concreting has not appeared on the QBCC top ten lists but was identified as high-risk trade in this project.

#### 4.4.1.2 Swimming Pool Construction, Installation and Maintenance

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Swimming pool construction, installation and maintenance was identified as high-risk trade. Respondents were asked to explain the reason if they have indicated a 4 or greater for likelihood or impact. Most respondents have replied that rectification cost for Swimming pool construction, installation and maintenance as expensive. Various issues such as lower standard of tradesmen, compatible material issues were highlighted by the respondents in this trade. The major problem associated with this trade as leaks in swimming pools that are very expensive to rectify. The average likelihood was 3 for this trade, but the average impact was rated as 4. The figure 4.70 below provides the answers why participant has either rated likelihood or impact 4 or greater.

**If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

(6 responses)

Generally a lower standard of tradesmen in the pool industry
due to nature of the work, pools are expensive to rectify defects, mainly leaks
expensive to rectify
Compatible materials.
very costly, hard to sometime pin point problems
needs to designed for soil and environment i.e. rain, snow/ice environments are more involved

Figure 4.70: Responses for why likelihood or impact was rated 4 or greater for Swimming pool construction, installation and maintenance.

Swimming pool construction, maintenance and installation also haven't appeared in the QBCC top ten defect list for similar reasons as of Concreting. In this trade, likelihood was rated moderate, but the impact was rated high by the majority of the participants it is due to the high impact of having defects, Swimming pool construction has made to the high-risk trade.

#### 4.4.1.3 Waterproofing

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Waterproofing was identified as high-risk trade. Participants were asked to explain the reason if they have indicated a 4 or greater for likelihood or impact. Most respondents have replied that rectification cost for waterproofing as very expensive. Some of the problem associated with this trade are; other trades can inadvertently damage waterproofing and defects are not found until the project is complete, highly disruptive to clients to have issues fixed and high skill and attention to details are required for success. The figure 4.71 below provides the answers why participant has either rated likelihood or impact 4 or greater. The average likelihood rating for this trade was 4 for this trade while the impact was rated as 5 for this trade.

**If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

(12 responses)

Very expensive to fix. Other trades can inadvertently damage waterproofing
defects not found until project is complete and therefor expensive to rectify considering other finishing trades.
expensive to rectify can impact various other trade
DFT issues and product issues and application issues.
Endless problems.
costly to repair, hard to prove fault
Major damage
high skill and attention to detail is required for success; failure is disasterous as it always detected late eg. often well after a final certificate has issued
expensive to fix, other trades are affected
attention to detail, failure can be disastrous
expensive to fix problems highly disruptive to clients to to have issues fixed
flood testing, skin thickness testing recomended

Figure 4.71: Responses for why likelihood or impact was rated 4 or greater in Waterproofing.

Waterproofing has appeared in the QBCC top ten-defect list for several years and identified as the most troublesome trade through this survey as well. The majority of the respondents rated the likelihood of having defects in this trade as high and the impact as very high.

#### 4.4.2 Cross Participant’s Analysis and the Impact on Results

As mentioned in section 4.2, 24 responses were received for the first stage survey. Respondents with various job titles within the residential construction industry participated in the survey. The majority of the responses were received from site supervisors, followed by Project Managers and Architects. After analysing responses from various participants, it was found that none of the participants with the specific job title had the impact on the overall results. As the average rating of likelihood and impact in waterproofing was rated 4 and 5 respectively, similarly the average rating of the likelihood of having defects in waterproofing by Site-supervisors, Architects and the project manager was also rated 4 and it was the same case with the impact of having defects. The average impact rated by the Site supervisors, project managers and Architects were also very high (5). Similarly, average likelihood and impact in Concreting by various job titles participants corresponded to the overall rating in Concreting. The same case was repeated in the swimming pool construction, maintenance and installation trade. For impact in painting, project managers and site supervisor’s rated 3, whereas the average rating of architects were 2 and the overall impact rating for

Painting was still a 3. Thus it was safe to say that any one-job title participants did not impact the overall results. This may be due to the small sample size; maybe if a large number of responses were received any one-job title participants could have impacted the overall result.

## 4.5 Responses for Second Stage Survey

Responses to second stage survey are analysed in this section; only four trades were selected for second stage survey. They are as follows:

- Waterproofing
- Concreting
- Swimming pool construction maintenance and installation
- Painting and decorating

All four trades are analysed separately.

### Waterproofing

Waterproofing was identified as high-risk trade from the first stage survey. In the second stage survey participants were asked to select three most useful strategies and rank them as 1,2 and 3 with 1 being the most suitable.

The figure 4.69 shows the summary of responses received for rank 1 Strategy for Waterproofing.

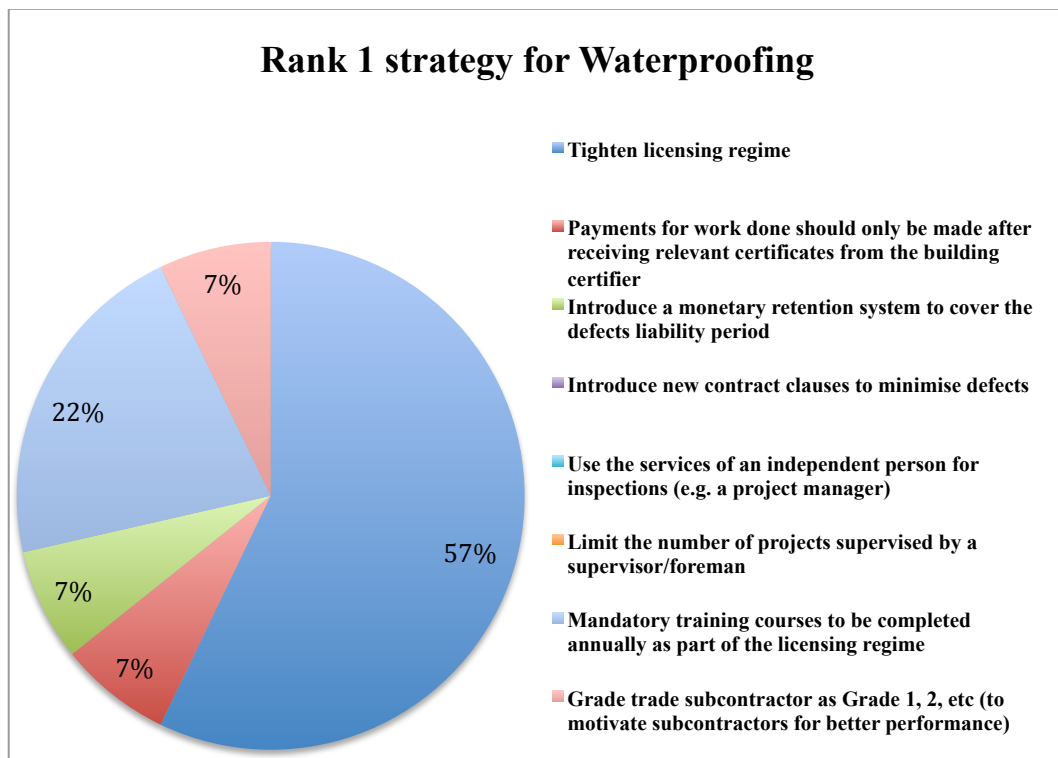


Figure 4.69: Rank 1 strategy for Waterproofing.

The majority of participants (57%) indicated that tightening the licencing regime as the rank 1 strategy for minimising defects in Waterproofing trade. Out of 14 respondents, 8 respondents selected this strategy. Respondents include 3 project managers, 3 architects, 1 managing director and 1 site supervisor. 22% of the respondents indicated mandatory training courses to be completed annually as part of the licensing regime as rank 1 strategy.

Participants were also asked, to what extent will your rank 1 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of tightening the licensing regime was rated on average 4, which indicates that this strategy will be hard to be acceptable to the industry. Similarly, participants were also asked how easy would it be to implement your rank 1 strategy. Implementability of tightening the licensing regime was rated on average 3, which indicates moderate difficulty in implementing this strategy. Participants were also requested to comment about the acceptability and implementability of the rank 1 strategy. Unfortunately, very few responses were received. Responses received indicated that the subcontractors might be reluctant to accept this strategy but QBCC needs the will to change.

The figure 4.70 shows the summary of responses received for rank 2 Strategy for Waterproofing.

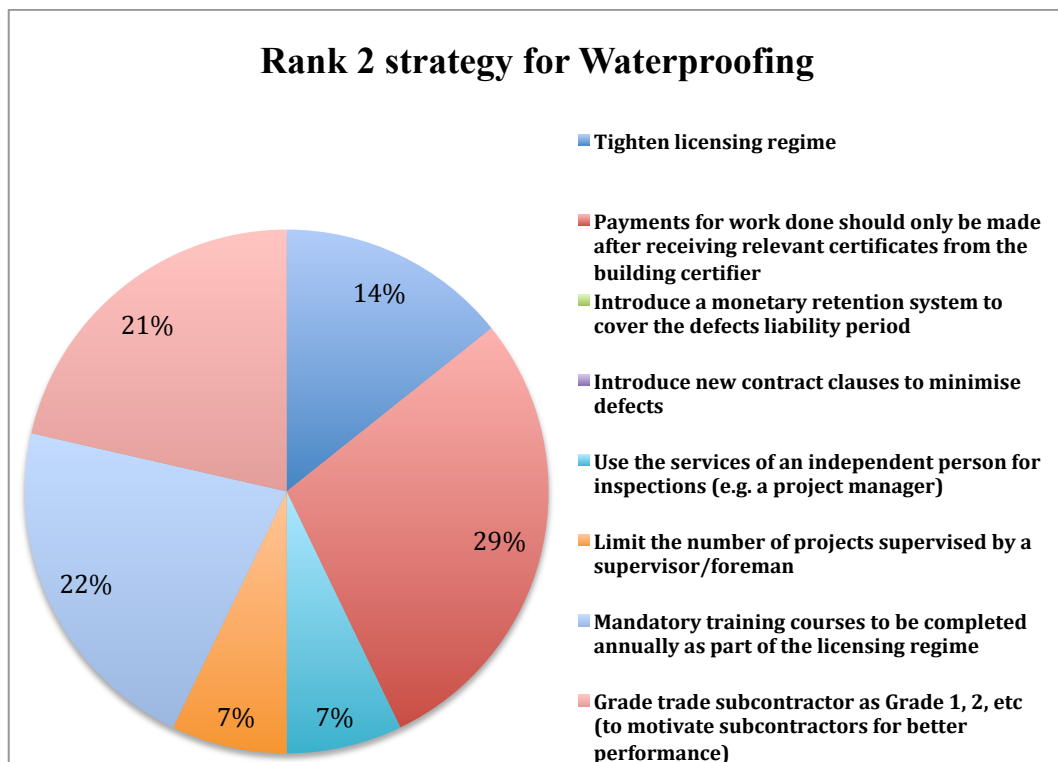


Figure 4.70: Rank 2 strategy for Waterproofing

The majority of participants (29%) indicated that payments of work done should only be made after receiving relevant certificates from the building certifier as the rank 2 strategy for Waterproofing trade. Out of 14 respondents 4 respondent that includes 1-project

managers, 1 architects, 1 foreman and 1 site supervisor selected payments of work done should only be made after receiving relevant certificates from the building certifier regime as rank 2 strategy. 22% of the respondents indicated grade trade subcontractor as Grade 1, 2, etc. (to motivate subcontractors and mandatory training courses to be completed annually as part of the licensing regime as rank 2 strategy for Waterproofing.

Participants were also asked, to what extent will your rank 2 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of payments of work done should only be made after receiving relevant certificates from the building certifier was rated on average 3, which indicates that this strategy will be moderately acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 2 strategy. The implementability of payments of work done should only be made after receiving relevant certificates from the building certifier was rated on average 3, which indicates moderate difficulty in implementing this strategy.

The figure 4.71 shows the summary of responses received for rank 3 Strategy for Waterproofing.

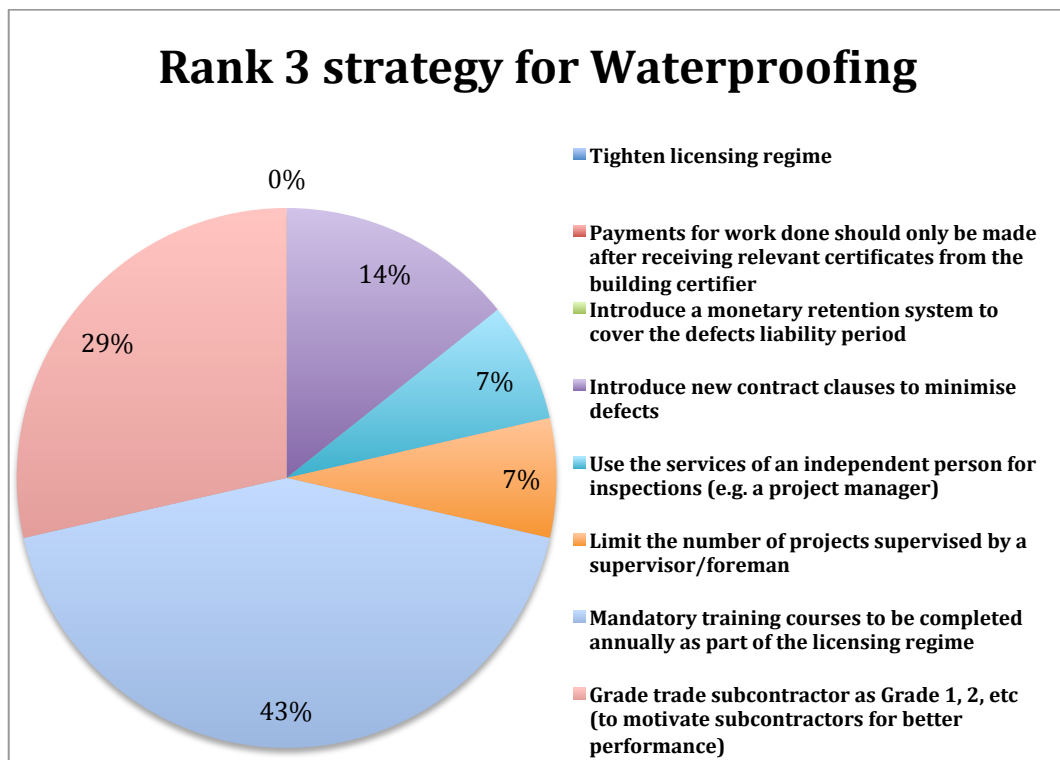


Figure 4.71: Rank 3 strategy for Waterproofing

The majority of participants (43%) indicated that mandatory training courses to be completed annually as part of the licensing regime as the rank 3 strategy for Waterproofing trade. Out of 14 respondents, 6 respondent that includes 1 project managers, 1 architects, 1 managing director, 1 foreman and 2 site supervisors selected tightening licensing regime as rank 3 strategy. 29% of the respondents indicated grade trade subcontractor as Grade 1,2 etc. (to motivate subcontractors for better performance)



as rank 3 strategy for Waterproofing.

Participants were also asked, to what extent will your rank 3 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of mandatory training courses to be completed annually as part of the licensing regime was rated on average 4, which indicates that this strategy will be hard to accept by the industry. Similarly, participants were also asked how easy would it be to implement your rank 3 strategy. The implementability of mandatory training courses to be completed annually as part of the licensing regime was rated on average 4, which indicates high difficulty in implementing this strategy. Participants were also requested to comment about the acceptability and implementability of the rank 3 strategy. Unfortunately very few responses were received. Responses received indicated that subcontractors might be reluctant to mandatory training courses but QBCC needs the will to change.

### Concreting

Concreting was identified as high-risk trade from the first stage survey. In the second stage survey participants were asked to select three most useful strategies and rank them as 1,2 and 3 with 1 being the most suitable.

The figure 4.72 shows the summary of responses received for rank 1 Strategy for Concreting.

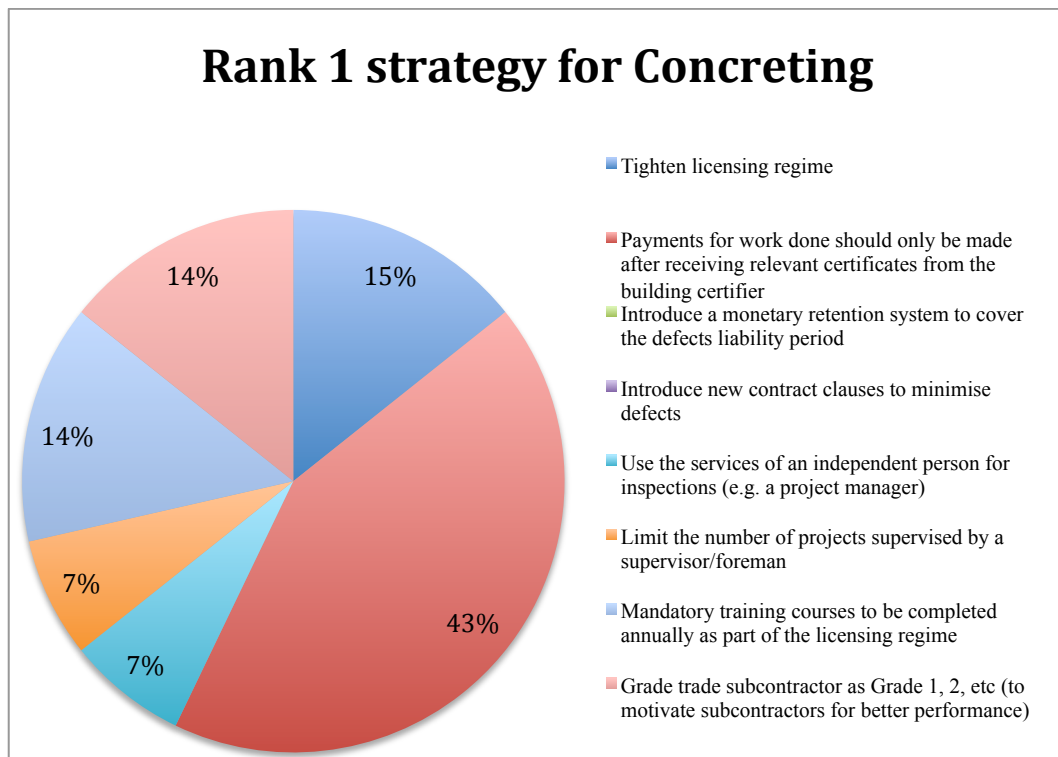


Figure 4.72: Rank 1 strategy for Concreting

The majority of participants (43%) indicated that payment for work done should only be made after receiving relevant certificates from the building certifier as the rank 1 strategy for minimising defects in concreting trade. Out of 14 respondents 6 respondents that includes 2 project managers, 2 architects, 1 foreman and 1 site supervisor selected tightening licensing regime as rank 1 strategy. While 15% of the respondents indicated grade subcontractor as grade 1, 2, etc. (to motivate subcontractors for better performance), mandatory training courses to be completed annually as part of the licensing regime and tighten licensing regime as rank 1 strategy.

Participants were also asked, to what extent will your rank 1 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of payment for work done should only be made after receiving relevant certificates from the building certifier was rated on average 3, which indicates that this strategy will be moderately acceptable, by the industry. Similarly, participants were also asked how easy would it be to implement your rank 1 strategy. Implementability of payment for work done should only be made after receiving relevant certificates from the building certifier was rated on average 3, which indicates moderate difficulty in implementing this strategy. Participants were also requested to comment about the acceptability and implementability of the rank 1 strategy. Unfortunately, very few responses were received. Responses received indicated that the subcontractors might be reluctant to accept the strategy but QBCC needs the will to change.

The figure 4.73 shows the summary of responses received for rank 2 Strategy for Concreting.

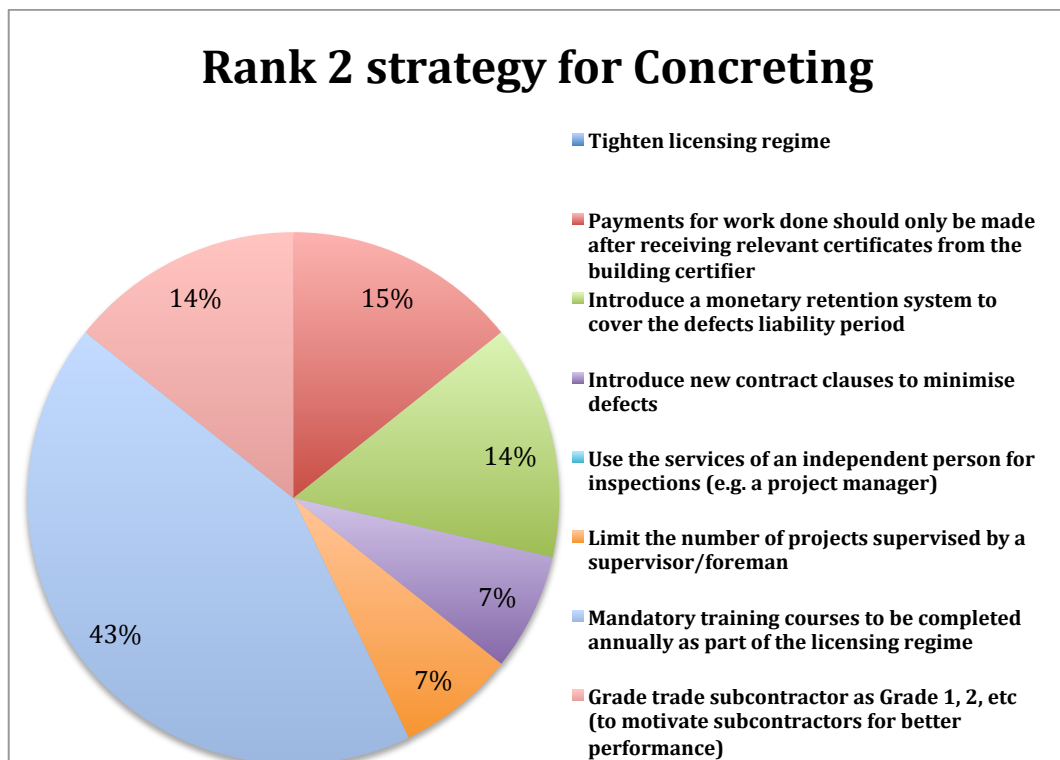


Figure 4.73: Rank 2 strategy for Concreting

The majority of participants (43%) indicated that mandatory training courses to be completed annually as part of the licensing regime as the rank 2 strategy for minimising defects in concreting trade. Out of 14 respondents 6 respondent that includes 2 project managers, 2 architects, 1 managing director and 1 foreman selected tightening licensing regime as rank 2 strategy. While grade subcontractor as grade 1, 2, etc. (to motivate subcontractors for better performance), introduce a monetary retention system to cover the defects liability period and payment for work done should only be made after receiving relevant certificates from the building certifier was selected by 14% of the respondents as rank 2 strategy.

Participants were also asked, to what extent will your rank 1 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of mandatory training courses to be completed annually as part of the licensing regime was rated on average 3, which indicates that this strategy will be moderately acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 2 strategy. Implementability of mandatory training courses to be completed annually as part of the licensing regime was rated on average 3, which indicates moderate difficulty in implementing this strategy.

The figure 4.74 shows the summary of responses received for rank 3 Strategy for Concreting.

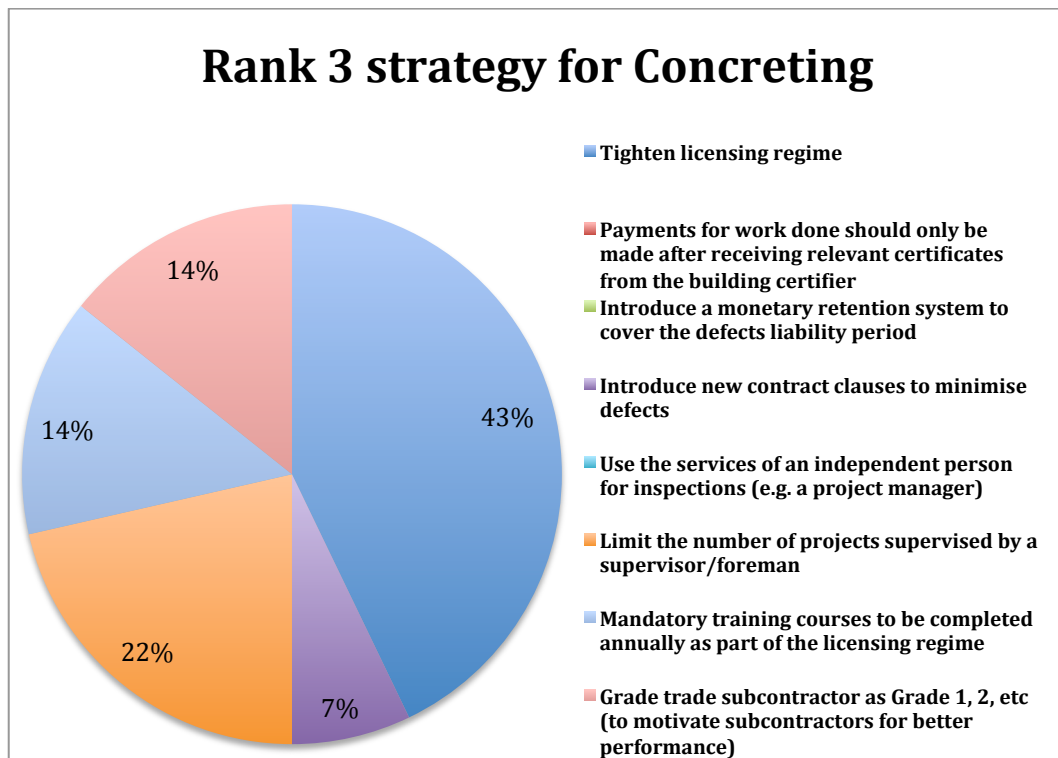


Figure 4.74: Rank 3 strategy for Concreting

The majority of participants (43%) indicated that tighten licensing regime as the rank 3 strategy for Concreting. Out of 14 respondents 6 respondent that includes 2 architects, 1

managing director, 1 foreman, 1 building certifier and 1 site supervisor selected tightening licensing regime as rank 1 strategy. 22% of the respondents indicated limit the number of projects supervised by a supervisor/foreman as rank 3 strategy for Concreting.

Participants were also asked, to what extent will your rank 3 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of tightening the licensing regime was rated on average 4, which indicates that this strategy will be hard to accept by the industry. Similarly, participants were also asked how easy would it be to implement your rank 2 strategy. The implementability of tighten licensing regime was rated on average 3, which indicates moderate difficulty in implementing this strategy.

**Swimming pool construction, maintenance and installation**

Swimming pool construction, maintenance and installation was identified as high-risk trade from the first stage survey. In the second stage survey participants were asked to select three most useful strategies and rank them as 1,2 and 3 with 1 being the most suitable.

The figure 4.75 shows the summary of responses received for rank 1 Strategy for Swimming pool construction, maintenance and installation.

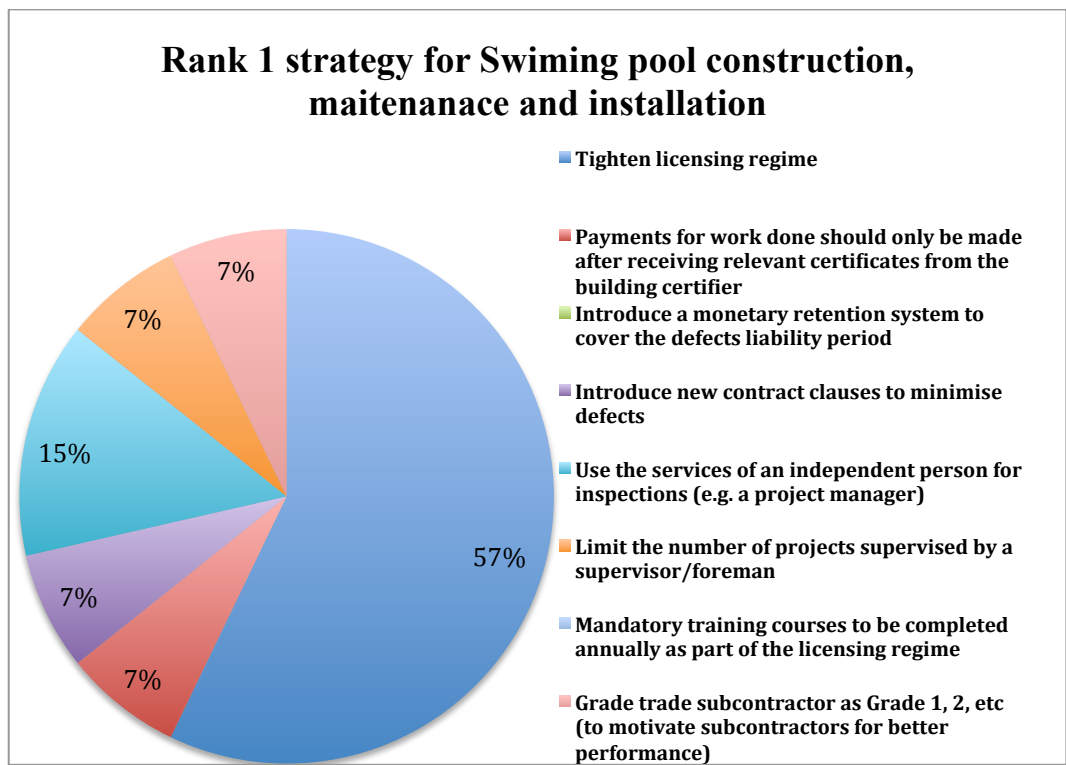


Figure 4.75: Rank 1 strategy for Swimming pool construction.

The majority of participants (57%) indicated that tightening the licencing regime as the rank 1 strategy for minimising defects in Swimming pool construction, maintenance and installation. Out of 14 respondents, 8 respondents selected this strategy and respondents

include 2 project managers, 2 architects, 2 foremen, 1 managing director and 1 site supervisor. 15% of the respondents indicated use the service of an independent person for inspection (e.g. a project manager) as rank 1 strategy.

Participants were also asked, to what extent will your rank 1 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of tightening the licensing regime was rated on average 3, which indicates that this strategy will be moderately acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 1 strategy. Implementability of tightening the licensing regime was rated on average 3, which indicates moderate difficulty in implementing this strategy. Participants were also requested to comment about the acceptability and implementability of the rank 1 strategy. Unfortunately, very few responses were received. Responses received indicated that the subcontractors might be reluctant to accept the strategy but QBCC needs the will to change.

The figure 4.76 shows the summary of responses received for rank 1 Strategy for Swimming pool construction, maintenance and installation.

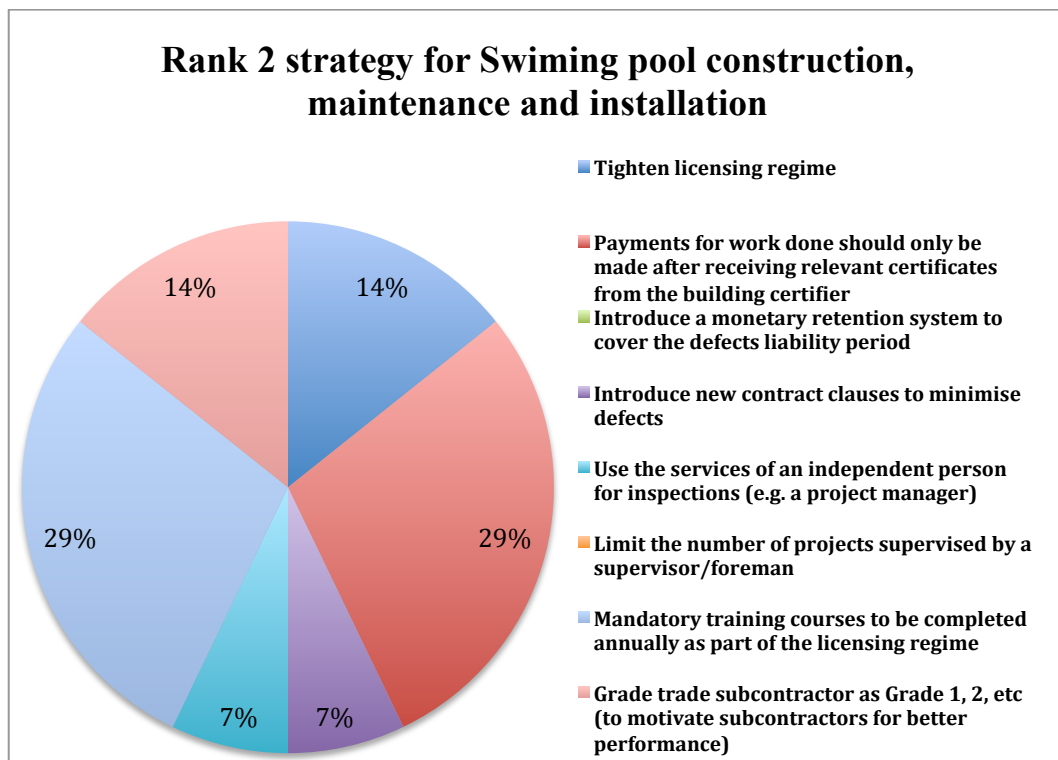


Figure 4.76: Rank 2 strategy for Swimming pool construction

The same number of respondents selected both mandatory training courses to be completed annually as part of the licensing regime and payment for work done should only be made after receiving relevant certificates from the building certifier as the rank 2 strategy for minimising defects in Swimming pool construction, maintenance and installation trade. As payment for work done should only be made after receiving relevant certificates from the building certifier was selected 6 times in all three rank but

mandatory training courses to be completed annually as part of the licensing regime was selected 5 times in all ranks, thus payment for work done should only be made after receiving relevant certificates from the building certifier was selected as rank 2 strategy for Swimming pool construction, maintenance and installation.

Participants were also asked, to what extent will your rank 2 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of payment for work done should only be made after receiving relevant certificates from the building certifier was rated on average 4, which indicates that this strategy will be hard to be acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 2 strategy. Implementability of payment for work done should only be made after receiving relevant certificates from the building certifier was rated on average 3, which indicates moderate difficulty in implementing this strategy.

The figure 4.77 shows the summary of responses received for rank 3 Strategy for Swimming pool construction, maintenance and installation.

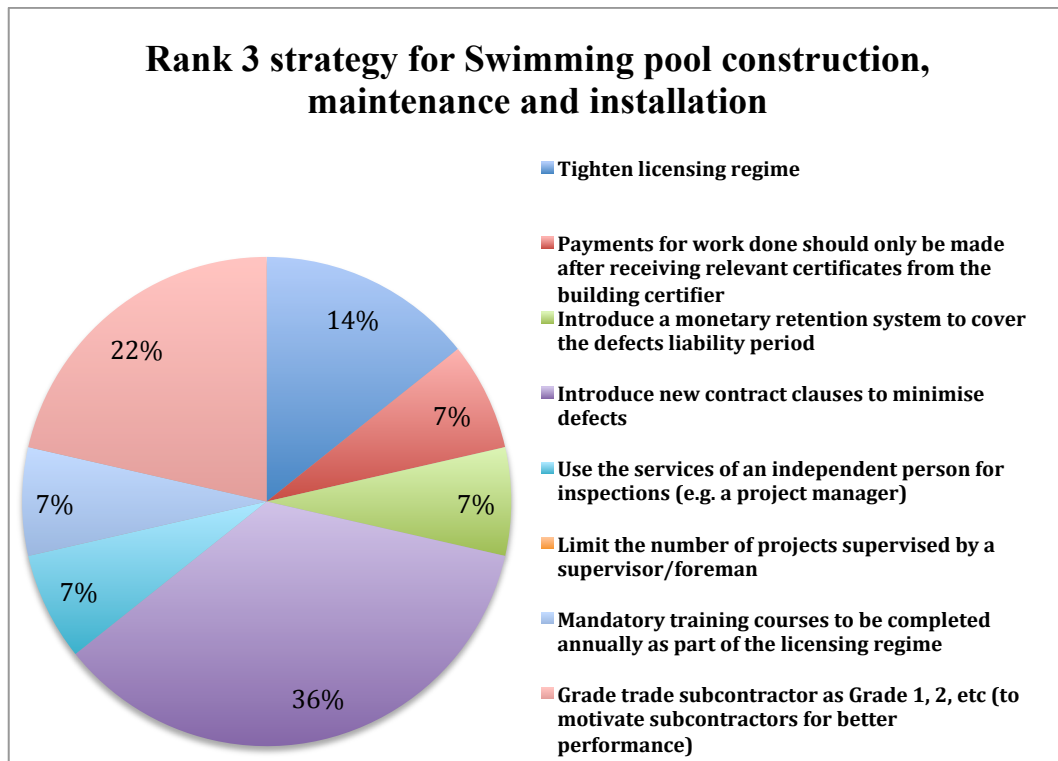


Figure 4.77: Rank 3 strategy for Swimming pool construction

The majority of participants (36%) indicated that introduce new contract clauses to minimise defects as the rank 3 strategy for Swimming pool construction, maintenance and installation. Out of 14 respondents 5 respondent that includes 2 architects, 2 managing director and 1 site supervisor selected introduce new contract clauses to minimise defect as rank 1 strategy. 22% of the respondents indicated grade trade subcontractor as Grade 1,2 etc. (to motivate subcontractors for better performance) and 14% indicated tightening licencing regime as rank 3 strategy for Swimming pool

construction, maintenance and installation trade.

Participants were also asked, to what extent will your rank 3 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of introducing new contract clauses to minimise defects was rated on average 3, which indicates that this strategy will be hard to accept by the industry. Similarly, participant were also asked how easy would it be to implement your rank 3 strategy. The implematability of introducing new contract clauses to minimise defects was rated on average 3, which indicates moderate difficulty to implement this strategy.

### Painting and decorating

Although the Painting and decorating trade was identified as the moderate risk trade, it was identified as fourth most troublesome trade in the first stage survey but due to its appearances in several years in the QBCC top ten defects lists and only falling short to high-risk trade by a very little margin in the first stage survey, it was decided to include this trade for the second stage survey.

The figure 4.78 shows the summary of responses received for rank 1 Strategy for Painting and decorating.

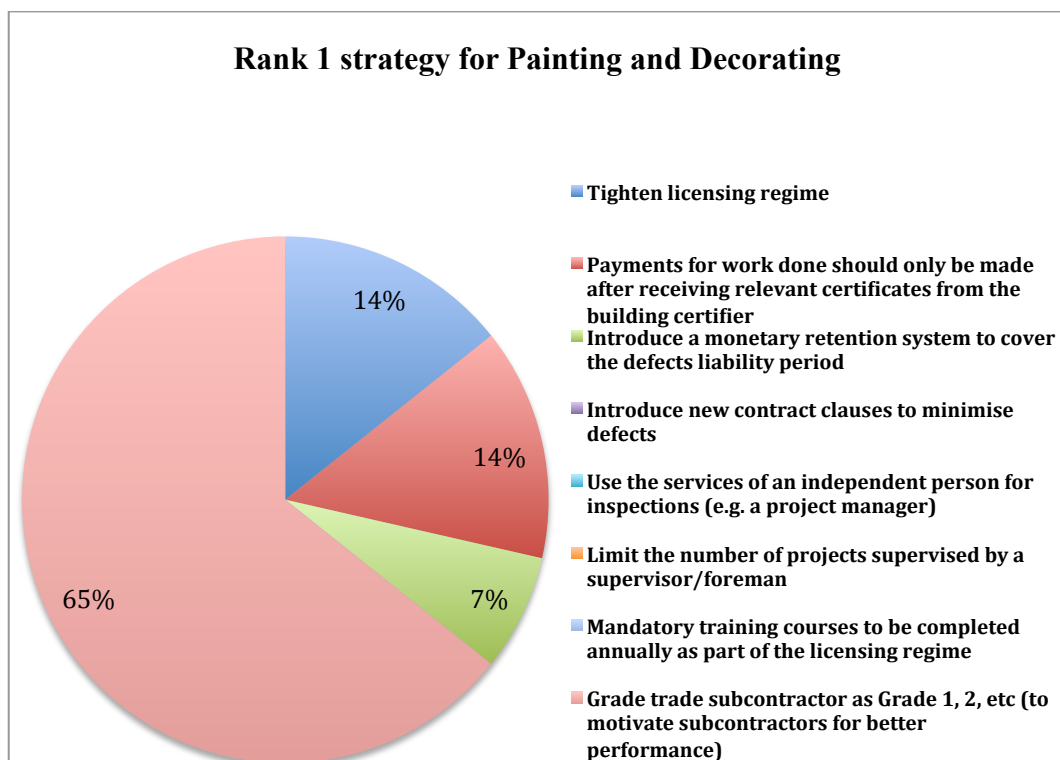


Figure 4.78: Rank 1 strategy for Painting and decorating

The majority of participants (65%) indicated that grade trade subcontractor as Grade 1,2 etc. (to motivate subcontractors for better performance) as the rank 1 strategy for Painting and decorating trade. Out of 12 respondents 9 respondent that includes 3 project

managers, 2 architects, 1 foreman, 2 managing director and 1 site supervisor selected tightening licensing regime as rank 2 strategy. 14% of the respondents indicated tightening licensing regime and payment for work done should only be made after receiving relevant certificates from the building certifier as rank 1 strategy for Painting and decorating trade.

Participants were also asked, to what extent will your rank 1 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of grade trade subcontractor as Grade 1,2 etc. (to motivate subcontractors for better performance) was rated on average 3, which indicates that this strategy will be moderately acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 1 strategy. The implematability of grade trade subcontractor as Grade 1,2 etc. (to motivate subcontractors for better performance) was rated on average 3, which indicates moderate difficulty in implementing this strategy.

The figure 4.79 shows the summary of responses received for rank 2 Strategy for Painting and decorating.

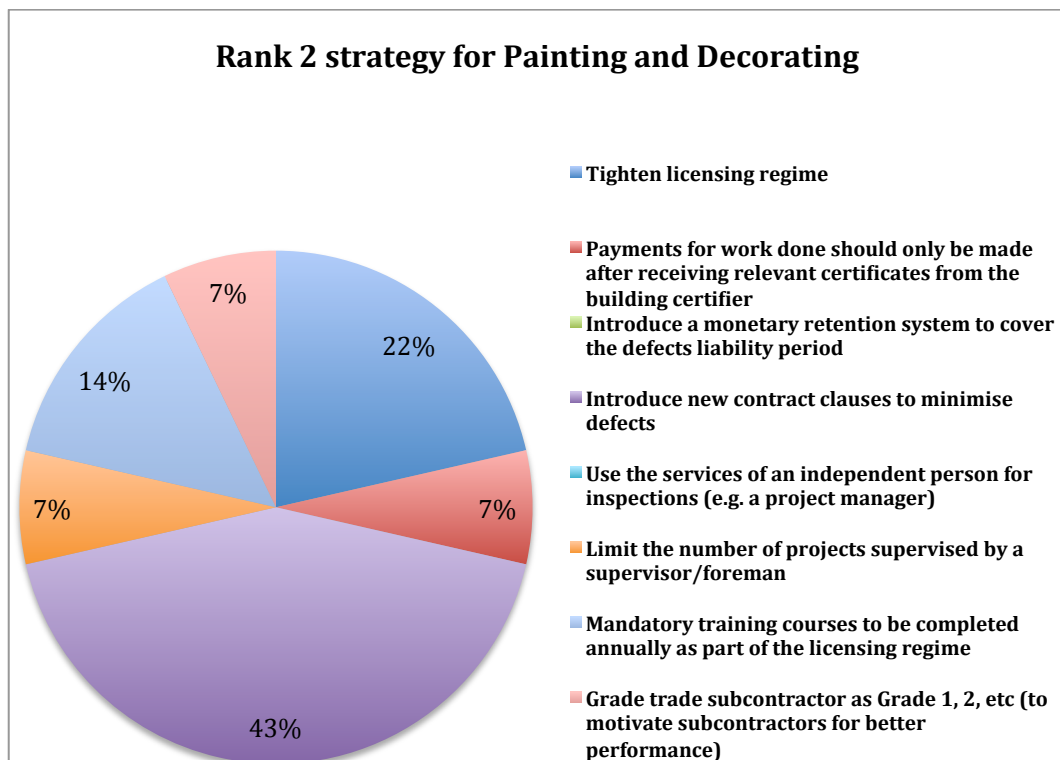


Figure 4.79: Rank 2 strategy for Painting and decorating

The majority of participants (43%) indicated introduce new contract clauses to minimise defects as the rank 2 strategy for Painting and decorating trade. Out of 14 respondents 6 respondent that includes 2 project managers, 2 architects, 1 building certifier and 1 site supervisor selected grade trade subcontractor as Grade 1,2 etc. (to motivate subcontractors for better performance) as rank 2 strategy. 17% of the respondents



indicated tightening licensing regime as rank 2 strategy for Painting and decorating trade.

Participants were also asked, to what extent will your rank 2 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of introduce new contract clauses to minimise defects was rated on average 4, which indicates that this strategy will be hard to be acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 2 strategy. The implematability of introducing new contract clauses to minimise defects was rated on average 3, which indicates moderate difficulty in implementing this strategy.

The figure 4.80 shows the summary of responses received for rank 3 Strategy for Painting and decorating.

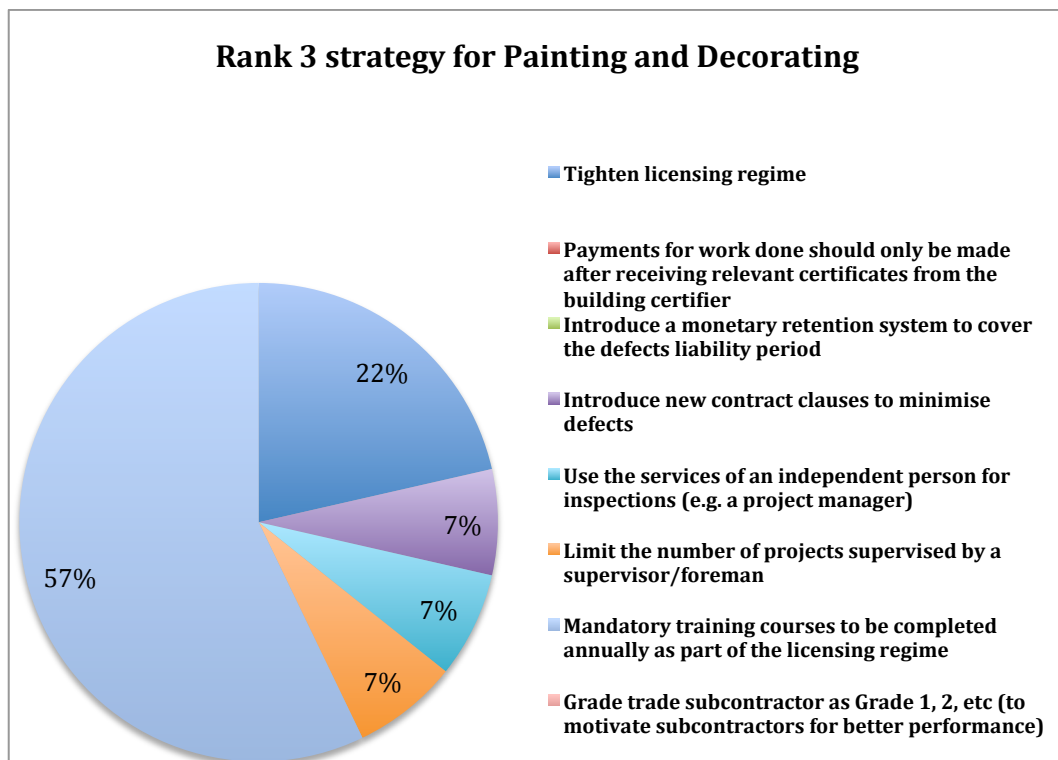


Figure 4.80: Rank 3 strategy for Painting and Decorating

The majority of participants (57%) indicated mandatory training courses to be completed annually as part of the licensing regime as the rank 3 strategy for Painting and decorating trade. Out of 14 respondents 8 respondent that includes 3 project managers, 2 architects, 1 building certifier, 1 foreman and 1 site supervisor selected mandatory training courses to be completed annually as part of the licensing regime as rank 3 strategy. 17% of the respondents indicated tightening licensing regime as rank 3 strategy for Painting and decorating trade.

Participants were also asked, to what extent will your rank 2 strategy be acceptable to the industry? The question was asked in a linear scale format using the scale 1 to 5 where 1 being very easy and 5 if not acceptable at all. The acceptability of mandatory training

courses to be completed annually as part of the licensing regime was rated on average 4, which indicates that this strategy will be hard to be acceptable by the industry. Similarly, participants were also asked how easy would it be to implement your rank 2 strategy. The implementability of mandatory training courses to be completed annually as part of the licensing regime was rated on average 3, which indicates moderate difficulty in implementing this strategy.

### 4.5.1 Summary

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After analysing the second stage survey 3 most suitable strategies to minimise defects in Waterproofing, Concreting, Swimming pool construction, maintenance and installation and Painting and decorating trades were identified. These findings are based on respondent's opinion and expertise having worked in the industry for significant numbers of years.

The 3 most suitable strategies for minimising defects in Waterproofing as selected by the respondents are:

1. Tightening the licensing regime.
2. Payment of work done should be made after receiving relevant certificates from building certifier.
3. Mandatory training courses to be completed annually as part of the licensing regime.

Respondents have also included mandatory inspection and test plan to be completed and new products should be industry tested and approved prior to introduction as other strategies that could be implemented to minimise defects in Waterproofing.

The 3 most suitable strategies for minimising defects in Concreting as selected by the respondents are:

1. Payments for work done should only be made after receiving relevant certificates from the building certifier.
2. Mandatory training courses to be completed annually as part of the licensing regime.
3. Tightening the licensing regime.

Respondent also included mandatory uses of curing compounds on slabs as it could prevent large percentage of slab cracking and certifiers should be required to inspect and sign off on any structural works as other strategies to minimise defects in Concreting.

The 3 most suitable strategies for minimising defects in Swimming pool construction, maintenance and installation as selected by the respondents are:

1. Tightening the licensing regime.
2. Payment for work done should be made after receiving relevant certificates from building certifier.
3. Introduce new contract clauses to minimise defects.

Respondent also included independent inspecting for Swimming pool construction like a

plumbing inspector could minimise defects in this trade.

The 3 most suitable strategies for minimising defects in painting and decorating as selected by the respondents are:

1. Grade trade subcontractor as Grade 1,2,etc (to motivate subcontractors for better performance).
2. Introduce new contract clauses to minimise defects.
3. Mandatory training courses to be completed annually as part of the licencing regime.

Respondent also included mandatory inspection and test plan as other strategies for minimising defects in Painting and decorating trade.

## Chapter 5 Conclusion

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### 5.1 Introduction

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The primary objective of this project was to understand how to manage defects in single and two storey residential projects within Queensland. Furthermore, the primary objective also involves taking a trade-based approach towards the investigation. In developed countries such as Australia, subcontractors do most of the on-site work. According to Pratt (2011), in residential projects subcontractors perform almost 80% of the work and often most of the on-site work is carried out by the tradies leaving the main builders as the co-ordinator of various trades. However, despite these tradies being the specialists in the specific area, there are yet many problems associated with subcontractors and tradies. Through literature review, it was identified that various causes of defect could be linked to these trades. Whether it is a motivational issue, error-based issues, knowledge-based issues, workmanship issues, etc. they all could be linked to various trades required to build a house. But there was a lack of knowledge of the problematic trade, although QBCC produces the list of top ten defects due to its limitations it was considered that there is a need to conduct a risk analysis that takes into account both likelihood and impact of having defects for all trades used in the residential projects. Risk analysis of all trades was conducted through first stage survey, and the overall findings are shown in section 5.2. The knowledge of troublesome trades would be benefits for builders, subcontractor and homeowners. With this knowledge, potential mitigation techniques could be implemented in construction to assist in minimising defects.

Despite various construction acts, regulations, standards, codes, licensing regimes, other management approaches such as quality management, risk management, defect management building are still handed with defects. Through first stage survey, troublesome trades were identified; second stage survey was conducted to identify the management strategies to manage these troublesome trades. The main finding of this survey is presented in section 5.2 below. Thus by conducting two-stage survey first to identify the troublesome trade and second to identify the management strategies to minimize defects in the troublesome trades the main objective of this project was achieved. This chapter will further provide the main findings, recommendations, limitations to this project and further areas to be investigated.

### 5.2 Main Findings and Recommendations

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By undertaking first stage survey that included various professional with various roles within the residential construction industry, the level of performance risk of various trades used in residential projects was identified. These findings are based on their opinion and expertise having worked in the industry for significant numbers of years. The main finding from the first stage survey was the identification of high-risk trades. The high-risk trades identified are as follows:

- Waterproofing
- Concreting

- Swimming pool construction, maintenance and installation

The overall performance risk identified by the first stage survey is presented in figure 5.1 below. In figure 5.1 below, left axis represents the risk score, trades with red bar are high-risk trades, trades with orange bar are moderate-risk trades and trades with yellow bar represent the low-risk trades.

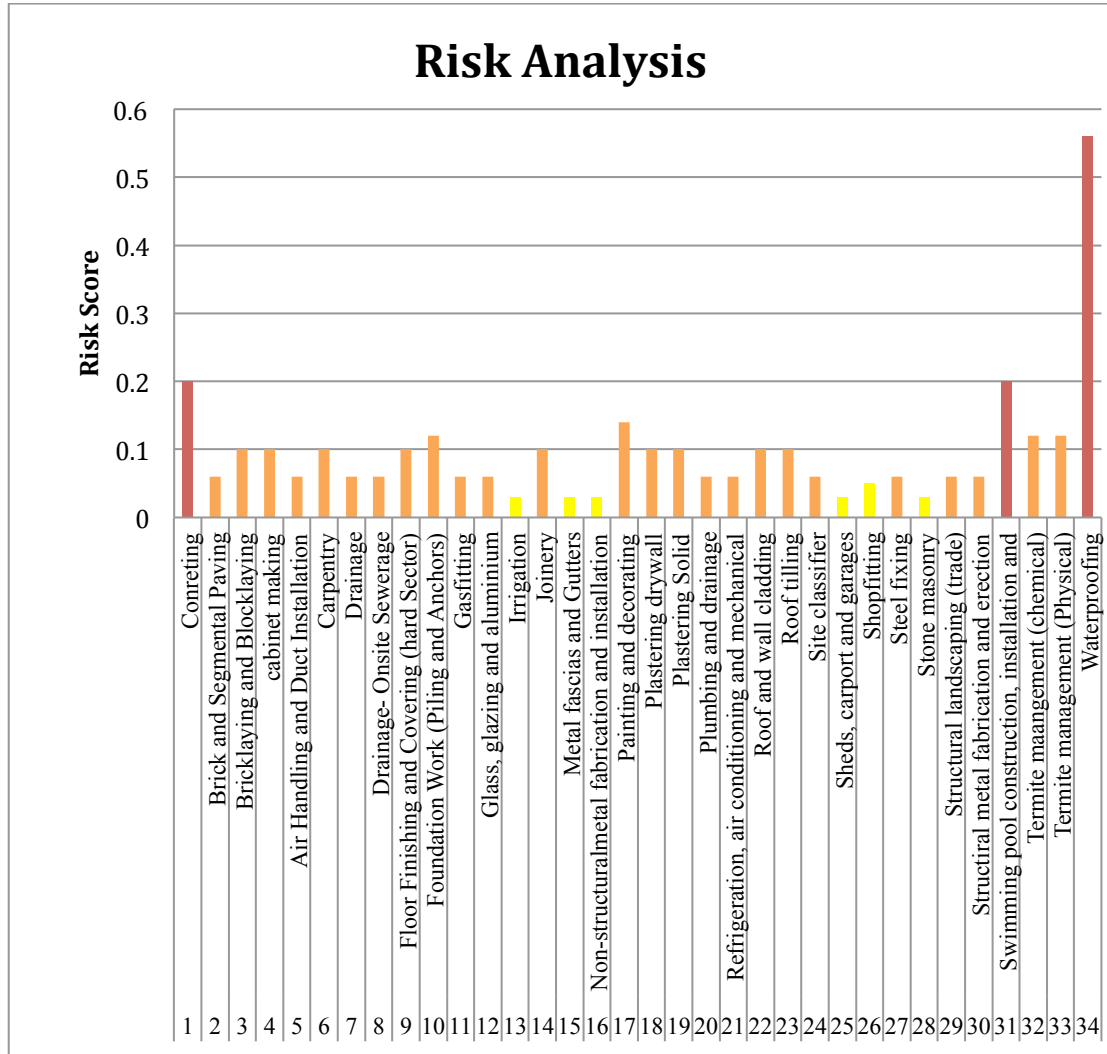


Figure 5.1: Risk analysis of 34 trades listed by QBCC

With this knowledge, it is recommended that builders, subcontractors and homeowners take extra measures and implement mitigation techniques to assists in minimising defects for high and moderate risk trades.

By undertaking second stage survey that included various professional with various roles within the residential construction industry. Three most suitable strategies to minimise defects in Waterproofing, Concreting, swimming pool construction, maintenance and installation and painting and decorating trades have been identified. These findings are

based on their opinion and expertise having worked in the industry for substantial amounts of years.

This research project has identified the most suitable strategies for minimising defects in waterproofing, and it is recommended that if strategies mentioned below are implemented it would assist in minimising defects in this trade. The 3 most suitable strategies for minimising defects in Waterproofing as selected by the respondents are:

1. Tightening the licensing regime
2. Payment of work done should be made after receiving relevant certificates from building certifier.
3. Mandatory training courses to be completed annually as part of the licensing regime.

This research project has identified the most suitable strategies for minimising defects in Concreting, and it is recommended that if strategies mentioned below are implemented it would assist in minimising defects in this trade. The 3 most suitable strategies for minimising defects in Concreting as selected by the respondents are:

1. Payments for work done should only be made after receiving relevant certificates from the building certifier.
2. Mandatory training courses to be completed annually as part of the licensing regime.
3. Tightening the licensing regime.

This research project has identified the most suitable strategies for minimising defects in Swimming pool construction, maintenance and installation and it is recommended that if strategies mentioned below are implemented it would assist in minimising defects in this trade. The 3 most suitable strategies for minimising defects in Swimming pool construction, maintenance and installation as selected by the respondents are:

1. Tightening the licensing regime
2. Payment for work done should be made after receiving relevant certificates from building certifier.
3. Introduce new contract clauses to minimise defects.

This research project has identified the most suitable strategies for minimising defects in Painting and decorating and it is recommended that if strategies mentioned below are implemented it would assist in minimising defects in this trade. The 3 most suitable strategies for minimising defects in Painting and decorating as selected by the respondents are:

1. Grade trade subcontractor as Grade 1,2,etc (to motivate subcontractors for better performance)
2. Introduce new contract clauses to minimise defects
3. Mandatory training courses to be completed annually as part of the licencing regime.

## 5.3 Limitations

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The survey was distributed to approximately 500 participants. The number of responses received were adequate but not very high perhaps if there was more time probably could have supplemented by other ways (On-site visit to builders) and increase the responses rate.

For the first stage survey, there were 34 trades and each trade had 3 questions, requiring participants to answer 102 questions plus 3 questions about their experience and roles within the industry. The number of questions may have resulted in the professionals being reluctant to participate in the survey. If this study is to continue further, perhaps a pilot survey could be conducted to limit the number of trades.

During the data collection phase attempts were made to visit construction site to increase the response rate, although all attempts were taken to ensure the anonymity (as the survey was online survey), it appeared that professionals were reluctant to disclose data on defects. This is understandable because it is a topic people would not discuss freely because of other ramifications.

The survey was conducted using Google Form, although it was available for free, but it has its limitation, the options for designing questions were limited. Particularly in relation to reducing the number of question for second stage survey. A preferred questionnaire format couldn't be achieved thus questionnaire seemed long. Which may have resulted in professionals being reluctant to participate in the survey.

## 5.4 Future Research

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Due to the scope of the project and the limitation of time, the investigation into various areas could not be conducted. Some of the future research areas identified through this research project are:

1. Feasibility of introducing the grading system for Subcontractors or trade contractors specific to troublesome trades identified in this project.
2. Further study into how licensing system could be tightened, specific to troublesome trades identified in this project.
3. Further research on how to incorporate continuous professional development programmes with licencing renewal for troublesome trades identified in this project.

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## Appendix A-Project Specification

**University of Southern Queensland**

**Faculty of Engineering & Surveying**

**ENG4111/ENG4112 Research Project**

### **Project Specification**

Revision 2

**For:** Bibek Dhakal  
**Title:** A Trade-based Approach for Defects Management in Residential Construction  
**Major:** Construction management (management)  
**Supervisor:** Dr. Vasantha Abeysekera  
**Enrolment:** ENG4111- ONC S1 2016  
ENG4112- ONC S2 2016

**Project Aim:** This project aims to understand how to manage defects in single and two storey residential projects in Queensland taking a trade-based approach given that most work is subcontracted.

**Programme:** Issue B, 24<sup>th</sup> April 2016

In order to do so, the following main objectives have been set up:

**Objective 1:** Understand broadly the technology used for building houses in Qld with specific reference to trades.

**Objective 2:** Understand the nature of defects in residential construction with respect to trades.

**Objective 3:** Understand about quality management and risk management bodies of knowledge but specifically related to defects management.

**Objective 4:** Synthesise a set of trades that can be used for this study.

**Objective 5:** Understand the nature of trade-based risk focussing on defect by undertaking a survey (having obtained ethics approval).

**Objective 6:** Identify strategies for managing critical trades by focusing on high-risk trades.

# Appendix B -First Stage Survey Questionnaire

8/12/2016

A Trade-based Approach for Defects Management in Residential Construction

## A Trade-based Approach for Defects Management in Residential Construction

Survey Questionnaire:

There are 34 trades and 3 questions for each trade. Each trade is provided with the scope of work as provided by Queensland Building and Construction Commission.

ANSWER ONLY those questions that you feel confident about the accuracy and reliability of the response. Your response should relate to your experience within the State of Queensland.

\* Required

### 1. What is your role within the residential construction industry? \*

Check all that apply.

- Site Supervisor
- Foreman
- Building Certifier
- Managing Director
- Architect (Project management)
- Project manager (residential)
- Other: .....

### 2. How long have you been working in the current position?

.....

### 3. How many years of experience do you have in residential construction industry?

.....

## Trade 1 - Concreting

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Concreting including install formwork, reinforcement and concrete

### 4. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**5. Please indicate the impact of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**6. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 2- Brick and Segmental Paving**

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Surface preparation, laying segmental or unit paving, concrete work for brick and segmental paving

**7. Please indicate the likelihood of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**8. Please indicate the impact of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**9. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 3 - Bricklaying and Blocklaying**

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Surface preparation, brick or block construction, build straight masonry steps and stairs with or without landings, lay segmental or unit paving, lay glass blocks, build battered masonry surfaces, install prefabricated window or door frames, Concreting to simple forms, including installation of formwork, reinforcement and concrete



**10. Please indicate the likelihood of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**11. Please indicate the impact of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**12. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 4 - Cabinet making**

Install, refurbish, restore or repair kitchen, bathroom, laundry and other fitted cabinets and fittings on-site

**13. Please indicate the likelihood of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**14. Please indicate the impact of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**15. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 5- Air Handling Duct Installation**

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Install ductwork and enclosures for air handling and mechanical ventilation system

16. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

17. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

18. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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**Trade 6- Carpentry**

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Construct and erect timber and steel wall framing, roof structures, non-load bearing internal partition walls, install windows and doors including framing, erect ceiling and subfloor framing, install exterior cladding, fascias, soffits, metal roofing, construct timber stairs, fix internal linings, panelling and mouldings, install door and window locks and furniture, install fittings, erect and strip formwork including slip form and jump form formwork

19. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

20. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

21. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 7 - Drainage

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Install, commission, maintain and test above and below ground waste water, stormwater and sanitary drainage, prepare plans and specifications for drainage work

22. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/> Very High

23. Please indicate the impact of having defects in this Trade.

Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/> Very High

24. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 8 - Drainage- On-site Sewerage

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Building work that is within the scope of work mentioned in the Plumbing and Drainage Regulation 2003, schedule 2, item 8, column 4, paragraph (a) & (b) for a Drainer – on-site sewerage facility licence.

25. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/> Very High

**26. Please indicate the impact of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**27. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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### Trade 9- Floor Finishing and covering (hard sector)

Prepare, sand and apply coatings to timber floors; install and repair cork flooring; prepare, install and repair mosaic and block parquet flooring, install and repair non-structural strip timber flooring, prepare, apply and finish epoxy and seamless floor covering

**28. Please indicate the likelihood of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**29. Please indicate the impact of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**30. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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### Trade 10- Foundation work (piling and Anchors)

Excavate and install support, construct underpinning, concreting for foundation work including install formwork, reinforcement and concrete, install piling including driven piles, cast-in piles, groutcrete

piles, compressed piles and bored cast-in-place piles, dewater site including sump and permanent dewatering systems

31. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5		
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

32. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5		
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

33. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 11- Gasfitting

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Install, commission, maintain, test, alter, repair and service a gas system

34. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5		
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

35. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5		
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

36. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 12- Glass, Glazing and aluminium

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Glaze and reglaze building, fabricate and install windows, doors, shower screens, metal framed sliding wardrobe doors, fixed mirrors

37. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

38. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

39. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 13- Irrigation

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Assess, select and install irrigation equipment for various landscaping, install and commission solar heating systems for swimming pools

40. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**41. Please indicate the impact of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**42. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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### Trade 14- Joinery

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Install sub floor framing, construct and erect wall framing including internal linings, partition frames, curtain walling

**43. Please indicate the likelihood of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**44. Please indicate the impact of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**45. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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### Trade 15- Metal fascias and Gutters

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Fabricate and install rainwater goods including metal fascias and gutters, external flashing and associated soffits, fascias and gutters

**46. Please indicate the likelihood of having defects in this Trade.**  
 Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**47. Please indicate the impact of having defects in this Trade.**  
 Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**48. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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### Trade 16 - Non-structural metal fabrication and installation

Prepare, fabricate and erect non-structural metal components

**49. Please indicate the likelihood of having defects in this Trade.**  
 Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**50. Please indicate the impact of having defects in this Trade.**  
 Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**51. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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**Trade 17 - Painting and decorating**

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Prepare surfaces to apply paint or other substance for protective, decorative or technical purposes, including colour matching, apply texture coatings, wallpaper, apply cement render no more thickness

52. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

53. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

54. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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**Trade 18 - Plastering drywall**

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Construct and install non-loadbearing partition wall and ceiling frames including fix plasterboard, plasterglass, fibre cement sheets, cornices, and finishing joints, fire-rated walls and ceilings, autoclaved aerated masonry wall and ceiling systems, suspended ceiling systems, suspended ceiling systems

55. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

56. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

57. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 19 - Plastering solid

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Concrete work for solid plastering, including installing formwork, reinforcement and concrete; fix steel for solid plastering; Cut with oxy-acetylene for solid plastering; Apply float and set coats for hard plaster-flat surfaces, Apply solid render; Apply trowelled texture-coat finishes, Install pre-cast decorative mouldings; Install cast plaster blockwork. Construct plaster mouldings, Conite construction, Apply paint for decorative, protective or technical purposes

58. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

59. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

60. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 20 - Plumbing and drainage

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Installing, commissioning, maintaining and testing plumbing and drainage services in all classes of buildings and premises

**61. Please indicate the likelihood of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**62. Please indicate the impact of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**63. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**

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### **Trade 21 - Refrigeration, air conditioning and mechanical services including unlimited design**

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Install, commission, service or repair refrigeration, air conditioning, mechanical ventilation and air handling systems for a building

**64. Please indicate the likelihood of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**65. Please indicate the impact of having defects in this Trade.**

*Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

65. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 22 - Roof and wall cladding

Select and install roof cladding other than terracotta and concrete roof tiles, fabricate and install rainwater goods, flash penetration through roofs and walls, design, fabricate and install external flashings, metal ceilings and associated soffits and fascias, erect fixed or operating box type louvre units, design roof drainage components, Design penetrations associated with mechanical services, including large penetration water management, Refurbish and maintain roofs, excluding painting roofs

67. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

68. Please indicate the impact of having defects in this Trade.

Mark only one oval.

1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

69. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 23 - Roof tiling

Cut and fix roof tiles (including tiles of concrete, clay, metal or similar material, shingles and shakes) to roof and fascia structures, Set out and fix battens, Bedding, pointing and installing of associated flashing, install safety mesh, sarking and antiponding boards, install firewall insulation and metal straps to battens, install skylights; Refurbish and maintain roofs, excluding painting roofs

**70. Please indicate the likelihood of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**71. Please indicate the impact of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**72. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 24 - Site classifier**

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Site survey, including use of dumpy and laser levelling equipment; Sample, test and assess materials on building sites, including moisture testing, particle distribution testing and field strength testing; Classify building sites through the interpretation of site and laboratory data  
Prepare plans, specifications and documents for on-site domestic wastewater management.

**73. Please indicate the likelihood of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**74. Please indicate the impact of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

75. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 25 - Sheds, carports and garages

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The following building work for sheds, carports and garages that are class 10a buildings with a maximum floor area of 100m<sup>2</sup>; prepare, fabricate and erect metal components; prepare site for and install concrete floor slabs

76. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

77. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

78. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Trade 26 - Shopfitting (trade)

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Set out, fabricate and assemble cabinets, showcases, wall units, counters and work stations; install subfloor framing, including bearers, joists and ladder frames

79. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**80. Please indicate the impact of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**81. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 27 - Steel fixing**

Place reinforcement steel in footing trenches for on-ground slabs and on formwork, in preparation for the placement of concrete

**82. Please indicate the likelihood of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**83. Please indicate the impact of having defects in this Trade.**

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**84. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 28 - Stone masonry (trade)**

Work with stone, including, for example, finish, lay, machine, renovate and shape; Construct with stone, including for example, arches, fireplaces, stairs and walls; Concrete work for stonemasonry; Set out and anchor facades; Apply or install waterproofing and damp-proofing for stonemasonry

**85. Please indicate the likelihood of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**86. Please indicate the impact of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**87. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.**


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**Trade 29 - Structural landscaping (trade)**

Prepare, fabricate and erect carports, decking, fences, gazebos, pergolas, retaining walls of a height that do not require an engineering certification under a local law, and ornamental structures; install prefabricated sheds, including associated concrete slabs, with a maximum floor area of 10m<sup>2</sup>; install surface and subsoil drainage systems for landscaping work; Prepare site and lay paving or concrete, not intended to carry vehicular traffic, for landscaping

**88. Please indicate the likelihood of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

**89. Please indicate the impact of having defects in this Trade.***Mark only one oval.*

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High



90. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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**Trade 30 - Structural metal fabrication and erection**

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Prepare, fabricate and erect structural and non-structural metal components

91. Please indicate the likelihood of having defects in this Trade.  
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

92. Please indicate the impact of having defects in this Trade.  
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

93. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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**Trade 31 - Swimming pool construction, installation, and maintenance**

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- Earthworks and drainage for the construction of concrete swimming pools and spas
- Place and fix reinforcement for the construction of concrete swimming pools and spas
- Construct formwork for concrete swimming pools and spas
- Place and finish concrete or other materials to provide a shape or form for concrete swimming pools and spas
- Ancillary pipework including general filtration, sanitation, water chemistry, solar heating and basic hydraulics for concrete swimming pools and spas
- Landscaping works associated with the construction of concrete swimming pools and spas, including pool fencing and paving
- Ceramic tiling, painting, coping and internal finishes associated with the construction of concrete swimming pools and spas
- Prepare plans and specifications for concrete swimming pools and spas, if the plans and

specifications are:

for the licensee's personal use, or  
for use in building work to be performed by the licensee personally  
Maintenance and general repair of concrete swimming pools and spas  
Install pool accessories, including, for example, pool heating systems

94. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

95. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

96. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 32 - Termite management (chemical)

Pre-slab and perimeter chemical treatment of new building work for termite management; inspect or investigate a completed building, and give advice or a report about the following:

- Termite management systems for the building
- Termite infestation in the building.

97. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

98. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

99. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 33 - Termite management (physical)

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Install a particular material or system designed for the prevention of termite infestation in accordance with the manufacturer's specification or any other applicable standard. Inspect or investigate a completed building, and give advice or a report about the use of the particular material or system for the building.

100. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

101. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

102. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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### Trade 34 - Waterproofing

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Apply, install and repair waterproofing including surface preparation, and apply or install material or systems for preventing moisture penetration.

103. Please indicate the likelihood of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

104. Please indicate the impact of having defects in this Trade.

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

105. If you have indicated a 4 or greater for one or both of the questions above, please explain the reasons for this response.

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## Appendix C- Second Stage Survey Questionnaire

10/11/2016

Strategies for managing troublesome Trades leading to defects

### Strategies for managing troublesome Trades leading to defects

Four trades have been identified as being high risk or moderately high risk from the First Stage survey, namely, Waterproofing, Concreting, Swimming Pool Construction, and Painting. The purpose of this survey is to identify strategies required to manage these trades with a view to minimising defects.

\* Required

#### 1. What is your role within the residential construction industry? \*

Mark only one oval.

- Site Supervisor
- Foreman
- Building Certifier
- Managing Director
- Architect (Project management)
- Project manager (residential)
- Other:

#### 2. How many years of experience do you have in residential construction industry?

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### Waterproofing

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How suitable are the following strategies for minimising defects? Select the three most useful strategies and rank them as 1, 2, and 3 with Rank 1 being the most suitable.

#### 3. Please select the rank 1 strategy for minimising defects in Waterproofing trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

4. To what extent will your Rank 1 strategy be acceptable to the Industry?  
Mark only one oval.

1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

5. How easy would it be to implement your Rank 1 strategy?  
Mark only one oval.

1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

6. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 1 strategy.

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7. Please select the rank 2 strategy for minimising defects in Waterproofing trade. \*  
Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

8. To what extent will your Rank 2 strategy be acceptable to the Industry?  
Mark only one oval.

1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

9. How easy would it be to implement your Rank 2 strategy?  
Mark only one oval.

1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

10. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 2 strategy.

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11. Please select the rank 3 strategy for minimising defects in Waterproofing trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

12. To what extent will your Rank 3 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

13. How easy would it be to implement your Rank 3 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

14. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 3 strategy.

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15. Please itemise any other strategies that can be used for minimising defects in Waterproofing.

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## Concreting

How suitable are the following strategies for minimising defects? Select the three most useful strategies and rank them as 1, 2, and 3 with Rank 1 being the most suitable

16. Please select the rank 1 strategy for minimising defects in Concreting trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc. (to motivate subcontractors for better performance)

17. To what extent will your Rank 1 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

18. How easy would it be to implement your Rank 1 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult



19. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 1 strategy.

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20. Please select the rank 2 strategy for minimising defects in Concreting trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

21. To what extent will your Rank 2 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

22. How easy would it be to implement your Rank 2 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

23. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 2 strategy.

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## 24. Please select the rank 3 strategy for minimising defects in Concreting trade.

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

## 25. To what extent the above selected rank 3 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

## 26. How easy would it be to implement your Rank 3 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

## 27. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 3 strategy.

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## 28. Please itemise any other strategies that can be used for minimising defects in Concreting.

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Swimming pool construction, maintenance and installation

How suitable are the following strategies for minimising defects? Select the three most useful strategies and rank them as 1, 2, and 3 with Rank 1 being the most suitable

29. Please select the rank 1 strategy for minimising defects in Swimming pool construction, maintenance and installation trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

30. To what extent will your Rank 1 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

31. How easy would it be to implement your Rank 1 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

32. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 1 strategy.

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33. Please select the rank 2 strategy for minimising defects in swimming pool construction, maintenance and installation trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

34. To what extent will your Rank 2 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

35. How easy would it be to implement your Rank 2 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

36. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 2 strategy.

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37. Please select the rank 3 strategy for minimising defects in Swimming pool construction, maintenance and installation trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc. (to motivate subcontractors for better performance)

38. To what extent will your Rank 3 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

39. How easy would it be to implement your Rank 3 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

40. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 3 strategy.

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41. Please itemise any other strategies that can be used for minimising defects in Swimming pool construction, maintenance and installation.

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## Painting and decorating

How suitable are the following strategies for minimising defects? Select the three most useful strategies and rank them as 1, 2, and 3 with Rank 1 being the most suitable

42. Please select the rank 1 strategy for minimising defects in Painting and decorating trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc. (to motivate subcontractors for better performance)

43. To what extent will your Rank 1 strategy be acceptable to the industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

44. How easy would it be to implement your Rank 1 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

45. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 1 strategy.

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**45. Please select the rank 2 strategy for minimising defects in Painting and decorating trade.**

Mark only one oval.

- Tighten licensing regime  
 Payments for work done should only be made after receiving relevant certificates from the building certifier  
 Introduce a monetary retention system to cover the defects liability period  
 Introduce new contract clauses to minimise defects  
 Use the services of an independent person for inspections (e.g. a project manager)  
 Limit the number of projects supervised by a supervisor/foreman  
 Mandatory training courses to be completed annually as part of the licensing regime  
 Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

**47. To what extent will your Rank 2 strategy be acceptable to the industry?**

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

**48. How easy would it be to implement your Rank 2 strategy?**

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

**49. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 2 strategy.**

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## 50. Please select the rank 3 strategy for minimising defects in Painting and decorating trade. \*

Mark only one oval.

- Tighten licensing regime
- Payments for work done should only be made after receiving relevant certificates from the building certifier
- Introduce a monetary retention system to cover the defects liability period
- Introduce new contract clauses to minimise defects
- Use the services of an independent person for inspections (e.g. a project manager)
- Limit the number of projects supervised by a supervisor/foreman
- Mandatory training courses to be completed annually as part of the licensing regime
- Grade trade subcontractor as Grade 1, 2, etc (to motivate subcontractors for better performance)

## 51. To what extent will your Rank 3 strategy be acceptable to the Industry?

Mark only one oval.

	1	2	3	4	5	
Very acceptable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Not acceptable at all

## 52. How easy would it be to implement your Rank 3 strategy?

Mark only one oval.

	1	2	3	4	5	
Very easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very difficult

## 53. Use the following space to comment about the ACCEPTABILITY and IMPLEMENTABILITY of your Rank 3 strategy.

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## 54. Please itemise any other strategies that can be used for minimising defects in Painting and decorating.

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