University of Southern Queensland

Faculty of Health, Engineering & Sciences

An Investigative Study of Road Construction Contract Variations

A dissertation submitted by

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Abstract

The state government plans to invest $18.1 billion in transport infrastructure across local, state and national networks over the next four years. The Department of Transport and Main Roads (TMR) is the state government agency responsible to deliver the investment with fit-for-purpose and value for money infrastructure. With multi-billion dollar investments, cost overruns of project budgets can result in millions of dollars of under delivery due to contract variations.

The aim of this research project is to assist TMR with the understanding of why variations to Road Construction Contracts (RCC) arise and their the root causes which result in cost overruns. Unplanned variations to contracts can cause excessive cost over-runs and place a strain on the overall project budget. Cost overruns on several of TMR's recent transport infrastructure projects have exceeded construction cost estimate performance targets and anecdotal evidence suggests that the average figure is in excess of 20% of the original construction budget. Whilst the construction phase is only one part of the project life cycle it can be a major contributor to the project's total cost overrun if unbudgeted contract variations occur. Therefore the gaining of a better understanding of the source, type and reasons of these variations is critical to effectively managing and controlling costs on projects to ensure best value for money.

To gain a better understanding of variations it was necessary to first undertake a literature review of relevant past studies and publications to gain a basic appreciation of what forms a road construction contract, define what contract variations are and to review the construction industry's research into the significance of cost over-runs on budgets. Preliminary research of information was also undertaken to identify the most appropriate data both from historical contracts and from expert opinion that would assist in achieving the desired outcomes of this research project.

The research methodology entailed a three step process by which the first step involved the collection of quantitative data from TMR databases in the form of historical contracts and associated variations. The second step required a detailed analysis of the historical data to provide the basis of the project outcomes, summarise the results and identify trends across variations. The third and final step involved collecting qualitative data through an on-line expert opinion survey to validate the results of the analysis of the historical variation data and to assess the level of understanding of the root causes of variations among road project delivery practitioners.

From the 111 contracts sampled there were 529 variations in total which combined with the survey results provide the basis of the research outcomes. On average all contracts sampled had a variation ratio of 24.2% of the original contract value. Another revealing statistic is that contracts with original values less than $10 million had an average variation ratio greater than the all contracts average and those contracts with original values greater than $10 million had variation ratio less than the all contracts average.

This research project concludes with recommendations to minimise the likelihood of typical variations studied in this research project from occurring in the future. Further work is required to consider the cost implications of the variations for future improvement of estimating and delivery of an RCC.

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Limitations of Use

Certification of Dissertation

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Alan G. Purvis

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Abbreviations

ANAO	Australian National Audit Office
BCIPA	Building and Construction Industry Payments Act 2004
CAS	Contract Administration System
CoT	Conditions of Tendering
FAP	Financial Approval Process
GCoC	General conditions of Contract
NDRRA	Natural Disaster Relief and Recovery Arrangements
PCEM	Project Cost Estimating Manual
PUP	Public Utility Plant
QPP	Queensland Procurement Policy
QTRIP	Queensland Transport and Roads Investment Program
RCC	Road Construction Contracts
SCoC	Supplementary Conditions of Contract
SPIDA	Statewide Program Investment Delivery Application
SPO	State Program Office
TIC-CO	Transport Infrastructure Contract - Construct Only
TIPDS	Transport Infrastructure Project Delivery System
TMR	Department of Transport and Main Roads
VfM	Value for Money

Chapter 1

Introduction

1.1 Background

Queensland has the longest state-controlled road network of any Australian state or territory, with 33,352km of roads spanning the state. The road network is the state government's largest single asset and requires a huge investment from public funds to keep it at a level that meets the majority of road users needs. A map of the vast extent of the Queensland state controlled road network is shown in Figure 1.1.

In the Queensland Transport and Roads Investment Program (QTRIP) 2014-15 to 2017-18 the Premier states that a key priority for Queensland continues to be delivering a better road network by building a transport system that supports the needs of Queenslanders, industry and local government. For this reason the state government plans to invest $18.1 billion in transport infrastructure across local, state and national networks over the next four years. The Department of Transport and Main Roads (TMR) is the state government agency responsible to deliver the QTRIP with fit-for-purpose and value for money infrastructure.

With multi-billion dollar investments such as QTRIP, cost overruns of project budgets can result in millions of dollars of under delivery of the program. Cost overruns in the construction phase on several of TMRs recent projects have not only exceeded TMR's cost estimate performance target of 5% but anecdotal evidence suggests that the average figure is in excess of the 10% industry average. Whilst the construction phase is only one part

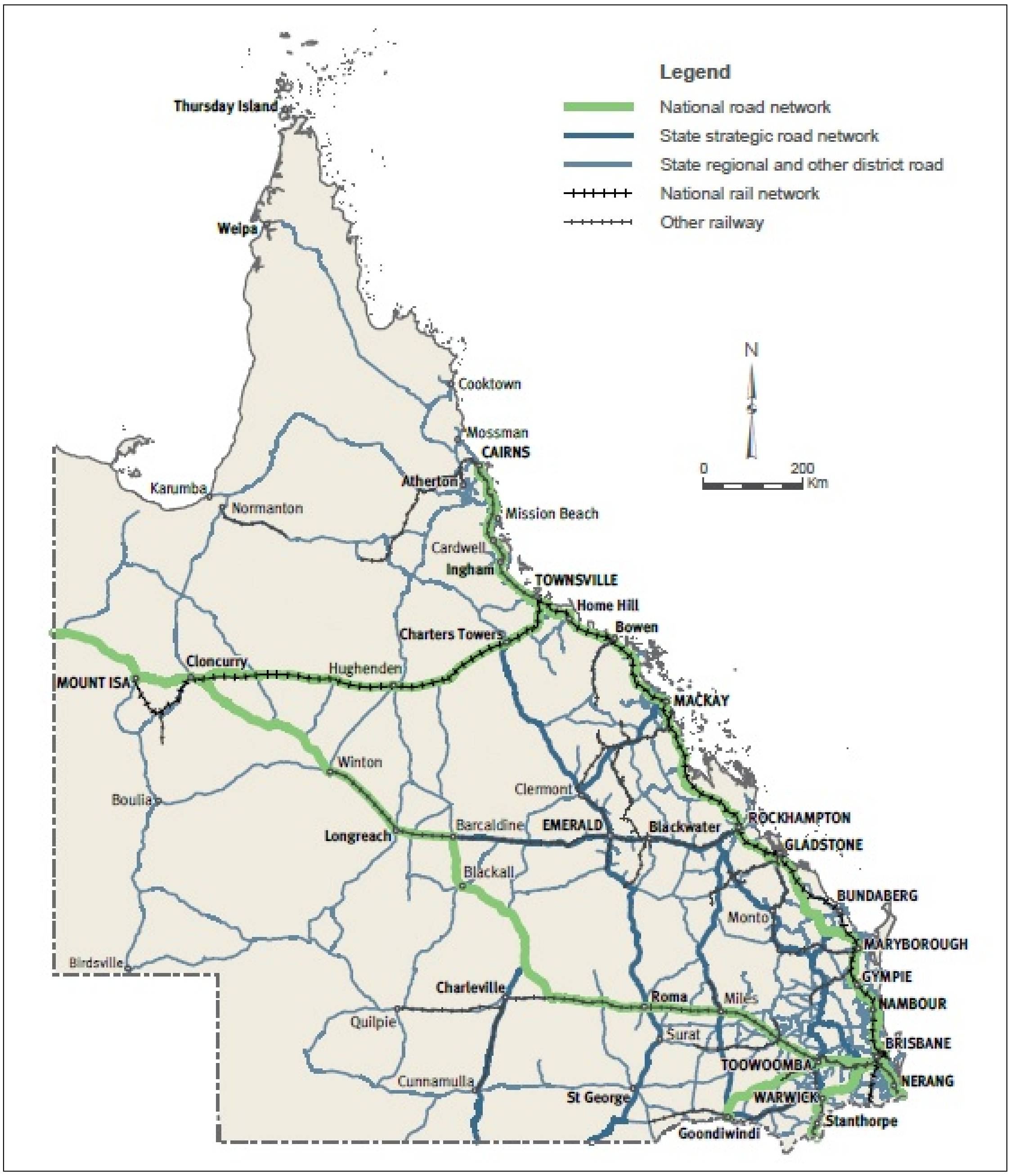

Figure 1.1: Queensland's Transport and Road System Map (Source: TMR website)

of the project life cycle it can be a major contributor to the project's total cost overrun if unbudgeted contract variations occur. Therefore the gaining of a better understanding of the root causes of these cost overruns due to contract variations is critical to effectively managing and controlling costs on projects to ensure best value for money.

1.2 Aims

The aim of this research project is to assist TMR with the understanding of why variations to Road Construction Contracts (RCC) arise and their root causes which result in cost overruns on recent road construction projects. RCCs are the most commonly used construction contracts in TMR for routine projects and this research project will specifically study variations on recent RCCs. Cost overruns of project budgets can arise for various reasons throughout the project life-cycle however this investigative study will focus on the construction phase only and the subsequent variations during the execution of the construction contract.

1.3 Objectives

In order to achieve the aim of this research project there were several objectives to be accomplished:

1. Undertake a literature review to establish previous research into the root causes of variations to RCCs within TMR;
2. Collect quantitative variation data from historical contracts to form the basis of the research;
3. Analyse the historical data and summarise the variations into high level categories of source, type and reasons;
4. Undertake an expert opinion survey of road construction practitioners across TMR to provide qualitative data to substantiate the results from the historical data analysis ;
5. Review the overall research findings, summarise the results and identify trends across variations;
6. Provide recommendations to minimise the likelihood of typical variations studied in this research project from occurring in the future.

The project entailed state wide research into current and recent RCC variations and provide statistical analysis of those variations which will also provide an indication if the contracts sampled have achieved TMRs cost estimate performance target. Therefore analysis of the reasons for the contract variations of construction projects is a necessary step for the improvement of the project delivery process and can be used to pinpoint areas where the greatest improvements can be obtained.

1.4 Conclusions

Key findings of the research were that the better the understanding of the construction scope and site conditions prior to contract award the more accurate the resultant design and cost estimate. Therefore the more accurate design and cost estimate the less likelihood of unplanned and unbudgeted variations.

The research also found that projects should be appropriately resourced with well trained and experienced people in both contract management and contract administration. The enhancement of the dissemination of lessons learnt among peers to allow for continuous improvement of project and contract management was another key finding of the research.

This research project concludes with recommendations to minimise the likelihood of typical variations studied in this research project from occurring in the future. Further work is required to investigate the cost impact of contract variations versus the effort of site investigations at the preconstruction phase. Also further investigations should be made to improve the capture of all contract variation data to enable continuous state-wide monitoring and improvement of contract variation management.

Chapter 2

Literature Review

2.1 Introduction

As discussed in chapter one the main aim of this research project is to assist TMR with the understanding of why variations to Road Construction Contracts (RCC) arise and their root causes which result in cost overruns on recent road construction projects. The gaining of a better understanding of the root causes of these contract variations is critical to effectively managing and controlling costs on projects to ensure best value for money (VfM).

Whilst various definitions of VfM exist in the current literature most include both cost and non-cost factors. The U.K.s "Her Majestys (HM, Treasury 2006, p.7) Value for Money Assessment Guide" describe VfM as:

Value for money is defined as the optimum combination of whole-of-life costs and quality (or fitness for purpose) of the good or service to meet the users requirement. The term whole-of-life is used to refer to the lifecycle of the good or service. VfM is not the choice of goods and services based on the lowest cost bid (Staples and Dalrymple 2012).

Another similar definition is that from a paper by Evans and Peck (2011) in which they describe VfM as:

Value for money is a determination of the outcomes of an individual reconstruction project assessed against how it has contributed to the advancement of Government priorities, as well as cost and non-cost factors that include, but are not limited to whole-of-life and transaction costs and fitness for purpose.

The TMR's own Transport Infrastructure Project Delivery System manual (TIPDS) Volume 2: Tendering for Infrastructure Works also defines Value for Money in broader terms than the initial cost of a project. Achieving value for money within the bounds of the Queensland Procurement Policy requires consideration of:

- overall objectives of the procurement and the outcome being sought;
- cost related factors including whole-of-life costs and transaction costs associated with acquisition, use, holding, maintenance and disposal;
- non-price factors such as fitness for purpose, quality, service and support and sustainability impacts;

and is determined by the appropriate combination of price and non-price criteria for the specific project.

Therefore contract variations to contracts not only pose a risk of causing cost overruns but also risks which may ultimately impact on the non-cost factors which determine a project's value for money. These non-cost factors include sustainable outcomes, stakeholder satisfaction, quality of product, acceptable delivery time frames, etc.

To gain a better understanding of the root causes of contract variations it was necessary to undertake a literature review of relevant past studies and publications to first gain a basic appreciation of what forms a road construction contract, secondly to define how variations occur and thirdly to review the relationship between contract variations and cost over-runs on budgets.

2.2 Road Construction Contract

Construction contracts are legally binding agreements between a Contractor and the Principal to carry out road construction works. Baker and McKenzie (2013) explain that when the Contractor contracts with the Principal to carry out construction works, the Principal is entitled to the performance of those works in the manner and to the extent prescribed by the contract. Similarly, the Contractor is entitled to the contract sum in the manner and as may be adjusted by the contract. Typically there are three parties to a road construction contract:

1. The Principal who is the Owner;
2. The Contractor who is the builder; and
3. The Superintendent who is given the role of administering the contract.

The Principal and the Contractor are contractually bound by the contract terms and conditions whilst the Superintendent is contractually required to implement the contract in an honest and fair manner.

TMR has a number of contractual arrangements in place to ensure value for money in the delivery of projects. Examples include:

- Road Construction Contract (RCC)
- Early Contractor Involvement (ECI)
- Minor Works Contract (MWC)
- Alliance
- Design and Construct (D&C)
- Roadworks Performance Contract (RPC)

The TIPDS manual has been prepared for use by those who have the responsibility for ensuring that value for money is obtained in the delivery of a project. The aim of TIPDS is to provide guidance for the procurement of works and states that the most common contract type in TMR used on routine projects is the RCC. The RCC is a traditional contract type in which TMR acting as the Principal prepares a detailed design with detailed project documentation and the contractor is then engaged to undertake the construction phase of the project.

The TIPDS explains that when using RCCs, interested contractors are invited to submit competitive tenders for the work. The contractor, once selected, assumes no risk for design or deficiencies in the design documentation. One of the attractions of the RCC for TMR is that all parties to the contract understand the risk allocation and it is a fairly balanced contract. The sustainability of this traditional form of contract is conditional upon TMR retaining client leadership and competence in the detail design phase. Hence, the traditional contract form of delivery is dependent on the design and documentation competence of TMR as the design risk remains with TMR (TIPDS 2014).

Poor documentation is the greatest source of claims and disputes in the construction industry (Contract Control International Pty Ltd 2015). RCCs are made up of several documents that are provided by the Principal, in this case TMR, to selected Contractor's to tender for the work. The following order of precedence applies where there is any ambiguity, discrepancy or inconsistency between the documents comprising the Contract. Documents higher in the list have a higher priority (SCoC 2009).

(a) Formal Instrument of Agreement;

(b) Letter of Acceptance;

(c) Notices to Tenderers;

(d) Any Special Conditions of Contract;

(e) Supplementary Conditions of Contract;

(f) General Conditions of Contract;

(g) Drawings;

(h) Standard Drawings Roads;

(i) Project-Specific Supplementary Specifications;

(j) Standard Specifications Roads;

(k) Manual of Uniform Traffic Control Devices;

(l) Conditions of Tendering;

(m) Completed Tender Form and Tender Schedules modified as necessary by post tender correspondence;

(n) Other Contract Documents

The Tendering Manager is responsible for ensuring the various components of the tender documents are appropriate for the specific project and are complete in all respects as these tender documents become part of the contract documents once the contract is awarded. The more accurate and detailed the documents supplied by the Principal are, the less likely a Contractor is going to load their rates for unknown risks. Good project documentation involves getting the project philosophy and risk allocation right and expressing the concepts clearly (TIPDS 2014).

It should be noted that TMR have recently rolled out a new suite of contracts for infrastructure procurement including the Transport Infrastructure Contract - Construct Only (TIC-CO) that now replaces the current Road Construction Contract (RCC). There is a transition period for any RCCs already going through the tender process to continue with the normal RCC tendering and award process. Any new tenders from May 2015 will be required to use the TIC-CO templates (Source: Standard Contract Provisions Roads Volume 1). However at the time of this study commencing, no TIC-COs had been in place therefore only RCCs were included in the research.

Whilst it can be appreciated from the literature review that RCCs are a traditional form of contract that have been in use by TMR for many years it can also be concluded that unless the contract documents are accurate there is a high likelihood of unplanned and unbudgeted variations arising during the execution of the contract.

2.3 Contract Variations

Throughout the lifecycle of a contract there may be circumstances where a variation is required. The Australian National Audit Office (ANAO 2012) defines a variation as an amendment to a contract that changes the original terms or conditions of the contract. Whilst TMR's Contract Administration System (CAS) manual defines a variation under the Contract as a change to the scope of works, materials, design, additional work or removal of work no longer required. The CAS manual also describes the term "variation" in the context of construction contracts as meaning two things, namely:

(a) a variation or change to the contract terms; and

(b) a physical variation or change to the work (quantity or quality) required to be carried out under the contract.

The industry-leading construction publication Construction Week Online describes a variation to the contract terms (or conditions), as a change to the terms that the parties had agreed and accepted when the contract was signed. To vary the terms and conditions of a contract the same degree of formality is required as was the case with the original contract. It must be in writing, signed by the respective authorised party representatives, and in same form as the original contract e.g. signed under hand or executed as a deed (Brand 2008).

The delivery of any infrastructure construction project faces risk and uncertainty and road construction projects in particular face both. Road construction projects are often complex by nature and therefore the RCC form of contract provides a method that allows the Principal to legally manage variations. For example the RCC allows the Principal to make changes to the scope of works and by signing to this the Contractor effectively consents to such changes being made. The RCC also provides a method that allows the contractor to propose changes however if the Principal rejects these proposals the Contractor has no right of redress.

The RCC is based in part on the Australian Standard Form of Contract AS2124 which possesses a number of clauses that enable the Principal to instruct changes in the scope or detail of work from that originally agreed upon and to enable payment to be made to the Contractor for that work should the work form an extra to the original scope. For example Clause 40.1 “Variations to the Work” states:

The Superintendent may direct the Contractor to -
(a) increase, decrease or omit any part of the work under the Contract;
(b) change the character or quality of any material or work;
(c) change the levels, lines, positions or dimensions of any part of the work under the Contract;
(d) execute additional work; and/or
(e) demolish or remove material or work no longer required by the Principal.

The Contractor shall not vary the work under the Contract except as directed by the Superintendent or approved in writing by the Superintendent under Clause 40. The Contractor is bound only to execute a variation which is within the general scope of the Contract. The Contractor shall not be bound to execute a variation directed after Practical Completion unless the variation is in respect of rectification work referred to in Clause 37 (AS2124 1992).

Another example is a latent condition which is technically not a variation because there is a mechanism for dealing with latent conditions under the contract (GCoC Clause 12). However in TMR, latent conditions are included as a type of variation because it results in an adjustment to the contract sum (Contract Control International 2015).

AS2124 Clause 12 “Latent Conditions” states: Latent Conditions are -
(a) physical conditions on the Site or its surroundings, including artificial things but excluding weather conditions, which differ materially from the physical conditions which should reasonably have been anticipated by a competent and experienced contractor at the time of the Contractors tender if such a contractor had -
(i) examined all information made available in writing by the Principal to the Contractor for the purpose of tendering; and
(ii) examined all information relevant to the risks, contingencies and other circumstances having an effect on the tender and obtainable by the making of reasonable enquiries; and
(iii) inspected the Site and its surroundings; and
(b) any other conditions which the Contract specifies to be Latent Conditions.

The more usual form of variation provision that allows the client to alter the scope of works will also provide that the contractor is compensated for any additional costs and, where appropriate, given an extension of time. Whilst it is almost a matter of course for a contractor to claim compensation for extra costs due to a variation to the contract and, where appropriate, be given an extension of time, it is up to the Superintendent to value the claim for cost and time in accordance with the contract provisions. There are also circumstances when a contractor may be granted an extension of time but as they have not incurred any additional costs they will receive no financial compensation.

Some contracts contain a provision that triggers a variation in the event of certain quantities being increased or decreased in excess of a fixed percentage and this is not unusual with civil works, where many quantities are forecast. Another example of variation is where the contractor is required to change the timing, order or sequence of the work. While they will be carrying out the same work with probably the same quantities, by requiring them to do it at a different time or in a different sequence to that previously agreed may need additional deployment of labour or equipment in order to accommodate the change. Some forms of variation require the contractor to perform the work in a different way. This may result in a need for more or different equipment and labour skills.

However claims for compensation by the contractor due to contract variations usually arise from failure on the part of the Principal. It is also possible that the claim may arise because of some outside event that has affected the contractor's work (Brand 2015).

A document outlining TMR's strategy regarding engineering innovation states that it is expected of professional engineers to understand the basis of TMR's specifications. However they should evaluate the risks and benefits of innovation or minor variations that lead to value for money solutions, rather than blindly applying specifications. Therefore "innovation" may trigger a scope change that ultimately leads to a variation to the contract conditions.

Other circumstances in which variations might arise (Brooks et al 2011):

- Instructions from the Contract Administrator
- Changes to drawings
- Changes in site/work management, methods and procedures e.g. changes in access or changes to site accommodation
- Requests from the Principal
- Instructions to expend provisional sums
- Changes in Statutory Requirements and Regulations - post formation of contract
- Requests from the Contractor
- Discrepancies in and/or between contract documents
- Agreed tender assumptions proven to be incorrect
- Unforeseen ground conditions

From the literature review it can be resolved that variations are acknowledged and in fact expected to arise during the execution of a road construction project. However further reviews were required to understand the risk of variations in causing cost overruns which may ultimately impact on the factors which determine a project's value for money.

2.4 Cost Overrun

The main aim of this research project is to gain an understanding of why contract variations arise and their root causes which result in cost overruns. However it is important to first gain an understanding of what is a cost overrun to be able to review its relationship with contract variations.

A cost overrun, also known as a cost increase or budget overrun, involves unexpected costs incurred in excess of budgeted amounts due to an underestimation of the actual cost during budgeting. In line with the conventional methodology, the inaccuracy of cost estimates is measured as the size of cost overruns. Cost overrun is measured as actual out-turn costs minus estimated costs as a percentage of estimated costs. Actual costs are defined as real, accounted construction costs determined at the time of project completion. Estimated costs are defined as budgeted or forecasted construction costs determined at the time of the decision to build (Chantel et al 2010).

Cost overruns can be reported in multiple ways:

- as a percentage of the total expenditure;
- as a total percentage including and above the original budget; or
- as a percentage of the cost overruns to original budget.

For example, considering a bridge with an original construction contract of $100 million where the actual cost was $150 million. This scenario could be truthfully represented by the following statements:

- the cost overrun constituted 33% of the total expense;
- the budget for the bridge increased to 150%; or

- the cost overruns exceeded the original contract amount by 50%.

The final example specifically describes the cost overruns exclusively to the original contract value whereas the other two describe the overrun as an aspect of the total expense. Therefore in this research project the analysis and discussion around cost overrun will reflect the third scenario. This is so the results of the analysis of the contract variation values in this study are consistent with TMR's cost estimate overrun reporting requirements. TMR's Project Cost Estimating Manual (PCEM) requires project Business Case estimates to have a 90% likelihood of not being exceeded, this is referred to as a P90 Estimate. The expectation is that individual project estimates, prepared progressively from business case forward, have a 90% confidence factor of not being exceeded by the cost at completion. The variation of estimates at each phase, as a percentage of the actual Total Project Cost is expected to fall within the ranges shown in Table 2.1.

Table 2.1: Percentage Variance of Completed Project Cost (Adapted from TMR Project Cost Estimating Manual)

Cost Estimate Document	**Lower**	**Upper**
Business Case	-15%	+20%
Preliminary Design	-10%	+15%
Detailed Design	-5%	+10%
Construction	-2.5%	+5%

The upper limit of the percentage variation of completed project cost at the construction estimate stage is 5%. This study will include a comparison of contract variation values against original contract values with the upper limit expected by TMR.

Many studies have been conducted to investigate cost deviation and overruns in construction projects. A research study undertaken by Evans and Peck on behalf of the Business Council of Australia in 2011 reports that the road projects studied in the report showed to have an average cost overrun of 10% calculated as actual final cost to deliver a project as at contract award. Evans and Peck (2011) found that at contract award a greater understanding and level of knowledge regarding the project will provide more accurate, yet potentially considerable different cost outcome than at business case. This is depicted in Figure 2.1 below, which shows the project lifecycle and the anticipated cost estimation accuracy.

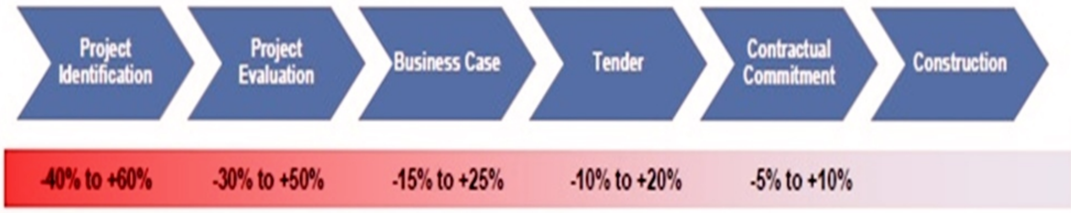

Figure 2.1: Anticipated Cost Estimation Accuracy During the Project Lifecycle (Source: Evans and Peck 2011)

Al-Zarooni et al. (2000) conducted a survey to investigate variations in the United Arab Emirates public projects' estimates. They found that the cost overruns between feasibility and contract cost, ranging between -28.5% and +36% which supported the findings in the Evans and Peck study. They stated that these cost overruns could be explained by the fact that feasibility estimates in the government agencies are usually budgeted using a Single Unit Estimating (e.g. cost per square metre) basis, regardless of the nature of projects and their associated risks or the construction complexity of the works. They also found that it may be because feasibility studies are normally done before any details are settled.

Mahamid and Bruland (2012) investigated the statistical relationship between actual and estimated cost of road construction projects using data from Palestinian road construction projects awarded over the years 2004 to 2008. The study was based on a sample of 169 road construction projects on which several regression models were developed. The findings revealed that all projects suffered from cost deviation with 76% of projects having cost under-estimates and 24% having cost over-estimates. However the deviation between estimated and actual cost was on average 14.6% over the construction budget.

Flyvbjerg et al. (2003) conducted a study of 258 transportation infrastructure projects. The distribution of the projects was as follows: rail: 58, fixed link (bridges and tunnels): 33, and road: 167 projects. The projects were located in twenty nations on five continents, including both developed and developing nations and the main findings from the study was that nine out of ten transport infrastructure projects experienced cost overrun. For fixed links (tunnels and bridges) the average cost overrun was 34% and for roads the average cost overrun was 20%. Interestingly this study found that cost overrun has not decreased over the past 70 years.

Yeo (1990) suggests that the most frequent sources of reasons for overruns are:

1. Scope and quantity increases;
2. Engineering and design changes, faulty design, and late design;
3. Underestimation;
4. Mis-estimation;
5. Unforeseen inflation.

Yeo also goes on to state that while the reasons for overruns are so painfully obvious, the problem remains and that an estimate is only a forecast of a cost to be incurred sometime in the future. The problem is that the future is not always predicable therefore there is a need for contingencies to cater for unforeseen circumstances.

Akinci and Fischer (1998) in their study of cost overrun consider design and project-specific factors to be the key factors affecting the cost estimate of a project, including vagueness in scope, design complexity, and project size. However their study focuses on risk management of cost overruns from a general contractor's point of view, whilst this study will focus on the root causes and how they may be better managed prior to contract award.

Another relevant paper on the evaluation of risk factors leading to cost overruns in the delivery of road construction projects is by Creedy et al. (2010). Their research found that design and scope changes are the highest contributing risk factor to cost overrun in highway projects. Their research also indicated that the percentage of project cost overrun is linked to the economy of scale, such that smaller dollar projects can attract larger percentages of cost overruns, and larger dollar projects have the potential for smaller percentages of cost overruns. This is also an important indicator of the risk contingency weighting that should be included in project estimates. Figure 2.2 provides a graphical illustration of the relative proportions of the top ten factors causing cost overruns in TMR projects as researched by Creedy et al (2010).

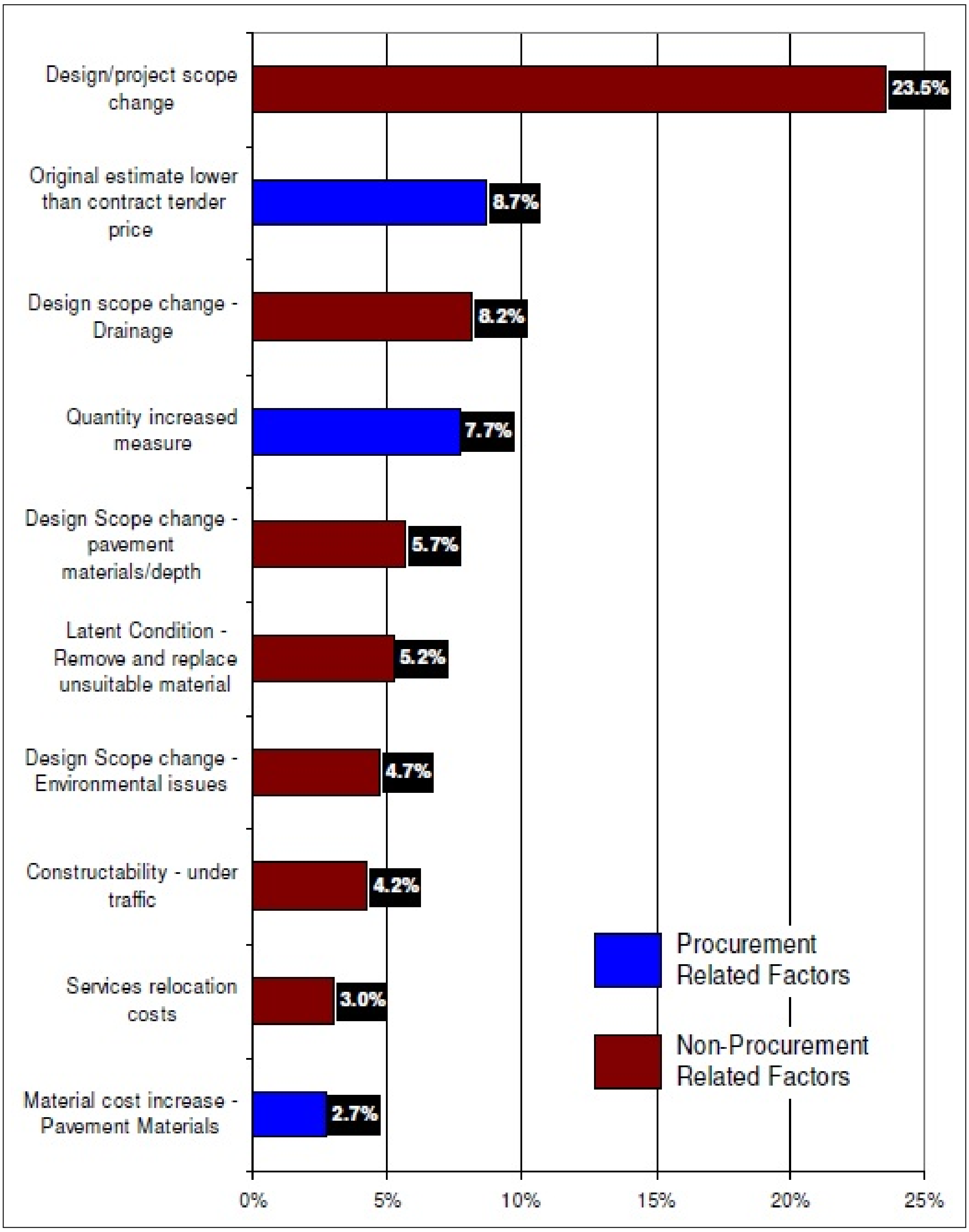

Figure 2.2: Relative Proportions of the Top Ten Factors Causing Cost Overruns in TMR Projects (Adapted from Creedy 2010)

2.5 Summary

A literature review was undertaken of relevant past studies and publications to gain a basic understanding of what forms a road construction contract, define how variations occur and research the significance of a cost overrun. The review found that whilst many past studies have been conducted to investigate cost overruns on road construction projects, these studies are usually whole of project from design concept through to construction finalisation. The literature review also revealed that cost overruns of project budgets can arise for various reasons throughout the project life-cycle.

The literature review also found that there has been little research undertaken specifically related to variations to the construction budget and more specifically to the identification of the root causes of RCC variations. Whilst all of the literature reviewed identified that cost overruns are predominant in road construction projects only Creedy et al. (2010) provided an understanding of the types of contract variations that occur. However none provided detailed recommendations to delivery improvement initiatives to reduce project cost overruns on TMR RCCs which is the key outcome of this research project.

In conclusion, the literature reviewed supports the notion that construction projects with accurate cost estimates based on well-defined designs are extremely important to reducing cost overruns.

Chapter 3

Preliminary Research of Information

3.1 Data Identification

Preliminary research of information available from TMR literature and databases was undertaken to explicate and identify the most appropriate data required to assist in achieving the desired outcomes of this research project.

3.1.1 Sample Contracts

Prior to the collection of the data, endorsement was requested from all TMR's District Director's to ensure their support for this research project which was received with 100% acceptance.

A review of TMR's website explains that Queensland is divided into Districts with some larger than others by area and some larger than others by population. Each District is then responsible for preparing and managing RCCs in accordance with the Standard Contract Provisions Roads Volume 1: Road Construction Contract within their area of responsibility. District project delivery personnel are then responsible to enter the contract data onto the relevant databases provided to assist in the contract management.

The interrogation of in-house historical databases is probably the best source of data to *assess risk occurrences or consequences of risk events, in many cases these databases are inadequate or disjointed, unavailable or supplemented with personal information bias* (Al-Bahar and Crandall 1990).

An “interrogation” of TMRs databases was undertaken to source the most relevant information for this research project regarding contract variations. TMRs databases are no different to those described by Al-Bahar and Crandall as TMR relies on a number of project management systems to support the procurement, financial and contract management of contracts and more importantly relies on the integrity of the data entered into these systems by the District personnel. Some of the databases located on TMR’s Portfolio Investment and Programming website include:

- SPIDA
- FAP
- RPM
- Primavera (P6)
- WMS
- Projman
- @Risk
- Expert Estimation
- ARMIS
- SmartCost

TIPDS Volume 2 states that the The Financial Administration and Audit Act 1977 and the Financial Management Standard 1997 establish the processes by which approval is granted to incur government expenditure (that is, to pay a particular sum to a particular company or organisation). All expenditure administered by TMR, including projects funded by both state and federal governments, must comply with these requirements. Under the above legislation, the Director-General has the power to delegate responsibility to certain departmental officers to approve expenditure of government funds for the purchase of goods or services.

The Statewide Program Investment Delivery Application (SPIDA) defines the processes by which the Department implements infrastructure projects under the Financial Administration and Audit Act 1977 and the Financial Management Standard 1997. SPIDA has a module titled Financial Approval Process (FAP) that facilitates actions towards financial approval and award of contracts and identifies the current status of financial approval of any proposed contract at any time. The Project Manager initiates the financial approval process by entering details of the proposed contract into the FAP module.

TIPDS Volume 2 requires that before the contract can be formed, the best tender must be approved by the Principal's Delegate and financial approval processes completed, culminating in the issue of the Letter of Acceptance. Once the contract is approved by the financial delegate the contract award details are entered into the project management database called Projman. This is the database used by the Principal's Project Manager to manage the contract budget.

The Prequalification and Contracts unit has a state-wide responsibility for contract award, contract compilation, issuing the letter of acceptance, unsuccessful letters, contract execution and the management of contract securities for all RCCs. Prior to the collection of the data required for the basis of this research project a list of all RCCs awarded by TMR in the last several years was requested from this unit to commence the identification of sample contracts. An initial review of the awarded RCC list contained three hundred and sixty eight contracts which was too large a sample to include within the scope of this project. Therefore a criterion was established to cull the number of contracts to a more manageable sample.

The criteria that the sample contracts had to meet for this research project to provide credible results was limited to recent RCCs awarded by TMR between January 2013 and October 2014. This sample period was chosen to not only ensure the amount of data was manageable but that any RCCs still in progress were well under way with most of their variations documented and included in the data. Also the selection of only RCCs which usually have an original contract value greater than $1M would ensure that the minor works projects did not skew the results due to their simple and low risk nature (TIPDS) (2014).

It became apparent from the review of the TIPDS and other financial guidelines that the FAP system and Projman are the most appropriate databases to identify the sample contracts required to collect the historical variation data.

3.1.2 Historical Variation Data

If variations to the contract arise during the course of the execution of the contract and these variations add an additional cost to the contract then the TMR project manager must apply for a financial approval variation. This is done by completing the appropriate documentation including reasons for the variation(s) based on the Superintendent's variation register. RCCs contain provisions setting out how variations are to be valued. The GCoC Clause 40.5 states that "where the contract provides that a valuation shall be made under clause 40.5, the Principal will pay or the Contractor shall pay the Principal (as the case may require) an amount ascertained by the Superintendent using a selection of valuation options". The CAS manual states that the Superintendent should register the variation in the Variation Register (CAF026M).

Similarly to the original contract information, once the financial approval variation is approved by the procurement and financial delegates the information is entered into the FAP system including the reasons for the variations. This system is the only single point repository which provides access to the reasons for variations albeit only variations that add an additional cost to the original contract sum. Therefore for the purposes of this study the historical variation data will only include those variations that subsequently cause an increase to the original contract value. To include variations other than those within the FAP system would require access to each and every individual contract variation register which is outside the scope of this project.

TMR have also recently developed a central location to capture contract details called One TMR Contract Register. The information including variations pertaining to RCCs is uploaded by the Chief Procurement Office from Projman on a regular basis. However at the time of writing this register did not provide the data required to achieve the aim of this research project. Therefore the FAP system was the preferred source of the variation data as the data provided within the FAP system is able to provide a substantial sample required to achieve the aim of this project.

Further review of TMR's website also revealed that TMR's Program Management and Delivery unit has initiated the Portfolio, Program, Project and Contract Management

(3PCM) project to improve both the systems and processes TMR use to manage and delivery of the QTRIP. As stated on the website, changes within TMR over the last ten years, have resulted in inconsistent and fragmented business processes and practices across infrastructure portfolio, program, project and contract management. The 3PCM solution will provide a more integrated and streamlined solution to support business processes in these domains.

Whilst the project manager is responsible to validate the financial approval variation request with reasons, these reasons are usually based on those captured in the Superintendent's variation register and may not provide accurate or detailed explanation. Also variations that do not result in a cost overrun due to the over and under nature of a schedule of rates contract do not get recorded anywhere other than the Superintendent's variation register. This was deemed a limitation to the quantitative data available and therefore a wider collection of data was required to substantiate the variation reasons from FAP.

3.1.3 Expert Opinion Survey

Due to the limitation to the quantitative data available from FAP and in particular the reasons documented by the relevant project manager when seeking extra financial approval, a wider collection of data was required to substantiate the variation reasons. This was to substantiate any trends that may come from the analysis of the historical data which is predominantly subjective.

A common approach that helps to "triangulate" one set of findings from one method of data collection underpinned by one methodology, with another very different method underpinned by another methodology is the collection of qualitative data (Wisker 2007). Having already identified the quantitative data through collection of sample contracts and their associated historical variations, it required a more in depth collection of qualitative data through expert opinion. Elicitation from experts is a formal process for obtaining information or answers to specific questions where the information was highly subjective (Creedy 2010). The elicitation of the expert opinion regarding the root causes of contract variations from TMR's project delivery practitioners could provide this validating data.

Whilst the collective endorsement from TMR's District Directors for this project was unanimous it became apparent from middle management that any records found within the historical data would be difficult to validate with the originating project manager. This is due to most project management staff having either moved on from or moved around within TMR and were no longer available to discuss the details of particular variation reasons found in the FAP system.

A review of information regarding survey research revealed that on-line (internet) surveys are becoming an essential research tool for a variety of research fields, including marketing, social and official statistics research. According to ESOMAR (the global association of research professionals) on-line survey research accounted for 20% of global data-collection expenditure in 2006. Other studies comparing paper-and-pencil questionnaires with web-based questionnaires showed that employees preferred on-line survey approaches to the paper-and-pencil format. Therefore it was decided to collect the expert opinion data via a cloud based on-line survey tool called Survey Monkey.

3.2 Summary

A review of TMR information and databases was undertaken to identify the availability of historical contracts required for the analysis of the variations. The FAP system and Projman were found to be the most appropriate databases to identify the sample contracts required to collect the historical variation data.

However due to the limited nature of the documented historical data another source of data was required substantiate the recorded reasons for variations on RCCs. Therefore research was undertaken to decide the most appropriate method of collection of expert opinion on the subject of cost overruns and contract variations. To validate the historical data with expert opinion on the subject of contract variations the collection method of choice was via an on-line survey of TMR's project delivery practitioners.

Chapter 4

Research Methodology

4.1 Three Step Approach

To achieve the project aim of gaining of a better understanding of why contract variations arise and their root causes, the following three step research methodology process was adopted:

Step 1 Historical Data Collection
Step 2 Historical Data Analysis
Step 3 Expert Opinion Survey

This process was chosen to combine both quantitative and qualitative data and analysis. Whilst the historical data available is primarily quantitative, providing documented reasons for the variations, the expert opinion survey provides the qualitative data to substantiate the patterns in the historical data analysis.

4.1.1 Step 1: Historical Data Collection

The first step involved undertaking an in depth examination of Projman to source the sample contracts and the quantitative data in the form of the associated variations. Historical data was used as it provides the basis of the research problem through the examination of what has happened in the past, using analysis, analogy and trend extrapolation (Kirszner and Mandell 1992).

Once the eligible RCCs were identified the process of collating the individual contracts into a spreadsheet commenced with originating District name, contract number and the original contract value. The FAP system was then used to determine if the contract had any financial approval variations and if so the variation number and the variation cost was included in the analysis spreadsheet. The percentage of the variation to the original contract value was also determined to provide further cost analysis. To ensure the quality of the data was suitable for publication in this research project a process of data "cleansing" was undertaken by manipulating the contract variation data spreadsheet to identify any outliers and abnormalities within the data. Figure 4.1 indicates the information sourced from Projman and FAP on an extract from the analysis spreadsheet. In total the sample collected included 111 contracts with 529 associated variations.

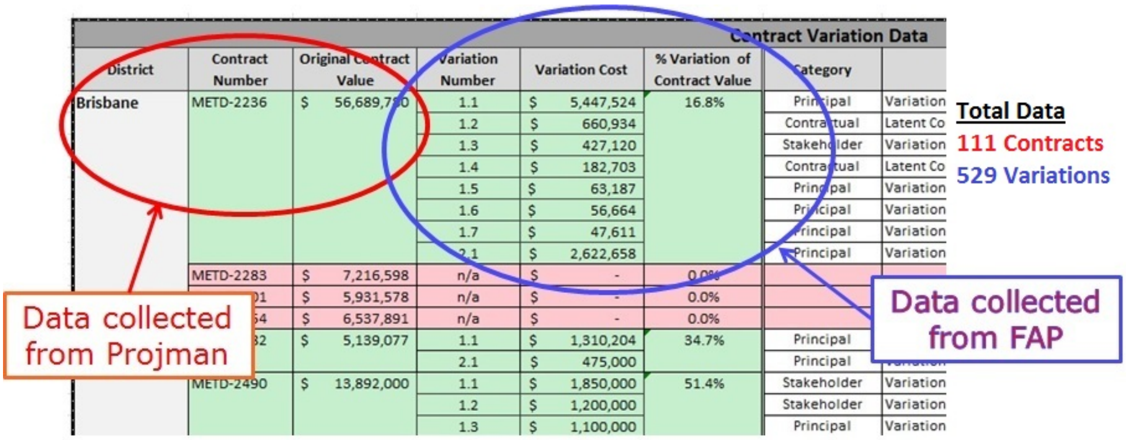

Figure 4.1: Contract and Variation Data Analysis Spreadsheet (Data Collection)

After the variation data spreadsheet was populated with all sample contracts and their associated variations, the variations were then divided into the appropriate category of source, type and reason based on the data extracted from the FAP system. Figure 4.2 indicates the variation categories, including the reasons that were sourced from the FAP system, on an extract from the analysis spreadsheet.

This spreadsheet became the central data analysis tool for the historical contract data. Appendix B contains the full contract variation data spreadsheet which lists the entire collection of historical data used for this project.

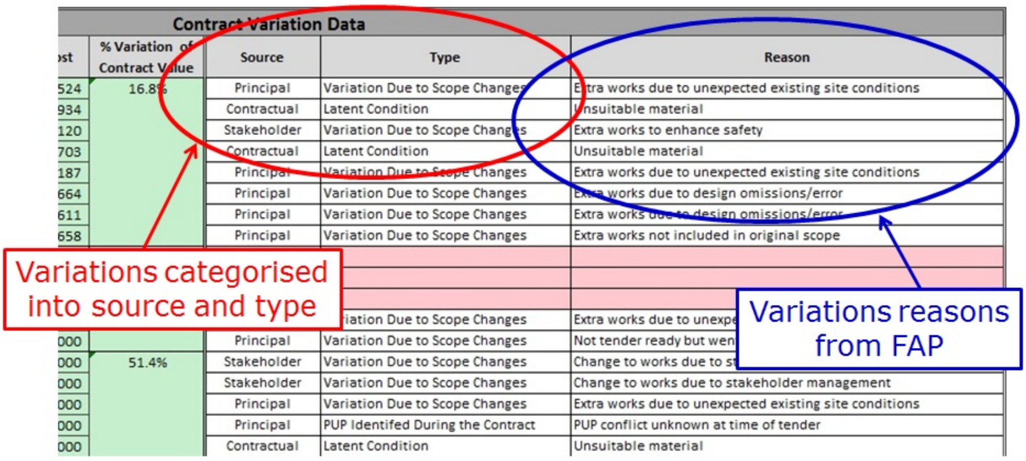

Figure 4.2: Contract and Variation Data Analysis Spreadsheet (Variation Categories)

Variation Source

The variations were first categorised into the following sources from which they originate:

- Principal: changes to the original contract directed by TMR through the Principal's Representative or the Superintendent as an agent of the Principal, e.g. variations to the work, acceleration of the works, etc.;
- Contractor: changes made for the convenience or in favour of the contractor, e.g. due to an unforeseen error in the Contractor's tender;
- Contractual: arising from entitlement under the Contract, e.g. latent condition, rise and fall, etc.;
- Non-contractual: arising from outside the Contract, e.g. ex-gratia payment;
- Stakeholder: changes to the scope or methodology of construction due to third party actions, e.g. political commitment, community expectations, etc.

The understanding of the source of a variation is an important indicator to identify and develop initiatives suited to that source. For example if the predominant source of contract variations are generated from the Principal then TMR as the Principal may be able to undertake mitigation strategies such as personnel training, improvement to pre-construction activities, identify and manage external influences as the case may be. Similarly depending if the source of the bulk of the variations are generated from the other areas then TMR can target those areas for improvement depending on the level of the frequency.

Variation Type

Once the variations were categorised by their source the next stage of the data collection was to further divide them into different types aligned with the relevant clauses of the RCC. The clauses chosen were only those that may entitle the Contractor to claim for a variation to the contract.

Variation clauses in the contract conditions are essential, as without such clauses Contractors would have no obligation to perform any work which was different to the work described in the contract documents. Further, any insistence by the Principal to vary the works to be performed (absent or outside a variation clause) may provide a basis for the Contractor to claim that the Principal had repudiated the contract (Baker and McKenzie 2013). The RCC is either a schedule of rates, lump sum or part lump sum/part schedule of rates and the General Conditions of Contract (GCoC) and Supplementary Conditions of Contract (SCoC) are based in part on the Australian Standard Form of Contract AS2124.

By dividing the variations into types aligned with the relevant variation clauses of the RCC it can be determined which clauses are the most predominant and whether or not there is a trend that requires attention. The clauses within the RCC that provide recourse for the Contractor to be paid an amount extra to the original contract amount as a variation in the context of this research project are listed below.

- Limits of Accuracy Cl 3.2
- Rise & Fall Cl 3.4
- Document Ambiguity/Discrepancy Cl 8.1
- Nominated Subcontract Cl 10.3(ii)
- Latent Condition Cl 12
- Change to Statutory Requirements Cl 14
- Excepted Risks Cl 16.3
- Public Liability Claim Cl 17.1

- Finding of Minerals, Fossils & Relics Cl 27.5
- Setting Out the Works Cl 28
- Examination and Testing Cl 31.7
- Change to Sequence of Works Cl 33.1
- Acceleration Cl 33.3
- Suspension Cl 34.4
- Delay and Disruption Cl 36
- Variations to the Work Cl 40.1
- Certificates and Payments Cl 42
- Default of the Principal Cl 44.7
- Public Utility Plant (PUP) Identified During the Contract SCoC Cl 23.4

Variation Reason

Following the identification of the type of variations a review of the reason for each variation was undertaken. These reasons are the basis of this investigative study into the root causes of the variations and will provide the focus of identifying areas for future improvements. As discussed earlier the reasons for the variations were sourced from the FAP system where the descriptions were often inconsistent and of varying detail depending on the discretion of the person entering the data. Therefore the reasons for the variations were grouped into common themes for the convenience of the data analysis and identification of particular trends. The common themes are listed below.

- Unsuitable material
- Extra works due to design omission/error
- Extra works due to unexpected existing site conditions
- Extra works due to increased scheduled quantities
- Savings due to reduction of work items

- Extra works not included in original scope
- Change to works due to stakeholder management
- Change to works due to design modifications
- Insufficient geotechnical investigations prior to tender
- Insufficient survey investigations prior to tender
- Not tender ready but went to market
- Public Utility Plant (PUP) conflict unknown at time of tender
- Adjustment to the contract sum
- Extra costs to meet key project milestones
- Extra works to enhance safety
- Change to works to avoid traffic management issues
- Change to works to enhance quality
- Additional environmental items
- Extra costs due to excessive wet weather
- Extra costs due to Principal supplied items
- Extra costs due to site access issues
- Change to specification/product type
- Additional complementary works to an existing NDRRA contract
- Insurance Claim
- Interest for late payment of progress claim
- Bonus payment not allowed for in the schedule
- BCIPA claim of costs lodged by the Contractor

This concluded the first step of the research methodology and the collection of the quantitative historical data. The quantitative data collection method, relied on structured sampling from the diverse range of construction contract variations and sorting it into predetermined response categories. The quantum of data resulted in the development of an analysis spreadsheet which enabled the data to be conveniently catalogued, categorised and hypothesised.

4.1.2 Step 2: Historical Data Analysis

The second step required a detailed analysis of the historical data to provide the basis of the project outcomes, summarise the results and identify trends across variations. In all at total of 111 contracts at a value of over $1.4 billion were analysed, with 83 of those contracts having variations resulting in a 73% frequency. The total number of associated variations came to 529 at a value of just over $250 million which resulted in a ratio of total variations to total contract value of approximately 18%. Table 4.1 provides a summary of the overall analysis of the contracts sampled for the study.

Table 4.1: Contract Data Analysis Summary

Number of contracts sampled	111
Number of total variations	529
Number of contracts sampled with variations	81
% of contracts sampled with variations	73%
Value of total contracts sampled	$ 1,410,136,020
Value of total variations	$ 258,387,455
% of total variation value to total contract value	18%

A statistical analysis was then undertaken to determine the frequency and magnitude of variations to the RCCs and to put some perspective to the level of the issue of variations and subsequent cost over-runs. This was done by determining the magnitude of the variation between the actual and original cost of individual contracts by calculation of the ratio of divergence defined as:

$$Vr = (\frac{\sum Vc}{Cv})x100$$

Where:

Vr = Variation magnitude ratio (%)

Vc = Cost of each variation within a contract

Cv = Original contract value

Analysis of the variation ratios revealed that on average all contracts sampled had a variation ratio of 24.2% of the original contract value. Another revealing statistic is that contracts with original values less than $10 million had an average variation ratio greater than the all contracts average and those contracts with original values greater than $10 million had variation ratio less than the all contracts average. Table 4.2 summarises the average percentage of variation ratios to various ranges of original contract values.

Table 4.2: Average Percentage of Variation Ratios to Varying Original Contract Values

Contract Value Range	**No. of Contracts**	**Average Variation Ratio (Vr)**
All Contracts	111	24.2%
Contracts < $5M	46	28.2%
Contracts $5M < $10M	35	24.3%
Contracts $10M < $20M	12	18.9%
Contracts $20M < $50M	12	21.4 %
Contracts $50M < $100M	3	7.4%
Contracts > $100M	2	6.5%

Figure 4.3 illustrates the regressive nature of the variation ratio compared to the original contract value using the same information from table 4.2 in graphical form. In effect, this model shows that there is a link to the economy of scale such that as the size of a project increases in contract value, then the percentage variation reduces. However to put this theory in perspective, the actual dollar magnitude of the cost overrun for a large project may still be greater, even though its percentage change is less. For example, a 5% cost increase on a $1 million project is $50,000, whereas a 1% cost increase on a $100 million project is $1 million (Creedy 2010). The assumption is that this is due to smaller projects not receiving the planning and delivery attention of large projects. This may be significant that if a particular District within TMR undertakes the majority of project delivery through contracts < $10 million then the collective over-runs may justify added resources to minimise the occurrence of variations whether that be before or after contract

award.

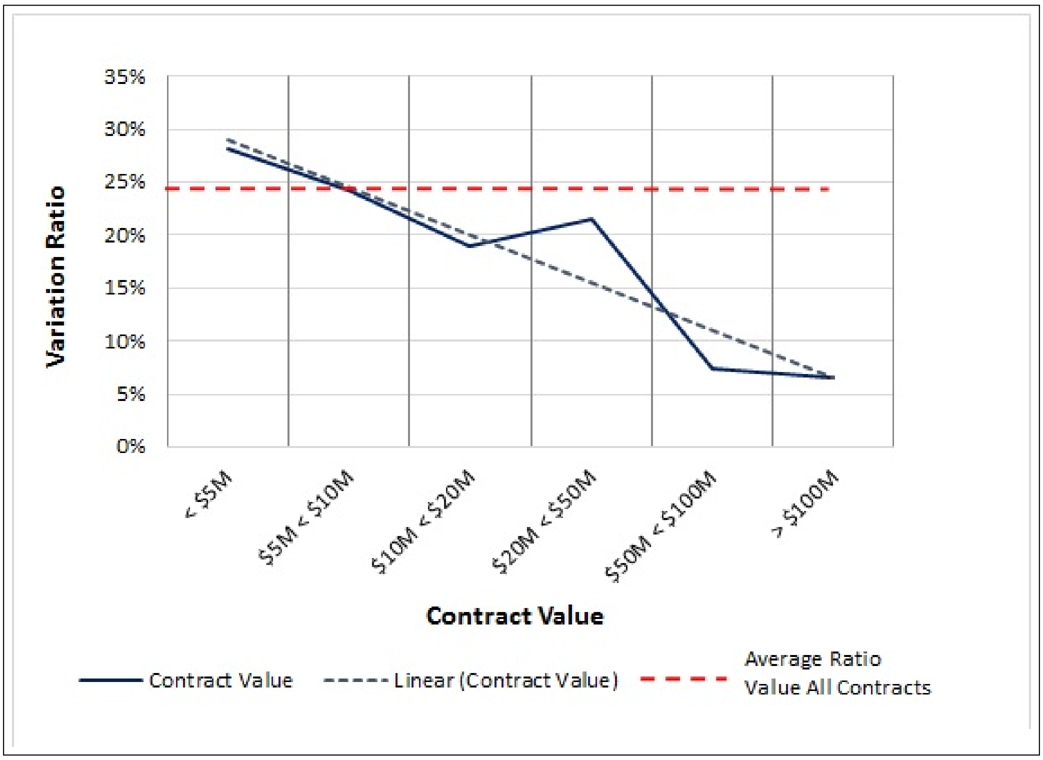

Figure 4.3: Average Percentage of Variation Ratios to Varying Original Contract Values

To further assist in the determination of the scale of the issue of RCC variations, the frequency of differing levels of variation ratios to the total number of contracts was analysed. This was done by determining the ratio of frequency defined as:

$$Vf = (\frac{Cn}{Ct})x100$$

Where:

Vf = Variation frequency (%)

Cn = Number of contracts within a particular variation ratio band

Ct = Total number of contracts

Analysis of the variation frequency showed that variation ratios greater than 20% but less than 50% had the greatest frequency of 34.2% of all contracts sampled. Keeping in mind that due to the limited data available, the definition of a variation in this study is a change to the contract that subsequently causes an increase to the original contract value. Therefore whilst this statistical analysis also reveals that 27% of all RCCs sampled did not have any variations this may simply be because each project budget had enough contingency to cover the extra costs of the variations and therefore there would be no requirement to request additional financial approval due to the variations. This is a limitation to the data integrity of this research project however as explained earlier unless the reasons for variations are entered into the FAP system, the availability of data is virtually non-existent.

Table 4.3 provides a summary of the frequency of differing levels of variations of all contracts sampled.

Table 4.3: Frequency of Differing Levels of Variation Ratios of all Contracts

Variation Ratio Band	**No. of Contracts**	**Variation Frequency** (Vf)
Nil Variations	30	27.0%
Variations < 5%	6	5.4%
Variations 5% < 10%	13	11.7%
Variations 10% < 20%	9	8.1%
Variations 20% < 50%	38	34.2%
Variations 50% < 100%	10	9.1%
Variations >100%	5	4.5%

On completion of the historical contract data statistical analysis the individual variations were analysed to identify trends in the root causes of the variations based on the variation categories of source, type and reason.

Figure 4.4 represents the proportions of each of the sources from which the sampled variations originate. The overwhelming majority of variations sampled are sourced from the Principal which is not surprising due to the Principal being the client and therefore has more interest to vary the contract requirements to ensure best value for money. This analysis reveals that variations originating from the remaining sources are not of a disproportionate nature to the overall contracts sampled.

The variation types, which were aligned with the relevant contractual clauses of the RCC, were then analysed to determine which were the most predominant and whether or not there is a trend that requires attention. The analysis revealed that the three most common types made up 94% of the total historical variation data sampled with the percentage of frequency as follows:

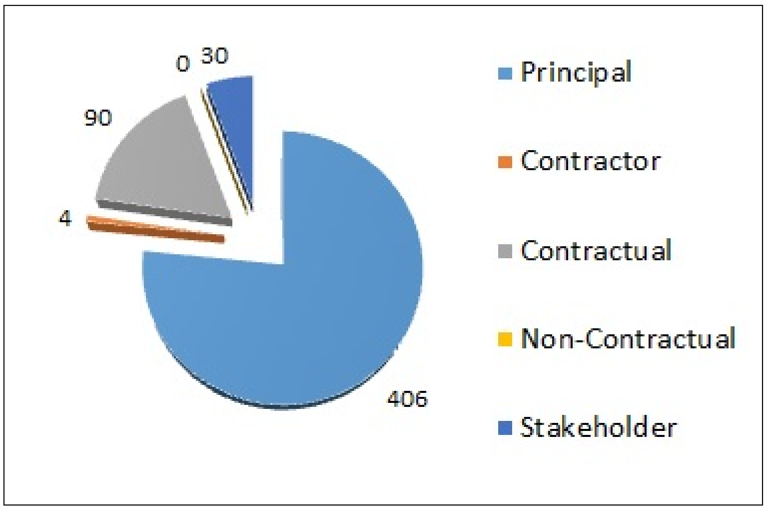

Figure 4.4: Variation Sources

1. Variation to the Work (Cl 40.1): 68%;
2. Latent Condition (Cl 12): 19%;
3. Delay and Disruption (Cl 36): 7%.

The first variation type "Variation to the Work (Cl 40.1)" is sourced from the Principal whilst "Latent Condition (Cl 12)" and "Delay and Disruption (Cl 36)" are Contractual sourced variations and the root causes of these three variation types will be further analysed in the study. Table 4.4 consists of the number of occurrences of the types, including reference to their relevant contractual clause, of all 529 variations sampled.

As discussed in the literature review, this representation is consistent with the research undertaken by Yeo (1990) that identifies changes to the work as the most frequent sources of variations. Further analysis was then performed on the three most common variation types due to them having significantly higher number of occurrences than the others the results of which are discussed in chapter 4.

Analysis was then undertaken on the reasons for the variations as sourced from the FAP system raw data. It was decided that the most appropriate method available to analyse the large collection of data was to apply a Pareto analysis. Pareto analysis is a statistical technique used for the selection of a limited number of tasks that produce significant overall effect. It uses the Pareto Principle (also known as the 80/20 rule) the idea that by addressing 20% of the most common causes, the results can generate 80% of the benefit of

Table 4.4: Variation Types

Variation Type	**Contract Clause**	**Number of Occurrences**
Variations to the Work	Cl 40.1	362
Latent Condition	Cl 12	102
Delay and Disruption	Cl 36	36
Rise & Fall	Cl 3.4	10
Acceleration	Cl 33.3	4
Limits of Accuracy	Cl 3.2	3
Excepted Risks	Cl 16.3	3
Notice of BCIPA Claim	Cl 7	2
Examination and Testing	Cl 31.7	2
Change to Sequence of Works	Cl 33.1	2
Document Ambiguity/Discrepancy	Cl 8.1	1
Change to Statutory Requirements	Cl 14	1
Setting Out the Works	Cl 28	1
Certificates and Payments	Cl 42	1

addressing the entire sample. The Pareto diagram is illustrated in figure 4.5 and reveals that 80% of the sample is made up of 12 reasons.

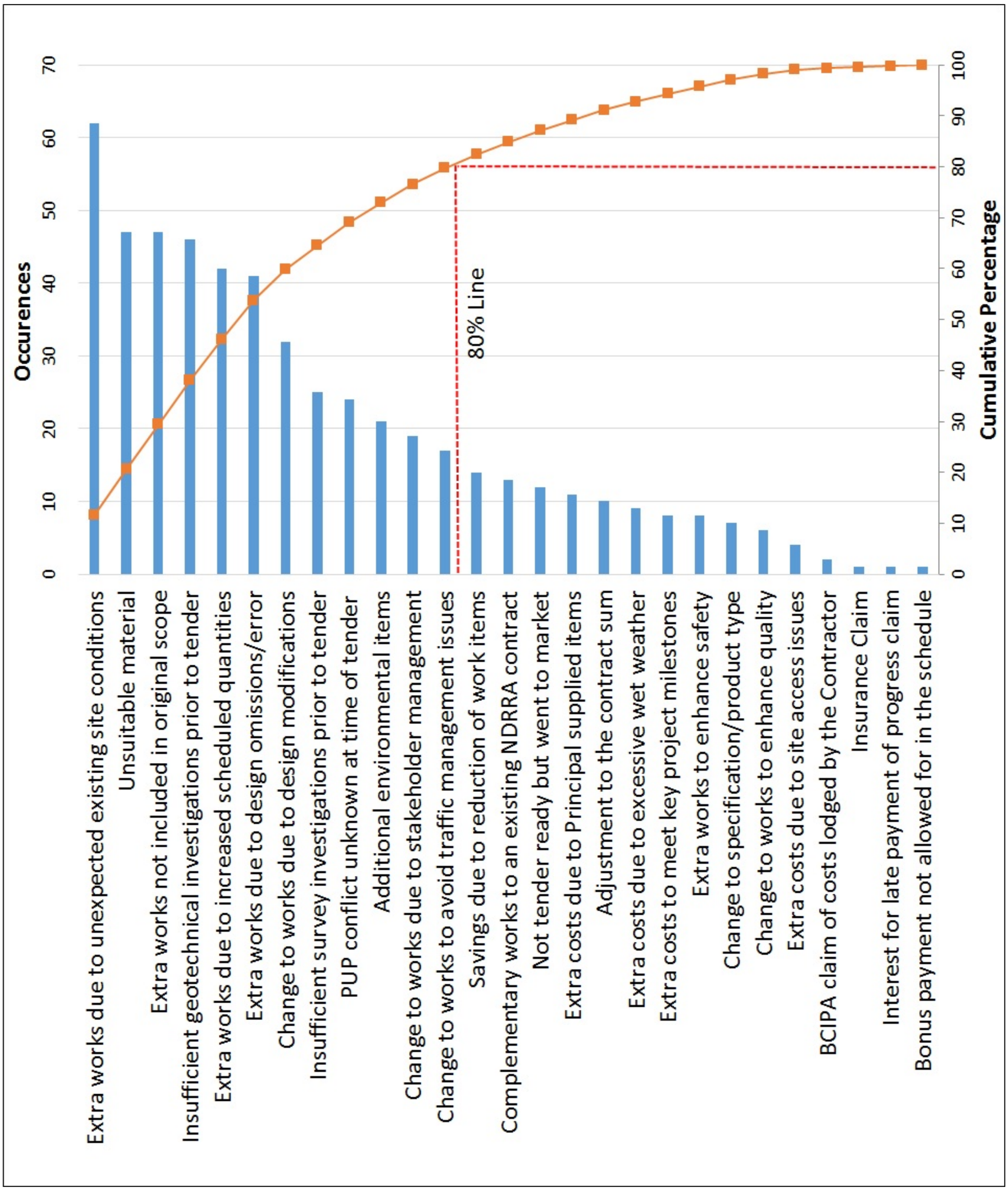

Figure 4.5: Variation Reasons (Historical Data)

Each of these reasons was then collaborated with the qualitative data collected from the expert opinion survey the results of which is discussed in chapter 5.

4.1.3 Step 3: Expert Opinion Survey

The third and final step involved collecting qualitative data through an on-line expert opinion survey to substantiate the trends revealed by the Pareto analysis. The survey was evenly distributed among forty targeted TMR project delivery practitioners across each district in the state as well as experts from the State Program Office (SPO) to ensure opinions were received from a cross section of experts. The district delivery practitioners were nominated by the local manager responsible for the program delivery. The numbers of nominated practitioners from each district is provided in table 4.5.

Table 4.5: Number of Nominated Road Construction Practitioners by District

Brisbane	9
Central West	2
Darling downs	6
Far North	2
Fitzroy	0
Mackay/Whitsunday	1
North Coast	1
North West	2
Northern	3
SPO	2
South Coast	4
South West	3
Wide Bay/Burnett	5

The survey consisted of nine questions that provided a combination of multiple choice and open ended responses. The questions were designed to evaluate the perceived frequency, severity and the importance of contract variations. At the end of the survey the respondents were also given the opportunity to provide feedback to assist in the understanding the root causes of RCC variations and how best to minimise their re-occurrence in the future. Following are the questions included in the survey:

1. What role have you performed most often in the delivery of Road Construction Contracts (RCCs)?

2. For projects > $1M how often do you think the final RCC contract value exceeds the original contract value by more than 10% due to variations?

3. Assuming the majority of variations to a contract were design related which reason do you think would be the most common cause?

4. What do you consider are the THREE most common variation reasons arising from design issues?

5. What do you consider are the THREE most common variation reasons arising other than from design issues?

6. How often do you utilise relationship management and conflict resolution strategies, e.g. partnering, dispute resolution board, etc. in the delivery of RCCs?

7. Do you believe that relationship management strategies can reduce the magnitude of variation claims and potential disputes when done correctly?

8. How often do you undertake or participate in post construction reviews and/or project learning workshops?

9. In your opinion what are the three most realistic strategies for TMR to mitigate the occurrence of variations to RCCs?

The raw data received from the nine questions in the expert opinion survey was then analysed and compared to the results of the historical data. The collaboration of the results of all data is discussed in chapter 5.

Chapter 5

Results and Discussion

5.1 Historical Data

As discussed in Chapter 4 Research Methodology each of the variation were sorted by variation type to identify if there is a trend in a particular contractual clause that requires attention. The analysis revealed that the three contractual clauses were predominant in the number of occurrences of variations. Pareto analysis was then performed on these three variation types to determine the top 80% and this chapter provides discussion on the results.

Variation to the Work (GCoC Clause 40.1)

Figure 5.1 displays the Pareto diagram of reasons for "Variation to the Work (GCoC Clause 40.1)" and as can be seen, the most common reason for variations to the work was due to "extra works not included in original scope". This may be due to the original scope not being fully clarified in the business case or perhaps due to the competitive nature of RCCs the tenders returned below the design estimate therefore extra funds were available to increase the scope. The next six most common reasons for Clause 40.1 type variations were related to design issues. Therefore it can be assumed that if extra investigative design effort was provided in the pre-construction stage of the project then these design issues may not have occurred in all instances however the data available doesn't provide details to validate this assumption.

The remaining three reasons for "variation to the work" inside the top 80% may have

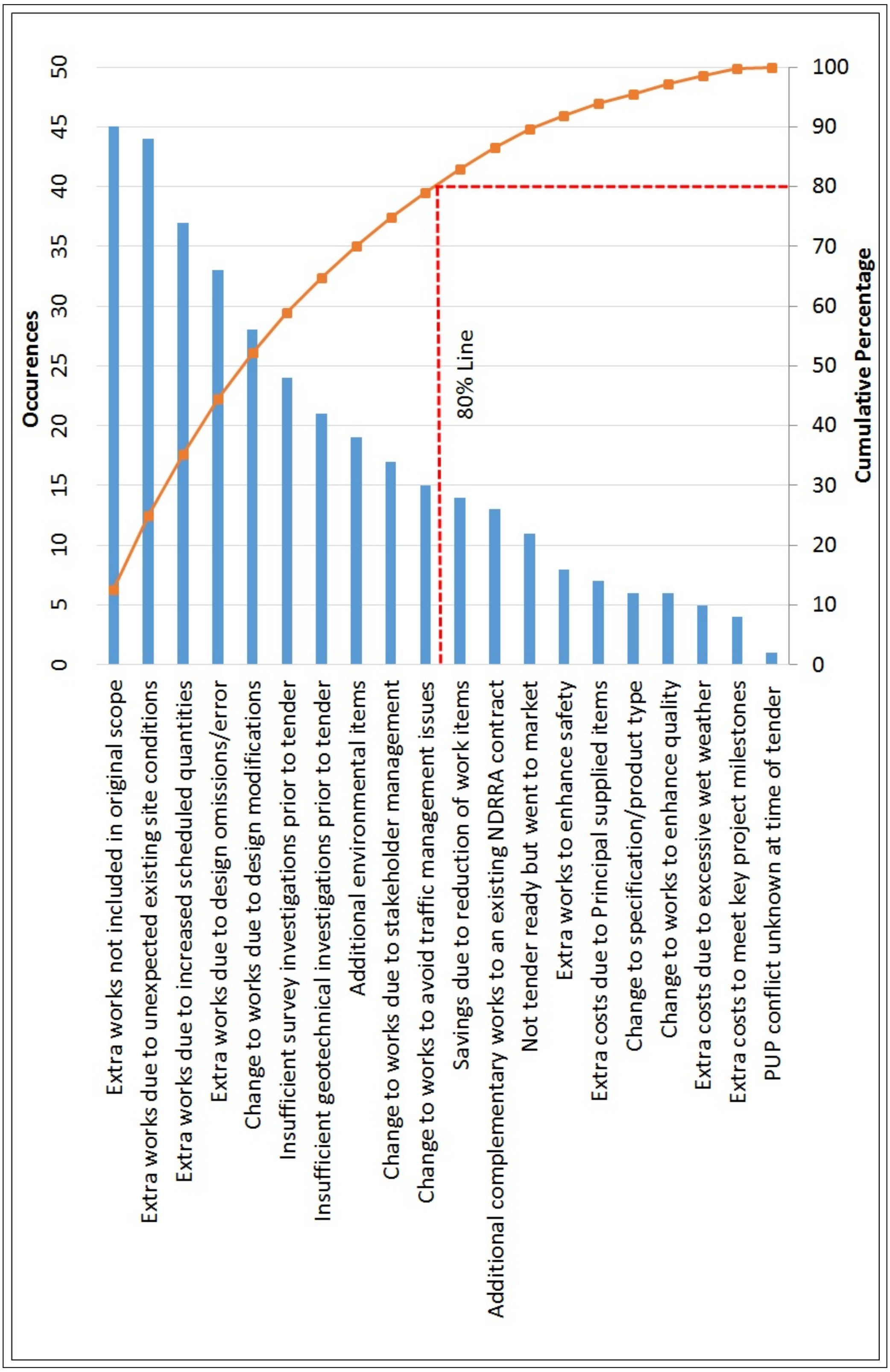

Figure 5.1: Reasons for Variation to the Work (GCoC Cl 40.1) Variations

also been avoided if specialists were consulted to address these areas. Assumptions can be made that "additional environmental items" may have been avoided if the design was reviewed by a specialist environmental officer. Similarly "changes to works due to stakeholder management" may have been avoided if a TMR Customer and Stakeholder Management Officer was engaged to consult with key stakeholders prior to finalising the design. The final reason in the top 80%, "changes to works to avoid traffic management issues" may have been avoided if a peer review was undertaken by specialists in road construction and traffic management to test assumptions made during the design phase.

Latent Condition (GCoC Clause 12)

As with the variations to the work it can be observed in figure 5.2 that the most common reasons for variations due to "Clause 12 Latent Conditions" may have been avoided if extra investigative design effort was provided in the pre-construction stage of the project. For example, unsuitable material estimated to be on site was often under-estimated and may have been predicted more accurately with a more thorough site specific geotechnical investigation. Unsuitable soil material often has to be transported from site and more suitable material imported to use in its place. This can result in significantly more costs not allowed for by the Contractor therefore resulting in a variation to the contract.

Similarly, conflicts with Public Utility Plant (PUP) may have been avoided if more thorough investigations into their actual location on site prior to going to tender, were undertaken. The implication is that the exact location of overhead and underground PUP such as power lines, gas pipes, watermains and telecommunication cables are often left to the contractor to determine which is a huge risk to TMR as the Principal if infrastructure to be constructed as part of the new works is in conflict with the location of the existing or even planned future PUP. If new infrastructure activities, e.g. earthworks, drainage, electrical and ITS conduit installation, conflict with existing or future PUP infrastructure this quite often leads to "variation to the work" and "delay and disruption" type variations. Various geophysical techniques exist to provide information of subsurface conditions which depending on the size and budget of the project may include non-destructive technology to accurately locate underground PUP. If conflicts involve PUP asset owners future infrastructure plans conflicting with the road design and therefore late changes to either the asset owner's or TMR's plans are required this may also result in "variation to the work" or "delay and disruption" type variations. These conflicts may be avoided through early consultation with the asset owners and key stakeholders.

The third and fourth reason for "latent condition" type variations resemble the previous example as assumptions can be drawn that pre-construction site investigations including geotechnical and geospatial, were not undertaken or at least not in accordance with TMR's design standards prior to the contracts having been released to tender. The collection of geotechnical information and the evaluation of site conditions prior to finalising the design assumptions is paramount for the purpose of minimising variations during the construction of the foundations of the road carriageway and associated structures, e.g. bridges, retaining walls, large culverts, etc. Likewise the collection of current survey data and review of its accuracy is critical for the planning and design of the appropriate infrastructure in particular on brownfield projects where constraints exist due to the need to retain existing infrastructure within the design scope. The evidence provided by the historical and survey data has found that without adequate pre-construction site investigations the risk of latent condition type variations increases significantly.

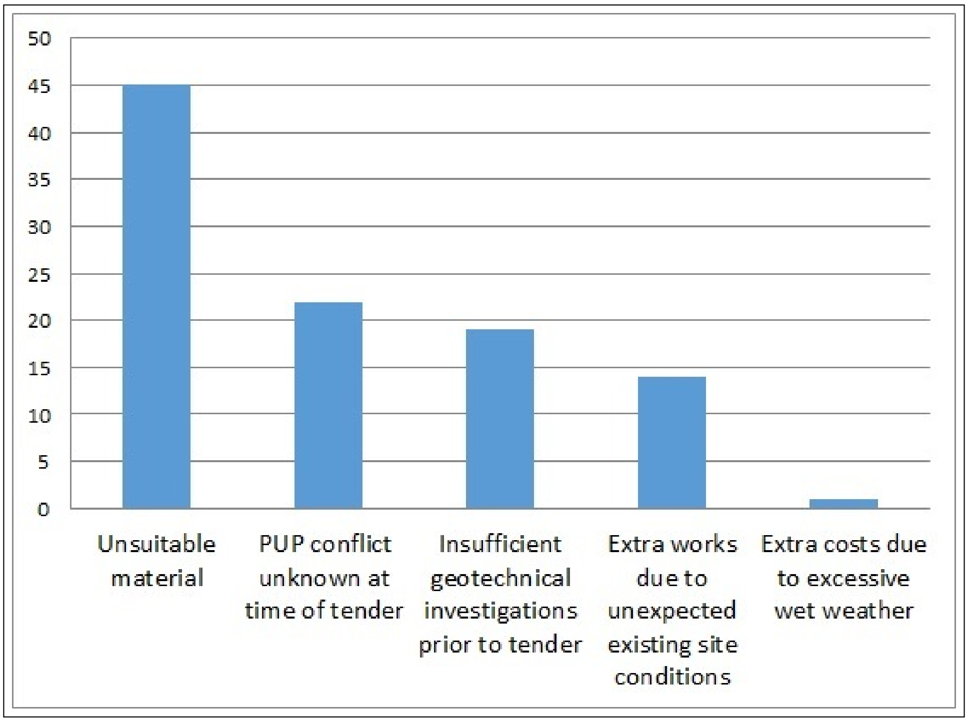

Figure 5.2: Reasons for Latent Condition (GCoC Cl 12) Variations

Delay and Disruption (GCoC Clause 36)

As a result of "variations to the work" and "latent conditions" it comes as no surprise that the Contractor submits claims for compensation due to "delay and disruption" to the works program. As the Principal carries the risk for the scope, design and site conditions, claims by the Contractor for delay and disruption resulting from changes made by the Principal add costs to the original contract and are therefore treated as variations. Whilst many of the reasons for variations studied in this research project are explicit and are able to be measured against some part of the contract, "delay and disruption" variations are implicit in their nature. These types of variations are usually acknowledged by each party at the initial stage however they can be ambiguous and often lead to contractual and relational conflict and potential arbitration in many cases. From the analysis of the historical variation data the five most common reasons for "Delay and Disruption (GCoC Cl 36) Variations" are:

1. Extra works due to design omissions/error;
2. Insufficient geotechnical investigations prior to tender;
3. Extra works due to unexpected existing site conditions;
4. Change to works due to design modifications;
5. Extra costs due to site access issues.

Figure 5.3 list the frequency of all reasons for "delay and disruption" type variations.

As discussed earlier in this study, the detail of the reasons for variations is limited to the historical data found in the FAP system. Therefore the root causes for the reasons for "delay and disruption" type variations can only be surmised. However it is a fair assumption that the five most common reasons may not have arisen if the design had not gone to tender until the design was thoroughly reviewed for omission and errors and sufficient pre-construction site investigations had been undertaken.

This analysis provides an important result because if variations to the work and latent condition type variations can be minimised this will inevitably reduce the number of delay and disruption claims which will potentially have a positive flow on affect by avoiding conflict and decreasing the magnitude of any potential cost overruns.

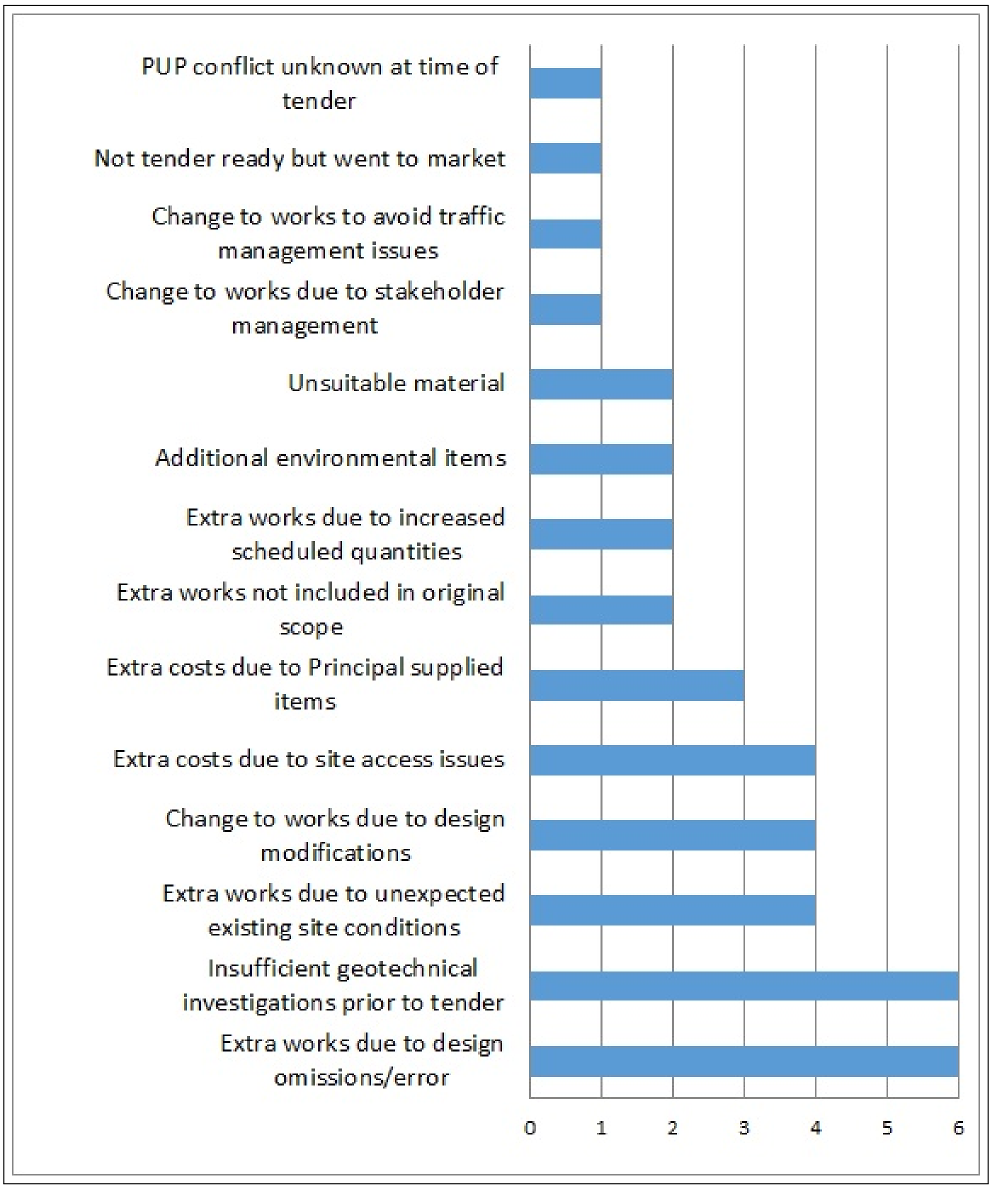

Figure 5.3: Reasons for Delay and Disruption (GCoC Clause 36) Variations

5.2 Expert Opinion Survey

The expert opinion survey was evenly distributed among forty targeted TMR personnel across each district in the state to ensure opinions were received from a cross section of TMR's project delivery experts. The nominated participants were given one week to answer the questions on-line and there were thirty three responses received in total. This equates to a return rate of over 82.5% therefore the data was considered representative of the target group.

Question one was asked to determine the proportion of expert representation that contributed to the on-line survey data collection. As shown in figure 5.4 of the thirty three respondents to return the survey, the role performed most often among the participants in the delivery of RCCs was that of Contract Administrator followed by Project Manager. Whilst these roles are predominantly hands on with the contract management, there were nine responses received from managers and two from other roles related to the delivery of RCCs. This was deemed a good representation of the road construction practitioners and their collective expert opinion could be considered credible.

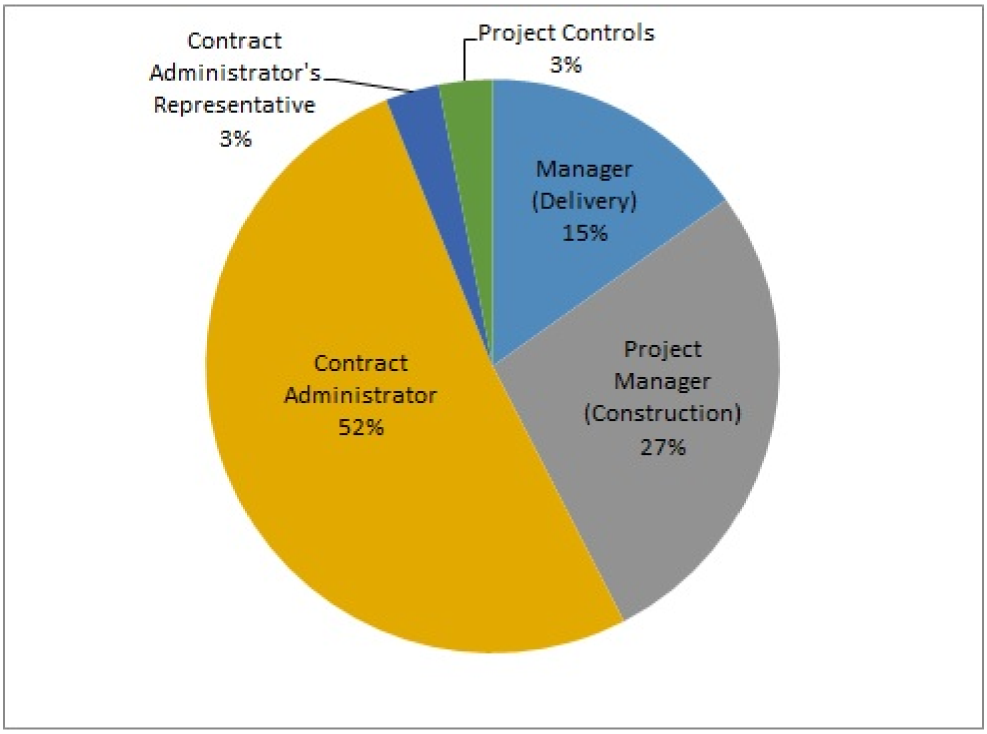

Figure 5.4: Q1 - What role have you performed most often in the delivery of RCCs?

Question two was asked to determine if the percentage of cost over-runs on RCCs was comparable to the results found in the historical contract variation data. From Figure 5.5 for contracts > \$1 million fifteen of the respondents felt that, due to variations, the final RCC contract value exceeds the original contract value by more than 10% less than 50% of the time. Whilst fifteen of the respondents felt that due to variations, the final RCC contract value exceeds the original contract value by more than 10% more than 50% of the time. Therefore on average the respondent's opinion is that due to variations, the final RCC contract value exceeds the original contract value by more than 10% about 50% of the time. This compares favourably with the 56% frequency of historical contracts exceeding 10% as deduced from Table 4.3. Therefore this somewhat validates the historical contract variation data collected from the TMR FAP system.

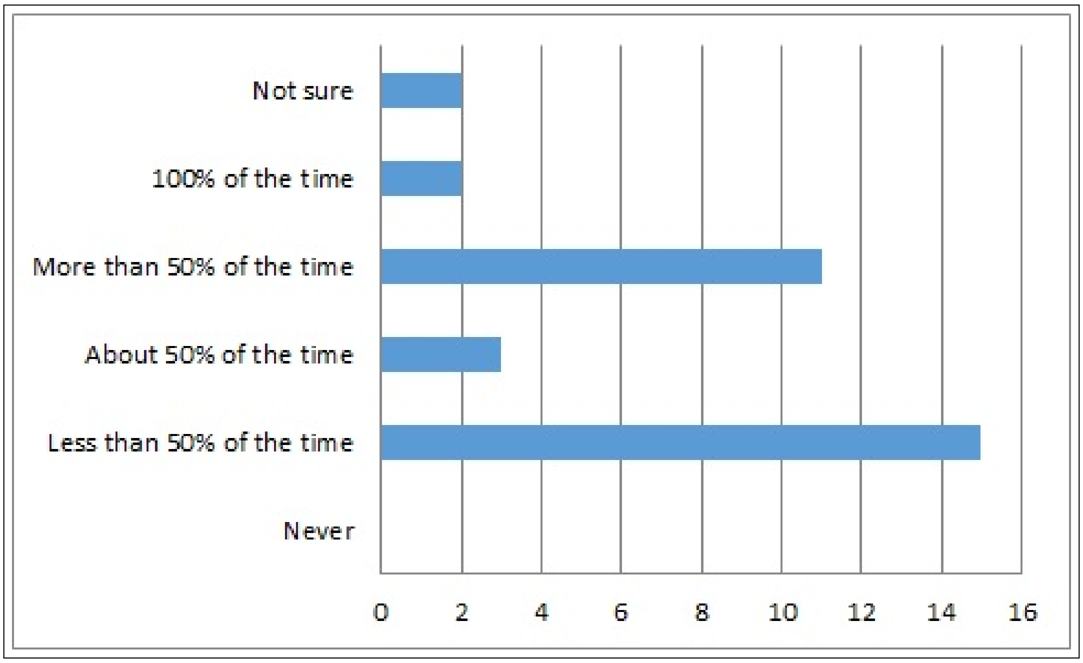

Figure 5.5: Q2 - For projects > \$1M how often do you think the final RCC contract value exceeds the original contract value by more than 10% due to variations?

Question three was asked of the respondents to determine what they thought was the most common cause of design related variations. The most common cause of design related variations received from the respondents as shown in figure 5.6 was due to "poor quality of design due to unvalidated design assumptions". The second and third most common reasons among the project delivery practitioners is that there is a lack of pre-construction site investigations due to lack of budget or time constraints and urgency to release the tender to the market prior to the design being fully ready.

These responses are all directly attributable to the Principal as the contract party that carries the risk for the design. This substantiates the historical data in particular the variation sources illustrated in figure 4.4 originating overwhelmingly from the Principal. This result also validates the assumption that the majority of variations sampled may not have arisen if the design had not gone to tender until the design was thoroughly reviewed for omission and errors and sufficient pre-construction site investigations had been undertaken.

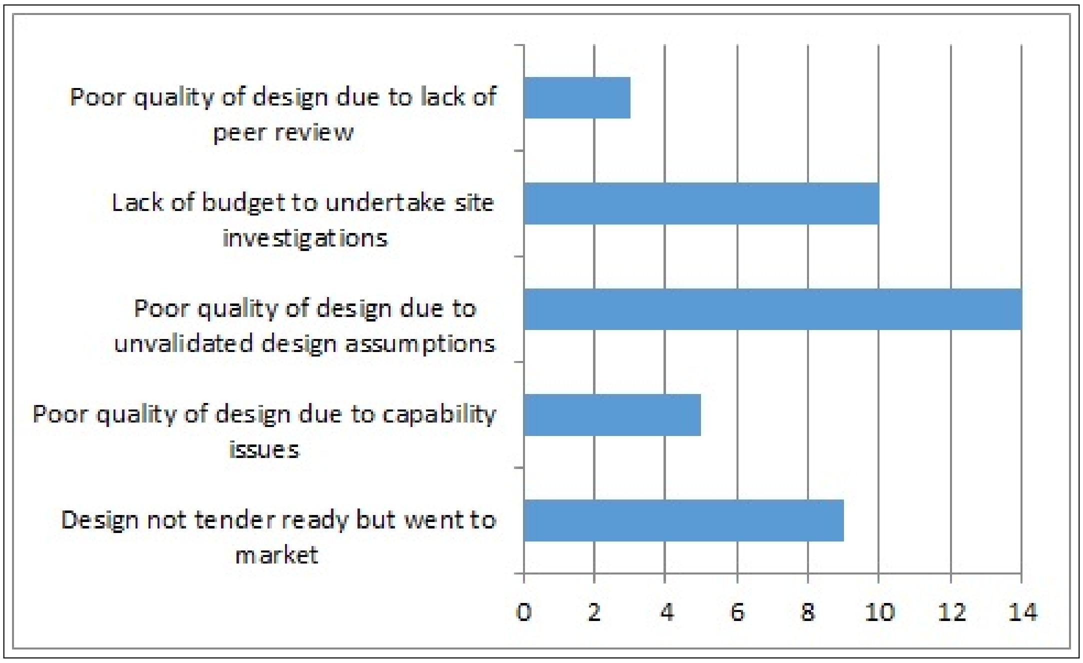

Figure 5.6: Q3 - Assuming the majority of variations to a contract were design related which reason do you think would be the most common cause?

Question four asked the respondents to consider the three most common variation reasons arising from design issues. A list of design related reasons resulting from the historical data analysis were provided to the respondents for their selection. The results of this response would assist in identifying a qualitative convergence toward the three most common design related reasons which could then be compared to the reasons collected from the historical data and assist in preparing recommendations to avoid such variations occurring in the future. Table 5.1 provides a list of what the respondents considered were the three most common variation reasons arising from design issues.

Table 5.1: Q4 - What do you consider are the THREE most common variation reasons arising from design issues?

Design Related Variation Reason	**Number of Occurrences**
Extra works due to omissions / errors in the scheduled quantities	17
Excessive unsuitable material (inc rock) due to insufficient geotechnical investigations prior to tender	16
Public Utility Plant (PUP) conflicts	14
Unexpected existing site conditions	11
Pavement design change due to weaker than expected subgrade	10
Insufficient survey investigations prior to tender	9
Insufficient constructability reviews, e.g. traffic management	9
Insufficient site investigations of existing infrastructure, e.g. guardrail, drainage, etc.	3
Latent conditions (other than geotechnical and PUP) that could have been managed	3
Incorrect/insufficient specification information, e.g. annexures incomplete, supp specs missing, etc.	2
Insufficient consultation with stakeholders	2
Lack of integration between design disciplines	1
Insufficient constructability reviews therefore design is not constructible in particular to bridges and other concrete works	1
PUP design and build cost not understood early enough to sufficiently build into estimate and schedule	1

Question five is similar to question four in that it requests the opinion of the respondents regarding the three most common variation reasons arising other than from design issues. A list of non-design related reasons resulting from the historical data analysis were provided to the respondents for their selection. Table 5.2 provides a list of the respondents most common reasons for variations other than design related reasons. It can be seen from these tables that there is a reasonable comparison between the reasons collected from the historical data and the data provided in the expert opinion survey. The responses also provide tangible evidence that the root causes of the predominant number of contract variations arise from reasons that may have been prevented in the pre-construction phase of the project. These results also provide a validation to the historical data collected to ensure recommendations from this research project based on the most significant reasons are appropriate to these findings.

Table 5.2: Q5 - What do you consider are the THREE most common variation reasons arising other than from design issues?

Other Than Design Related Variation Reasons	**Number of Occurrences**
Additional works ordered outside the scope of the original works	23
Public Utility Plant (PUP) issues not known at time of tender	17
Claims due to excessive wet weather	11
Delay and disruption due to issues with Principal supplied service/product	11
Change to work methodology due to stakeholder management	7
Change to work methodology due to safety or environmental issues	7
Change in scope ordered by the Principal	6
Acceleration to meet key deliverables	5
Rise and fall provisions (as a variation to the budget)	4
Possession of site/site access issues	3
Change to statutory requirements	2
Incomplete scope assessment	2
Contractor manufacturing claims to cover poor pricing/ construction practice	1

Question six takes the focus away from the reasons for cost over-runs and variations and focuses on strategies to reduce the occurrence of each. The question posed to the respondents asked how often is relationship management and conflict resolution strategies, e.g. partnering approach, dispute resolution boards, etc., utilised in the delivery of RCCs. The results of this question reveals that 27% of the respondents diligently undertake some form of relationship and conflict resolution strategies when delivering RCCs whilst 34% utilise them on complex projects only. The remaining 39% utilise relationship management and conflict resolution strategies either occasionally or not at all. Figure 5.7 illustrates the proportion of responses to question six.

Question seven follows on from question six by asking the respondents whether or not they believe that relationship management strategies can reduce the magnitude of variation

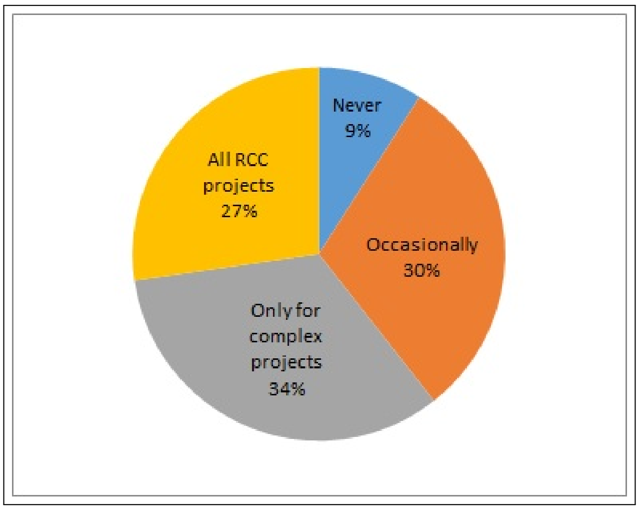

Figure 5.7: Q6 - How often do you utilise relationship management and conflict resolution strategies, e.g. partnering, dispute resolution board, etc. in the delivery of RCCs?

claims and potential disputes when done correctly. Figure 5.8 shows that the majority of project delivery practitioners do believe that these strategies are effective in reducing the magnitude of variation claims. Whilst these tools and techniques are encouraged for use by the TIPDS guidelines they are not compulsory. However based on the results of this question these tools will be considered in the recommendations to mitigate the occurrence, or at least the severity, of variations and their subsequent impact to budget cost overrun.

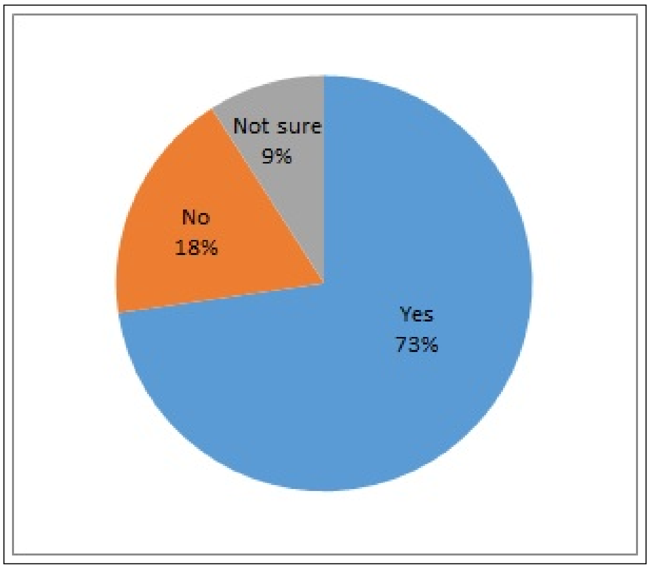

Figure 5.8: Q7 - Do you believe that relationship management strategies can reduce the magnitude of variation claims and potential disputes when done correctly?

Question eight seeks the opinion of the project delivery experts about how often they participate in post construction reviews and/or project learning workshops. This question was posed to determine whether or not post construction reviews and learning workshops could be better utilised to share the reasons why variations arise to facilitate continuous improvement of contract management. Figure 5.9 reveals that all the respondents have participated in post construction reviews and/or project learning workshops therefore this will be a recommendation for TMR to ensure the capture of these discussions is documented and disseminated among project delivery personnel.

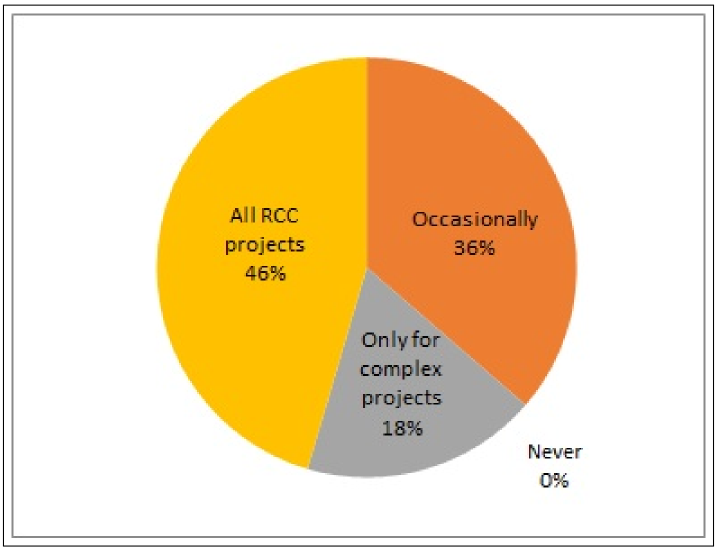

Figure 5.9: Q8 - How often do you undertake or participate in post construction reviews and/or project learning workshops?

Question nine asks the experts for their opinion of what are the three most realistic strategies for TMR to mitigate the occurrence of variations to RCCs. This question was asked to determine if the recommendations suggested by this research project will align with the opinion of the expert road construction practitioners. Table 5.3 categorises the responses into similar themes to provide a list of suggested mitigation strategies from the experts.

The three most common responses relate to strategies to improve the quality of design through constructibility and peer reviews, improved pre-construction processes and scope definition. Other strategies worthy of mention is the improvement in time management of the pre-construction phase to allow for site investigations including PUP locations to occur and catered for in the design. It is also worth noting that due to lack of project delivery experience and capability in some districts it was suggested that TMR encourages the sharing of resources across the state particularly now that technology has reduced the tyranny of distance.

Table 5.3: Q9 - In your opinion what are the three most realistic strategies for TMR to mitigate the occurrence of variations to RCCs?

Mitigation Strategies	**Number of Occurrences**
Ensure constructibility and peer reviews are undertaken well in advance of detailed design completion	24
Improve pre-construction processes to ensure a well-defined design	18
Improve scope definition and handover process from business case stage	13
Improve time management of the pre-construction phase including realistic design preparation durations and service relocations	10
Improve handover process from detailed design to tender stage	10
Improve cost management of the pre-construction phase including realistic design cost estimates	7
Utilisation of relationship management strategies during the execution of the contract	6
Train and share internal design resource capabilities to improve design deliverables including design cost estimates	5
Undertake post construction reviews and share learnings with others	5

The results of the expert opinion survey were cross-tabulated with the results of the historical data to enable a convergence toward the ten most common reasons for variations. This was done by ranking the number of occurrences of each variation found in both the historical and survey data and adding those rankings together. By identifying the ten most common reasons, recommendations to minimise the likelihood of the variations from occurring in the future, could then be established. Following is a list of the top ten variation reasons ranked in order of the most commonly identified in both the historical variation data and the expert opinion survey.

1. Extra works due to unexpected existing site conditions
2. Unsuitable material
3. Extra works due to design omissions/errors
4. PUP conflict unknown at time of tender
5. Extra works not included in original scope
6. Insufficient geotechnical investigations prior to tender
7. Additional complementary works to an existing NDRRA contract
8. Insufficient survey investigations prior to tender
9. Change to works due to stakeholder management
10. Change to works to avoid traffic management issues

The results of the on-line expert opinion survey assisted in validating the historical contract variation data and therefore the feedback from the respondents has been utilised in the preparation of the recommendations in the following chapter.

Chapter 6

Recommendations

The following are recommendations provided to minimise the likelihood of the variations analysed in this research project from occurring in the future. These recommendations are a culmination of the historical data analysis and feedback from the expert opinion survey collected during the course of the research. The recommendations are directed to TMR's project deliverers on a whole of state perspective and whilst some of the recommendations may require substantial resources to be applied to achieve their objective others may simply require adherence to existing TMR procedures and work instructions. For convenience the recommendations are sorted into the different phases of the contract management, i.e. pre-construction, construction or post-construction phase.

6.1 Pre-Construction Phase

- Project budgets and planning schedules to allow for more detailed site investigations in particular geospatial and geotechnical surveys. This will avoid uncertainty of site conditions and the subsequent need to vary the scope of works due to latent condition type variations post contract award. The research found that variations were often raised due to inadequate site survey information resulting in an increase in work items and significantly larger quantities of material;

- A greater emphasis on public utility plant (PUP) investigations in the pre-construction phase of the project with an integrated inclusion in the design drawings could avoid PUP conflicts and subsequent variations during construction that were unknown at time of tender. Most urban based Districts have dedicated corridor management teams that assess and advise of conflicts between new works and existing PUP infrastructure. A compulsory hold point for these teams to undertake a peer review of the contract documents at the concept and preliminary design stage may be one option;

- More emphasis on validating design assumptions through peer reviews of drawings particularly in specialist technical areas such as concrete structures, high traffic volume pavements, environmental and cultural heritage management, etc. This will avoid variations being raised due to extra works not included in the original scope, increased scheduled quantities, design omissions/errors, design modifications, delays due to statutory regulations, expiry of licences/permits, etc.;

- Encouragement of sharing of the peer reviews between Districts with the resource capability and project experience available to undertake such reviews. Feedback from project delivery practitioners in the expert opinion survey suggested that there is an insufficient in-house capability for peer reviews in some Districts, e.g. in the fields of electrical and intelligent transport solutions (ITS), traffic management, etc.;

- Compulsory constructability reviews of contract documentation including specification annexures prior to release to tender to avoid scope changes post contract award. Change to works to avoid traffic management issues, extra works to enhance quality and safety, additional works to "tie-in" to existing infrastructure are all examples of variations that could be avoided by a constructability review;

- Pre-construction involvement of the construction project manager to supplement the design team with construction experience to review the non-design related issues such as landowner expectations, likely latent conditions, weather effects, availability of suitable plant and materials, etc. This may avoid delay and disruption type claims as a result of variations to the scope of the works due to these non-design related issues;

- Early engagement of key project stakeholders such as adjacent home and business owners, adjoining developers, politicians, etc. has been identified in the historical variation data and by several project delivery practitioners as crucial to avoid changes to the project scope or timing of contract post contract award. Variations often arise due to the influence of these stakeholders once construction commences and it becomes obvious to the community that the project may affect them.

6.2 Construction Phase

- Instigate better communication between pre-construction and construction delivery teams to ensure design concepts, assumptions and risks are understood prior to the release to tender of the contract. This may involve a formal minuted handover meeting between key team members of both teams;
- Compulsory training of TMR project delivery staff and consultants in Contract Administration including relationship and conflict resolution management to improve the expertise in this area. This will increase the consistency of assessments of variations and avoid unnecessary and frivolous claims for variations due to poor relationships and lack of communication between Contract Administrators and Contractors;
- Adequately resource the project and contract administration team so that all RCC reporting tasks are managed as required by TMR guidelines. This includes the keeping of accurate contractor's records, detailed scrutiny of the program of works, documentation of meeting minutes, etc. to ensure the assessment of variations is diligent and fair to all parties;
- A better collaboration between TMR financial and contract management databases to enable a more efficient and simpler input and extraction of contract variation data. In particular the documenting of consistent sources, types and reasons of all variations not just those that result in an increase to the original contract value and entered into the FAP system. This will assist in the regular state-wide monitoring of the root causes of the variations and enable on-going targeted improvement initiatives.

6.3 Post-Construction Phase

- Encourage the facilitation of post construction reviews and lessons learnt workshops to undertake and record the in-depth "post mortem" analysis of variations that have led to significant project cost overrun. This will strengthen the ongoing understanding of why variations arise and the root cause to substantial overruns of contract budgets which can be shared among road construction practitioners across the state.

Chapter 7

Conclusions

7.1 Conclusions

The aim of this research project was to assist TMR with the understanding of why variations to Road Construction Contracts (RCC) arise and their root causes which result in cost overruns on recent road construction projects. The project examined recent RCCs which are the traditional contract type and are the most commonly used by TMR for routine construction contracts. The project entailed state wide research into current and recent RCC variations and provides statistical analysis of those variations and an indication if the contracts sampled have achieved TMRs cost estimate performance target.

In order to achieve the aim of this research project there were several objectives to be that had to be accomplished:

- A background and literature review was undertaken of relevant past studies and publications to first gain a basic appreciation of what forms a road construction contract, secondly to define how variations occur and thirdly to review the construction industry's research into the significance of cost overruns on budgets. The literature review also assisted in the identification of the appropriate variation data required to form the basis of the research.
- Variation data was then collected from historical contracts sourced from TMR databases.

- An expert opinion survey was also undertaken to gauge the understanding of the issue of contract variations among project delivery practitioners. The feedback from this survey also supplemented the validation of the historical variation.

- The data from the historical variations and the opinion survey was then reviewed and summarised into high level categories of source, type and reasons.

- These categories of data were then analysed, results discussed and trends across differing variations identified.

Although it is acknowledged that if variations are minimised through, for example, better documentation at time of tender, then any potential cost overrun may subsequently be transferred to an increase in the tender box. However it is assumed that this increase at time of competitive tender will be less than the cost overruns due to of variations during the execution of the contract. Another benefit of minimising variations during the execution of the contract is a reduction in disputes arising from the Contract Administrator's decisions on variations to the contract that are not accepted by either party, i.e. the Principal or the Contractor.

Whilst some variations are expected, e.g. rise and fall, these can be either allowed for up front in the financial approval or calculated in as a contingency if rises are experienced. This type of "planned" variation if allowed for in the original contract value will reduce the perceived issue of cost overruns to contract budgets. Also an abnormally large number of Natural Disaster Relief and Recovery Arrangement (NDRRA) projects was included in the sample data due to extreme weather events over the past five years. This has probably skewed the quantum of scope changes due to the need to fast-track the establishment of contractors on the ground to reconstruct damaged roads. This fast-tracking of projects doesn't necessarily give best value for money and TMR pays a premium for this however due to the magnitude of the natural disaster reconstruction program this premium could not be avoided.

The key finding of the study was that the better the understanding of the construction scope and site conditions prior to contract award the more accurate the resultant design and cost estimate. Therefore the more accurate design and cost estimate the less likelihood of unplanned and unbudgeted variations. This study concluded with recommendations to TMR to minimise the likelihood of these contract variations occurring in the future.

7.2 Further Work

There is a need for further work into the cost impact of contract variations versus the effort of site investigations at the pre-construction phase. Risk assessments will dictate the balance between over cautious design investigation and the probability of a variations however this study has found a lack of consistency between the levels of design certainty versus budget contingency. As part of this further study, analysis of the 27% of contracts sampled that did not have variations that exceeded the original contract value could be examined to understand what was different to those contracts that did exceed the original contract value. If further studies found whether, for example, a particular district, contractor, type of project or reconstruction process was the reason for nil exceedence of the original contract value this will assist TMR in limiting cost overruns on projects.

Another area for future investigation is storage and retrieval of historical contract data. To allow estimators, planners and designers to generate and deliver better project cost estimates and designs, historical data of past contracts has to be made more accessible for interpretation and analysis. This may include the development of a central database that could capture all variations registers kept by the many contract administrator's across the state. This will improve the ability to monitor and review the reasons for variations and lessons learnt to share among road construction practitioners.

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Appendix A

Project Specification

ENG 4111/4112 Research Project

Project Specification

For: **Alan G. Purvis**

Topic: An Investigative Study of Road Construction Contract Variations

Supervisor: David Thorpe

Sponsorship: Faculty of Health, Engineering & Sciences
Department of Transport and Main Roads Qld (TMR)

Project Aim: This investigative study will entail state wide research into current and recent TMR Road Construction Contract (RCC) variations to analyse their root causes and to provide recommendations to eliminate, or minimise the likelihood of the variations occurring in the future.

Program: (Rev C: 7 March 2015)

1. Undertake a background and literature review to establish previous research into the root causes of variations in RCCs within TMR.
2. Seek endorsement of the study from senior TMR personnel then contact District personnel responsible for the delivery of RCC's to nominate sample contracts and provide access to historical data. Samples will be confined to RCC's above $1M value and awarded between Jan 2009 and Dec 2014.
3. Collect historical variation data from the sample contracts to form the basis of the research.
4. Analyse the contract data for variations and summarise the variations into high level categories, e.g.
   - Principal directed;
   - Contractor convenience;
   - Arising from entitlement under the Contract;
   - Others categories caused by stakeholder, political requirement, etc.
5. Identify trends across contracts which are reviewed to establish common types of variations (focusing on big ticket / high cost type variations, e.g.
   - Latent conditions;
   - Limits of Accuracy;
   - Changes in design.
6. Establish why variations are commonly arising (aligned to above) through detailed analysis of the documented variation reasons, e.g.
   - Due to poor geotechnical information provided at tender;
   - Due to ambiguity in contract clause interpretation in recovery of overheads;
   - Due to poor design rushed through at tender, not tender ready but went to market, etc.
7. Provide recommendations to TMR to eliminate, or minimise the likelihood of the variation occurring in the future.

As time and resources permit:

1. Provide statistical data of frequency of typical variation causes.
2. Determine financial impacts of typical variation types on contract budgets.
3. Determine trends of variations that lead to contractual disputes.

Appendix B

Historical Contract and Variation Data Analysis Spreadsheet

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
Brisbane	METD-2236	$ 56,689,780	1.1	$ 5,447,524	16.8%	Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.2	$ 660,934		Contractual	Latent Condition	Unsuitable material
			1.3	$ 427,120		Stakeholder	Variation Due to Scope Changes	Extra works to enhance safety
			1.4	$ 182,703		Contractual	Latent Condition	Unsuitable material
			1.5	$ 63,187		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.6	$ 56,664		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.7	$ 47,611		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.1	$ 2,622,658		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	METD-2283	$ 7,216,598	n/a	$ -	0.0%			
	METD-2401	$ 5,931,578	n/a	$ -	0.0%			
	METD-2454	$ 6,537,891	n/a	$ -	0.0%			
	METD-2482	$ 5,139,077	1.1	$ 1,310,204	34.7%	Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.1	$ 475,000		Principal	Variation Due to Scope Changes	Not tender ready but went to market
	METD-2490	$ 13,892,000	1.1	$ 1,850,000	51.4%	Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.2	$ 1,200,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.3	$ 1,100,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.4	$ 600,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.5	$ 500,000		Contractual	Latent Condition	Unsuitable material
			2.1	$ 1,892,311		Principal	Variation Due to Scope Changes	Change to works due to stakeholder management
						Contractual	Latent Condition	Unsuitable material
						Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	METD-2497	$ 25,441,355	n/a	$ -	0.0%			
	METD-2665	$ 5,770,327	1.1	$ 502,304	9.1%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 25,481		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	METD-2697	$ 1,721,400	n/a	$ -	0.0%			
	METD-2699	$ 6,707,095	1.1	$ 2,743,408	103.2%	Stakeholder	Change to Sequence of Works	Change to works to avoid traffic management issues
			2.1	$ 4,178,639		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	METD-2728	$ 6,608,930	1.1	$ 350,000	7.7%	Principal	Variation Due to Scope Changes	Not tender ready but went to market
			1.2	$ 144,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.3	$ 13,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	METD-2736	$ 18,521,859	1.1	$ 250,507	23.0%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			2.1	$ 2,177,876		Contractual	Latent Condition	Unsuitable material
			2.2	$ 863,515		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			3.1	$ 766,691		Contractual	Latent Condition	Unsuitable material
			3.2	$ 204,918		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
	METD-2773	$ 1,628,099	1.1	$ 123,380	28.7%	Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.2	$ 113,000		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.3	$ 102,000		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.4	$ 66,800		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.5	$ 42,000		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.6	$ 20,600		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
	METD-2846	$ 25,068,720	n/a	$ -	0.0%			
Darling Downs	STHD-1330	$ 6,158,072	1.1	$ 84,427	13.7%	Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.1	$ 37,971		Contractual	Latent Condition	Unsuitable material
			3.1	$ 63,637		Contractual	Latent Condition	Unsuitable material
			4.1	$ 659,621		Contractual	Latent Condition	Unsuitable material
	STHD-1352	$ 4,554,798	1.1	$ 630,000	18.7%	Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.2	$ 215,000		Contractual	Latent Condition	Unsuitable material

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			2.1	$ 5,544		Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
	STHD-1421	$ 4,342,542	1.1	$ 701,036	30.1%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 375,803		Contractual	Latent Condition	Unsuitable material
			2.1	$ 44,225		Stakeholder	Variation Due to Scope Changes	Additional environmental items
			2.2	$ 39,948		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.3	$ 30,468		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			2.4	$ 10,127		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			2.5	$ 10,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.6	$ 10,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			3.1	$ 31,339		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			3.2	$ 19,560		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			3.3	$ 34,934		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	STHD-1423	$ 38,867,523	1.1	$ 15,066,808	74.7%			
			2.1	$ 6,246,437		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			2.2	$ 2,280,931		Stakeholder	Variation Due to Scope Changes	Not tender ready but went to market
			2.3	$ 152,521		Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			3.1	$ 2,228,415		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			3.2	$ 203,026		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			4.1	$ 770,776		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			4.2	$ 641,146		Contractual	Excepted Risks	Insurance Claim
			4.3	$ 375,785		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			4.4	$ 263,567		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			4.5	$ 217,530		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			4.6	$ 198,974		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			4.7	$ 175,149		Principal	Variation Due to Scope Changes	Additional environmental items
			4.8	$ 161,734		Principal	Variation Due to Scope Changes	Additional environmental items
			4.9	$ 51,516		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	STHD-1438	$ 8,846,941	1.1	$ 786,653	34.1%	Principal	Variation Due to Scope Changes	Change to works to enhance quality
			1.2	$ 380,000		Contractual	Latent Condition	Unsuitable material
			1.3	$ 221,705		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.4	$ 122,660		Principal	Setting Out the Works	Insufficient survey investigations prior to tender
			1.5	$ 120,000		Stakeholder	Variation Due to Scope Changes	Extra works to enhance safety
			1.6	$ 90,000		Stakeholder	Variation Due to Scope Changes	Extra works to enhance safety
			1.7	$ 50,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.8	$ 40,000		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.9	$ 38,421		Principal	Variation Due to Scope Changes	Change to works to enhance quality
			1.10	$ 20,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.11	$ 7,623		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.12	$ 7,320		Principal	Variation Due to Scope Changes	Change to specification/product type
			1.13	$ 6,215		Stakeholder	Variation Due to Scope Changes	Extra works to enhance safety
			2.1	$ 423,077		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			3.1	$ 579,964		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			3.2	$ 120,532		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	STHD-1452	$ 4,092,098	n/a	$ -	0.0%			
	STHD-1477	$ 11,441,742	1.1	$ 3,870,021	31.5%	Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.2	$ 730,248		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.3	$ 98,915		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.4	-$ 835,788		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			1.5	-$ 261,615		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
	STHD-1494	$ 5,677,297	1.1	$ 380,769	43.3%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 1,623,920		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			2.2	$ 292,638		Principal	Delay and Disruption	Insufficient geotechnical investigations prior to tender
			2.3	$ 126,753		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			2.4	$ 77,635		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.5	$ 75,543		Contractual	Latent Condition	Unsuitable material
			2.6	$ 69,493		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.7	$ 61,273		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.8	-$ 252,566		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
	STHD-1510	$ 9,452,893	1.1	$ 2,179,871	46.9%	Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.2	$ 1,220,189		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.3	$ 523,689		Stakeholder	Variation Due to Scope Changes	Extra works to enhance safety
			1.4	$ 97,132		Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			1.5	-$ 334,606		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			1.6	-$ 382,310		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			2.1	$ 831,544		Principal	Latent Condition	Insufficient geotechnical investigations prior to tender
			2.2	$ 298,135		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
	STHD-1521	$ 22,608,966	1.1	$ 1,367,105	23.2%	Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.2	$ 721,156		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.3	$ 642,158		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.4	$ 587,077		Contractual	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.5	$ 442,000		Stakeholder	Variation Due to Scope Changes	Extra works to enhance safety
			1.6	$ 298,446		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			1.7	$ 48,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			2.1	$ 509,330		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			2.2	$ 148,442		Contractual	Variation Due to Scope Changes	Bonus payment not allowed for in the schedule
			2.3	$ 99,301		Principal	PUP Identifed During the Contract	Extra works due to design omissions/error
			2.4	$ 371,887		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
	STHD-1538	$ 2,094,966	2.1	$ 199,356	9.5%	Principal	Variation Due to Scope Changes	Change to works to enhance quality
Far North	PEND-1577	$ 6,294,809	1.1	$ 373,963	12.4%	Principal	Variation Due to Scope Changes	Change to works to enhance quality
			1.2	$ 90,281		Principal	Variation Due to Scope Changes	Additional environmental items
			1.3	$ 37,668		Stakeholder	Variation Due to Scope Changes	Extra works not included in original scope
			1.4	$ 24,004		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.5	$ 23,126		Stakeholder	Delay and Disruption	Additional environmental items
			1.6	$ 20,439		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.7	-$ 117,415		Principal	Variation Due to Scope Changes	Change to specification/product type
			1.8	-$ 7,496		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.9	-$ 1,010		Contractor	Variation Due to Scope Changes	Change to specification/product type
			1.10	-$ 40		Contractor	Variation Due to Scope Changes	Change to specification/product type
			2.1	$ 271,218		Principal	Delay and Disruption	Insufficient geotechnical investigations prior to tender
			3.1	$ 63,975		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	PEND-1615	$ 5,570,496	n/a	$ -	0.0%			
	PEND-1635	$ 11,000,798	1.1`	$ 2,399,919	54.5%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			2.1	$ 233,793		Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			2.2	$ 866,141		Principal	Variation Due to Scope Changes	Change to specification/product type
			2.3	$ 18,696		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			2.4	$ 46,139		Principal	Document Ambiguity/Discrepency	Extra works due to design omissions/error

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			2.5	$ 78,374		Contractual	Latent Condition	Unsuitable material
			2.6	$ 925		Contractual	Latent Condition	Unsuitable material
			2.7	$ 4,113		Stakeholder	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			2.8	$ 7,002		Principal	Variation Due to Scope Changes	Change to works to enhance quality
			3.1	$ 2,339,338		Principal	Acceleration	Extra costs to meet key project milestones
	PEND-1693	$ 7,847,610	1.1	$ 1,821,560	22.7%	Contractual	Excepted Risks	Extra costs due to excessive wet weather
			1.2	$ 191,234		Principal	Delay and Disruption	Extra costs due to Principal supplied items
			1.3	$ 107,876		Principal	Delay and Disruption	Extra works due to design omissions/error
			1.4	$ 33,884		Stakeholder	Delay and Disruption	Change to works due to stakeholder management
			1.5	$ 32,860		Principal	Delay and Disruption	Extra costs due to Principal supplied items
			1.6	$ 21,092		Principal	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.7	$ 20,844		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
			1.8	$ 4,119		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.9	-$ 346,525		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			1.10	-$ 83,208		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			1.11	-$ 21,464		Principal	Variation Due to Scope Changes	Change to works due to design modifications
	PEND-1694	$ 5,078,510	1.1	$ 333,596	6.6%	Principal	Delay and Disruption	Insufficient geotechnical investigations prior to tender
	PEND-1695	$ 2,523,258	1.1	$ 196,130	7.8%	Principal	Variation Due to Scope Changes	Extra costs due to excessive wet weather
	PEND-1697	$ 6,698,551	1.1	$ 740,751	33.4%	Principal	Variation Due to Scope Changes	Extra costs due to excessive wet weather
			1.2	$ 530,832		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.3	$ 232,374		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.4	$ 81,667		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.5	$ 72,029		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			2.1	$ 409,074		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.2	$ 169,582		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	PEND-1699	$ 1,067,575	1.1	$ 1,049,649	107.6%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 98,640		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	PEND-1700	$ 4,241,317	1.1	$ 49,128	8.6%	Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.2	$ 108,370		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.3	$ 80,199		Principal	Latent Condition	Unsuitable material
			1.4	$ 70,426		Principal	Latent Condition	Unsuitable material
			1.5	$ 55,842		Principal	Latent Condition	Unsuitable material
			1.6	$ 78,819		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.7	-$ 89,712		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			2.1	$ 11,233		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	PEND-1704	$ 4,101,654	1.1	$ 744,556	20.3%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			2.1	$ 88,066		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
	PEND-1712	$ 2,187,015	1.1	$ 323,944	38.0%	Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.2	$ 196,130		Principal	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.3	$ 110,476		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.4	$ 108,763		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.5	$ 56,381		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.6	$ 14,772		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.7	$ 7,511		Principal	Variation Due to Scope Changes	Additional environmental items
			1.8	$ 6,735		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.9	$ 4,063		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.10	$ 1,500		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
	PEND-1726	$ 7,188,503	1.1	$ 2,598,138	77.8%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			2.1	$ 604,406		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.2	$ 431,442		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			2.3	$ 392,779		Contractual	Acceleration	Extra costs to meet key project milestones
			2.4	$ 376,037		Principal	Variation Due to Scope Changes	Extra costs to meet key project milestones
			2.5	$ 215,700		Principal	Variation Due to Scope Changes	Extra costs to meet key project milestones
			2.6	$ 180,486		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.7	$ 35,692		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.8	$ 21,144		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
			2.9	$ 15,004		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			2.10	$ 12,282		Contractual	Latent Condition	Unsuitable material
			2.11	$ 10,000		Principal	Delay and Disruption	Extra works due to design omissions/error
			2.12	$ 6,724		Principal	Delay and Disruption	Extra works not included in original scope
			2.13	$ 5,440		Principal	Examination and Testing	Insufficient geotechnical investigations prior to tender
			2.14	$ 1,022		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			3.1	$ 685,000		Principal	Delay and Disruption	Extra works due to design omissions/error
	PEND-1732	$ 4,878,610	1.1	$ 2,990,359	132.3%	Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.2	$ 1,960,953		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.3	$ 884,816		Principal	Delay and Disruption	Extra works due to design omissions/error
			1.4	$ 376,437		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.5	$ 243,885		Principal	Variation Due to Scope Changes	Change to works due to design modifications
	PEND-1733	$ 9,446,787	1.1	$ 440,780	12.6%	Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			2.1	$ 157,965		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			3.1	$ 326,590		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			4.1	$ 265,468		Principal	Delay and Disruption	PUP conflict unknown at time of tender
	PEND-1734	$ 5,089,093	1.1	$ 481,128	59.3%	Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.2	$ 469,827		Contractual	Latent Condition	Extra costs due to excessive wet weather
			1.3	$ 360,734		Principal	Variation Due to Scope Changes	Extra costs to meet key project milestones
			1.4	$ 117,164		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.5	$ 114,408		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.6	$ 52,605		Principal	Latent Condition	Unsuitable material
			1.7	$ 38,360		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.8	$ 13,606		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.1	$ 608,748		Principal	Delay and Disruption	Unsuitable material
			2.2	$ 311,554		Contractual	Latent Condition	Unsuitable material
			3.1	$ 441,508		Principal	Change to Sequence of Works	Extra costs due to excessive wet weather
			3.2	$ 7,152		Contractual	Limits of Accuracy	Extra works due to increased scheduled quantities
	PEND-1738	$ 3,920,589	1.1	$ 167,611	121.1%	Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.2	$ 4,509		Contractual	Latent Condition	Unsuitable material
			2.1	$ 715,780		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			3.1	$ 686,622		Principal	Variation Due to Scope Changes	Extra costs to meet key project milestones
			3.2	$ 450,000		Principal	Delay and Disruption	Change to works due to design modifications
			3.3	$ 419,445		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			3.4	$ 193,634		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			3.5	$ 46,821		Principal	Variation Due to Scope Changes	Extra costs due to excessive wet weather
			3.6	$ 14,937		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
			4.1	$ 2,049,827		Contractor	Notice of BCIPA Claim	BCIPA claim of costs lodged by the Contractor
	PEND-1760	$ 2,867,342	1.1	$ 426,524	42.6%	Principal	Variation Due to Scope Changes	Extra costs due to excessive wet weather
			1.2	$ 294,099		Principal	Variation Due to Scope Changes	Change to works due to design modifications

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			1.3	$ 35,914		Principal	Variation Due to Scope Changes	Additional environmental items
			1.4	$ 25,985		Principal	Variation Due to Scope Changes	Extra works to enhance safety
			1.5	$ 24,580		Principal	Variation Due to Scope Changes	Additional environmental items
			1.6	$ 20,010		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.7	$ 13,461		Contractual	Latent Condition	Unsuitable material
			1.8	$ 11,201		Contractual	Latent Condition	Unsuitable material
			1.9	$ 10,065		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
			1.10	$ 9,406		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.11	$ 8,510		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.12	$ 7,917		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.13	$ 6,243		Principal	Variation Due to Scope Changes	Additional environmental items
			2.1	$ 326,591		Principal	Variation Due to Scope Changes	Extra costs due to excessive wet weather
	PEND-1777	$ 7,399,602	1.1	$ 207,772	24.1%	Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.1	$ 669,000		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			3.1	$ 302,000		Contractual	Latent Condition	Unsuitable material
			3.2	$ 20,000		Contractual	Limits of Accuracy	Extra works due to increased scheduled quantities
			3.3	$ 16,306		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			3.4	$ 927		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			3.5	$ 20,739		Principal	Variation Due to Scope Changes	Additional environmental items
			3.6	$ 120,000		Contractual	Latent Condition	Unsuitable material
			4.1	$ 259,986		Principal	Delay and Disruption	Unsuitable material
			4.2	$ 179,736		Contractual	Latent Condition	Unsuitable material
			4.3	-$ 9,722		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
	PEND-1782	$ 2,947,153	1.1	$ 181,171	28.3%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			2.1	$ 472,679		Contractual	Latent Condition	Unsuitable material
			3.1	$ 180,643		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	PEND-1790	$ 3,812,177	1.1	$ 1,040,227	46.5%	Contractual	Latent Condition	Unsuitable material
			1.2	$ 478,116		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.3	$ 241,168		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.4	$ 12,530		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
	PEND-1796	$ 2,428,321	1.1	$ 21,189	0.5%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 12,879		Contractual	Certficates and Payments	Interest for late payment of progress claim
	PEND-1811	$ 2,520,457	1.1	$ 1,499,593	59.5%	Contractual	Latent Condition	Unsuitable material
	PEND-1822	$ 1,077,352	n/a	$ -	0.0%			
Fitzroy	CEND-1068	$ 2,965,854	1.1	$ 312,731	28.6%	Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.2	$ 270,000		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.3	$ 72,930		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.4	$ 68,983		Contractual	Latent Condition	Unsuitable material
			1.5	$ 40,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.6	$ 16,228		Principal	Delay and Disruption	Extra works due to design omissions/error
			1.7	$ 16,157		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.8	$ 15,536		Contractual	Latent Condition	Unsuitable material
			1.9	$ 15,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.10	$ 9,481		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.11	$ 7,071		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.12	$ 2,883		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	CEND-1200	$ 12,823,485	1.1	$ 2,978	9.3%	Principal	Delay and Disruption	Extra costs due to Principal supplied items
			1.2	$ 2,787		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			1.3	$ 5,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.4	$ 63,092		Principal	Delay and Disruption	Change to works due to design modifications
			1.5	$ 3,707		Principal	Delay and Disruption	Change to works due to design modifications
			1.6	$ 1,106		Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.7	$ 1,191		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.8	$ 6,427		Principal	Examination and Testing	Extra costs due to Principal supplied items
			1.9	$ 1,428		Principal	Variation Due to Scope Changes	PUP conflict unknown at time of tender
			1.10	$ 65,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.11	$ 80,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.12	$ 110,000		Contractual	Latent Condition	Unsuitable material
			1.13	$ 75,000		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.14	$ 13,000		Principal	Variation Due to Scope Changes	Additional environmental items
			1.15	$ 767,500		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	CEND-1349	$ 4,537,701	1.1	$ 540,809	13.2%	Principal	Variation Due to Scope Changes	Additional environmental items
			2.1	$ 60,000		Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
	CEND-1350	$ 2,059,081	1.1	$ 508,504	37.0%	Principal	Variation Due to Scope Changes	Additional environmental items
			2.1	$ 104,050		Principal	Delay and Disruption	Extra costs due to site access issues
			2.2	$ 149,728		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	CEND-1402	$ 102,465,401	1.1	$ 4,400,000	13.1%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 4,078,035		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.3	$ 2,500,000		Contractual	Rise & Fall	Adjustment to the contract sum
			1.4	$ 1,235,253		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.5	$ 674,255		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.6	$ 500,000		Principal	Delay and Disruption	Change to works due to design modifications
			1.7	$ 12,457		Contractual	Change to Statutory Requirements	Change to specification/product type
	CEND-1422	$ 10,481,473	n/a	$ -	0.0%			
	CEND-1425	$ 7,512,318	1.1	$ 1,577,928	28.5%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
			2.1	$ 566,432		Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
	CEND-1426	$ 5,977,910	n/a	$ -	0.0%			
	CEND-1490	$ 5,061,108	1.1	$ 1,052,253	20.8%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
	CEND-1505	$ 2,423,791	1.1	$ 515,242	28.7%	Contractual	Latent Condition	Unsuitable material
			1.2	$ 181,175		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
Mackay Whitsunday	MACD-1234	$ 1,791,532	n/a	$ -	0.0%			
	MACD-1362	$ 2,860,935	1.1	$ 652,677	26.6%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 108,318		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	MACD-1367	$ 9,957,352	n/a	$ -	0.0%			
	MACD-1431	$ 4,232,111	1.1	$ 160,000	6.8%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 77,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.3	$ 36,256		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.4	$ 15,515		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	MACD-1483	$ 2,486,628	1.1	$ 70,000	8.9%	Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.2	$ 20,000		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.3	$ 60,500		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.4	$ 33,536		Principal	Variation Due to Scope Changes	Additional environmental items
			1.5	$ 34,000		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
			1.6	$ 4,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
North Coast	NCHD-2558	$ 10,583,432	1.1	$ 189,376	5.0%	Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			1.2	$ 101,427		Contractual	Latent Condition	Unsuitable material
			1.3	$ 148,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.4	$ 29,500		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.5	$ 57,361		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	NCHD-2559	$ 160,845,292	n/a	$ -	0.0%			
	NCHD-2578	$ 28,837,721	n/a	$ -	0.0%			
	NCHD-2581	$ 49,904,982	1.1	$ 3,697,000	36.3%	Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.2	$ 3,400,000		Principal	Delay and Disruption	Insufficient geotechnical investigations prior to tender
			1.3	$ 2,480,000		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			1.4	$ 2,195,000		Principal	Delay and Disruption	Not tender ready but went to market
			1.5	$ 1,000,000		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.6	$ 758,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.7	$ 437,000		Principal	Variation Due to Scope Changes	Additional environmental items
			1.8	$ 312,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.9	$ 273,000		Principal	Delay and Disruption	Insufficient geotechnical investigations prior to tender
			1.10	$ 163,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.11	$ 3,380,018		Contractual	Notice of BCIPA Claim	BCIPA claim of costs lodged by the Contractor
	NCHD-2588	$ 4,625,225	1.1	$ 1,893,323	40.9%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
	NCHD-2594	$ 7,643,595	1.1	$ 32,844	3.9%	Principal	Variation Due to Scope Changes	Change to works due to design modifications
			2.1	$ 266,342		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
	NCHD-2599	$ 1,820,833	1.1	$ 1,299,596	93.5%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 184,052		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.1	$ 65,776		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			2.2	$ 118,705		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			2.3	$ 34,400		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
	NCHD-2601	$ 6,188,995	1.1	$ 247,587	32.7%	Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			2.1	$ 330,000		Contractor	Latent Condition	Extra works due to unexpected existing site conditions
			3.1	$ 614,000		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			4.1	$ 832,400		Principal	Delay and Disruption	Extra works due to unexpected existing site conditions
	NCHD-2617	$ 99,029,254	n/a	$ -	0.0%			
	NCHD-2771	$ 12,246,754	1.1	$ 425,378	23.3%	Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.2	$ 779,173		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 388,837		Principal	Variation Due to Scope Changes	Additional environmental items
			3.1	$ 1,256,543		Principal	Delay and Disruption	Extra works due to design omissions/error
Nth West	NWTD-582	$ 12,755,925	n/a	$ -	0.0%			
Northern	NTHD-1167	$ 28,942,535	n/a	$ -	0.0%			
	NTHD-1171	$ 4,844,220	1.1	$ 1,221,797	51.1%	Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.2	$ 75,001		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.3	$ 57,335		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.4	$ 53,652		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.1	$ 465,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			2.2	$ 195,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			2.3	$ 185,000		Contractual	Rise & Fall	Adjustment to the contract sum
			2.4	$ 150,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			2.5	$ 75,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	NTHD-1173	$ 22,975,179	n/a	$ -	0.0%			

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
	NTHD-1185	$ 2,525,269	1.1	$ 180,327	24.2%	Principal	Acceleration	Extra costs to meet key project milestones
			1.2	$ 142,730		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.3	$ 136,618		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.4	$ 61,700		Contractual	Latent Condition	Unsuitable material
			1.5	$ 22,368		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.6	$ 22,364		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.7	$ 18,164		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.8	$ 15,004		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.9	$ 6,552		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.10	$ 5,072		Principal	Delay and Disruption	Extra costs due to site access issues
	NTHD-1186	$ 7,667,201	1.1	$ 68,000	3.3%	Principal	Delay and Disruption	Extra works due to increased scheduled quantities
			1.2	$ 66,350		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.3	$ 25,884		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.4	$ 4,129		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.5	$ 19,996		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.6	$ 30,341		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.7	$ 11,324		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.8	$ 3,320		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.9	$ 23,752		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	NTHD-1234	$ 4,920,034	1.1	$ 3,006,035	124.4%	Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.2	$ 174,411		Contractual	Latent Condition	Unsuitable material
			1.3	$ 46,583		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.4	$ 10,597		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.1	$ 760,184		Contractual	Latent Condition	Unsuitable material
			2.2	$ 709,862		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			2.3	$ 29,717		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.4	$ 25,630		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.5	$ 18,645		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			2.6	$ 9,417		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.7	$ 7,663		Principal	Variation Due to Scope Changes	Additional environmental items
			2.8	$ 5,393		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.9	$ 2,744		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			3.1	$ 1,080,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			3.2	$ 135,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			3.3	$ 100,000		Contractual	Rise & Fall	Adjustment to the contract sum
	NTHD-1237	$ 79,192,858	1.1	$ 157,000	5.6%	Principal	Latent Condition	PUP conflict unknown at time of tender
			1.2	$ 787,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.3	$ 200,000		Principal	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.4	$ 600,000		Principal	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.5	$ 600,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.6	$ 582,000		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.7	$ 222,000		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.8	$ 218,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.9	$ 80,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.10	$ 126,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.11	$ 35,000		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			1.12	$ 43,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.13	$ 750,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
	NTHD-1242	$ 1,457,116	n/a	$ -	0.0%			
	NTHD-1243	$ 2,476,753	1.1	$ 299,146	4.0%	Principal	PUP Identifed During the Contract	Change to works due to stakeholder management
			1.2	$ 200,854		Contractual	Latent Condition	Unsuitable material
			1.3	$ 100,000		Principal	Excepted Risks	Extra costs due to excessive wet weather
	NTHD-1318	$ 6,657,031	1.1	$ 450,000	63.7%	Stakeholder	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.2	$ 300,000		Stakeholder	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.3	$ 200,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.4	$ 200,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.5	$ 100,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.6	$ 100,000		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.7	$ 50,000		Principal	Delay and Disruption	Extra costs due to site access issues
			1.8	$ 50,000		Contractual	Latent Condition	Unsuitable material
			2.1	$ 496,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			2.2	$ 400,000		Stakeholder	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			2.3	$ 349,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			2.4	$ 304,944		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			2.5	$ 290,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			2.6	$ 258,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			2.7	$ 225,000		Principal	Delay and Disruption	Extra costs due to site access issues
			2.8	$ 213,000		Principal	Delay and Disruption	Extra works not included in original scope
			2.9	$ 155,000		Principal	Delay and Disruption	Additional environmental items
			2.10	$ 150,000		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			2.11	$ 36,025		Principal	Acceleration	Extra costs to meet key project milestones
			2.12	-$ 1,000		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			2.13	-$ 8,000		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			2.14	-$ 25,000		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
			2.15	-$ 50,000		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
	NTHD-1345	$ 2,428,592	n/a	$ -	0.0%			
South Coast	SCHD-2797	$ 48,972,372	1.1	$ 14,800,000	58.0%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 5,494,217		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.2	$ 2,215,865		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			3.1	$ 1,353,009		Principal	Latent Condition	Extra works due to unexpected existing site conditions
			3.2	$ 700,000		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			3.3	$ 553,800		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			3.4	$ 448,500		Principal	Variation Due to Scope Changes	Change to specification/product type
			3.5	$ 240,000		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			3.6	$ 170,000		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			3.7	$ 95,057		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			4.1	$ 1,781,738		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			4.2	$ 257,638		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			4.3	$ 245,539		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			4.4	$ 65,793		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	SCHD-2873	$ 2,732,338	1.1	$ 825,900	34.8%	Principal	Delay and Disruption	Extra works due to unexpected existing site conditions
			1.2	$ 76,410		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.3	$ 49,731		Contractual	Rise & Fall	Adjustment to the contract sum
	SCHD-2924	$ 12,588,229	1.1	$ 1,570,000	32.0%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.2	$ 870,000		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.3	$ 800,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			1.4	$ 458,000		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			1.5	$ 194,000		Contractual	Rise & Fall	Adjustment to the contract sum
			1.6	$ 130,000		Contractual	Rise & Fall	Adjustment to the contract sum
	SCHD-2947	$ 25,380,113	1.1	$ 1,143,614	30.0%	Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			1.2	$ 382,277		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.3	$ 94,430		Contractual	Rise & Fall	Adjustment to the contract sum
			2.1	$ 3,236,226		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			2.2	$ 1,131,000		Principal	Delay and Disruption	Extra works due to increased scheduled quantities
			2.3	$ 1,116,884		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			2.4	$ 506,245		Contractual	Rise & Fall	Adjustment to the contract sum
	SCHD-2988	$ 14,197,694	1.1	$ 1,099,000	15.9%	Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			1.2	$ 1,150,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.3	$ 344,000		Principal	Variation Due to Scope Changes	Not tender ready but went to market
			1.4	$ 140,000		Contractual	Rise & Fall	Adjustment to the contract sum
			1.5	-$ 480,185		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
	SCHD-3000	$ 9,423,930	1.1	$ 226,070	2.4%	Principal	Variation Due to Scope Changes	Additional complementary works to an existing NDRRA contract
	SCHD-3024	$ 13,996,823	n/a	$ -	0.0%			
	SCHD-3033	$ 7,845,296	1.1	$ 2,841,763	36.2%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
	SCHD-3061	$ 5,158,444	1.1	$ 2,017,436	40.9%	Contractual	Latent Condition	Extra works due to unexpected existing site conditions
			1.2	$ 84,380		Contractual	Rise & Fall	Adjustment to the contract sum
			1.3	$ 7,079		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	SCHD-3144	$ 3,981,802	n/a	$ -	0.0%			
	SCHD-3163	$ 2,529,476	n/a	$ -	0.0%			
	SCHD-3164	$ 11,139,929	n/a	$ -	0.0%			
	SCHD-3165	$ 2,440,369	n/a	$ -	0.0%			
	SCHD-3166	$ 6,107,102	1.1	$ 160,000	2.6%	Contractual	Latent Condition	Extra works due to unexpected existing site conditions
South West	SWTD-744	$ 6,381,725	1.1	$ 1,766,364	36.8%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 582,911		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	SWTD-888	$ 27,860,000	1.1	$ 303,226	28.9%	Principal	Variation Due to Scope Changes	Extra works not included in original scope
			2.1	$ 4,330,000		Contractual	Delay and Disruption	Insufficient geotechnical investigations prior to tender
			2.2	$ 1,569,000		Contractual	Delay and Disruption	Extra works due to unexpected existing site conditions
			2.3	$ 43,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			2.4	$ 21,000		Contractual	Latent Condition	Unsuitable material
			3.1	$ 1,777,069		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			4.1	$ 11,614		Principal	Variation Due to Scope Changes	Change to works due to design modifications
	SWTD-1002	$ 8,041,272	1.1	$ 62,000	37.5%	Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.2	$ 340,000		Principal	Latent Condition	Extra works due to unexpected existing site conditions
			2.1	$ 550,830		Principal	Variation Due to Scope Changes	Change to works due to design modifications
			2.2	$ 543,194		Contractual	Latent Condition	Unsuitable material
			2.3	$ 268,557		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			2.4	$ 200,700		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			2.5	$ 150,000		Principal	Variation Due to Scope Changes	Change to works to avoid traffic management issues
			2.6	$ 91,472		Principal	Variation Due to Scope Changes	Extra costs due to Principal supplied items
			2.7	$ 90,693		Principal	Delay and Disruption	Change to works to avoid traffic management issues
			2.8	$ 49,366		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			3.1	$ 159,714		Principal	Variation Due to Scope Changes	Insufficient geotechnical investigations prior to tender
			3.2	$ 33,370		Principal	Variation Due to Scope Changes	Extra works due to design omissions/error
			3.3	$ 107,760		Principal	Delay and Disruption	Extra works due to unexpected existing site conditions

Contract and Variation Data Analysis Sheet

District	Contract Number	Original Contract Value	Variation Number	Variation Cost	% Variation of Contract Value	Source	Type	Reason
			3.4	$ 60,900		Principal	Limits of Accuracy	Extra works due to increased scheduled quantities
			3.5	$ 304,050		Principal	Variation Due to Scope Changes	Change to works due to design modifications
Wide Bay Burnett	WBYD-0808	$ 20,080,047	1.1	$ 542,000	6.3%	Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.2	$ 296,000		Principal	Variation Due to Scope Changes	Additional environmental items
			1.3	$ 109,000		Principal	Variation Due to Scope Changes	Additional environmental items
			2.1	$ 313,000		Principal	Variation Due to Scope Changes	Extra works not included in original scope
	WBYD-0878	$ 2,595,565	n/a	$ -	0.0%			
	WBYD-1001	$ 4,553,101	1.1	$ 212,927	17.6%	Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.2	$ 198,862		Contractual	Latent Condition	Unsuitable material
			1.3	$ 146,618		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.4	$ 117,661		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.5	$ 50,737		Contractual	Latent Condition	Unsuitable material
			1.6	$ 8,000		Principal	Variation Due to Scope Changes	Additional environmental items
			2.1	$ 37,217		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			2.2	$ 27,657		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
	WBYD-1066	$ 8,511,056	n/a	$ -	0.0%			
	WBYD-1071	$ 3,581,102	n/a	$ -	0.0%			
	WBYD-1095	$ 3,825,000	1.1	$ 621,000	28.0%	Principal	Variation Due to Scope Changes	Change to works due to design modifications
			1.2	$ 296,300		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.3	$ 70,500		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.4	$ 25,000		Principal	Variation Due to Scope Changes	Extra works not included in original scope
			1.5	$ 22,800		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.6	$ 17,300		Stakeholder	Variation Due to Scope Changes	Change to works due to stakeholder management
			1.7	$ 11,300		Principal	PUP Identifed During the Contract	PUP conflict unknown at time of tender
			1.8	$ 5,800		Principal	Variation Due to Scope Changes	Extra works to enhance safety
	WBYD-1105	$ 1,486,097	1.1	$ 95,900	20.7%	Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.2	$ 82,064		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			1.3	$ 53,000		Principal	Variation Due to Scope Changes	Insufficient survey investigations prior to tender
			1.4	$ 23,600		Contractual	Latent Condition	Unsuitable material
			1.5	$ 15,000		Principal	Variation Due to Scope Changes	Extra works due to increased scheduled quantities
			1.6	$ 14,500		Principal	Variation Due to Scope Changes	Change to works to enhance quality
			1.7	$ 9,550		Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
			2.1	$ 67,457		Contractual	Latent Condition	Insufficient geotechnical investigations prior to tender
			2.2	-$ 53,326		Principal	Variation Due to Scope Changes	Savings due to reduction of work items
	WBYD-1128	$ 1,205,131	1.1	$ 118,192	9.8%	Principal	Variation Due to Scope Changes	Extra works due to unexpected existing site conditions
	WBYD-1156	$ 4,116,404	n/a	$ -	0.0%			
Totals	111	$ 1,410,136,020	529	**$ 258,387,455**				

Appendix C

Variation Reasons (FAP Raw Data)