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Contractor Performance on Mega Projects – Avoiding the Pitfalls

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CONTRACTOR PERFORMANCE ON MEGA PROJECTS – AVOIDING THE PITFALLS

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ABSTRACT

The Tier 1 contractors operating in the Australian marketplace have consistently failed to deliver their financial targets on mega projects. Although these organisations have theoretically developed expertise in delivery, been governed by astute directors, employed the best leaders, paid top salaries, and developed dependable systems, the industry has delivered disastrous financial outcomes and their results on mega projects have continued to erode shareholder value.

To quantify the scale and impact of financial failures in the industry, this study examined the performance of infrastructure mega projects in Australia since 2000, as well as the personal experiences of business executives and project leaders.

Analysis of the results from the mega projects studied indicates that on average, each completed project has posted a loss of 16%. This suggests that each project destroys its original 9% profit margin plus a further deterioration of 7%. This represents a loss of A$215m on an average project size of A$1.32b. Australian contractors have incurred losses of A$6b on mega projects completed between 2000 and 2015 and, if nothing changes, will potentially lose a further A$11b on current mega projects that will be delivered between 2015 and 2020.

A project delivery model was designed to provide a set of tools that executives can use to select project leaders and build project teams that have the skills and knowledge to eliminate the technical causes of these financial failures. The model was developed and tested on a series of infrastructure projects ranging over a period of five years.

The model is robust, simple to use and can be successfully applied to a diversity of project locations, types and sizes. The results achieved by the model are exceptional and provide contractors with a way of avoiding the pitfalls of delivering mega projects.

KEYWORDS

mega projects, contractors, financial, disaster, construction

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INTRODUCTION

The Australian infrastructure sector has experienced a considerable boom in mega projects since 2000. For the purposes of this study, a mega project is defined as a project greater than A$500m in value, this value being the final accounted revenue for the project on the contractor's balance sheet. Figure 1 shows the remarkable increase in individual project values over this period. In 1990, the largest single project tendered in Australia was worth A$50m. By 2000 this had grown to A$500m and in 2015 it was of the order of A$8b, an increase of 1,500%.

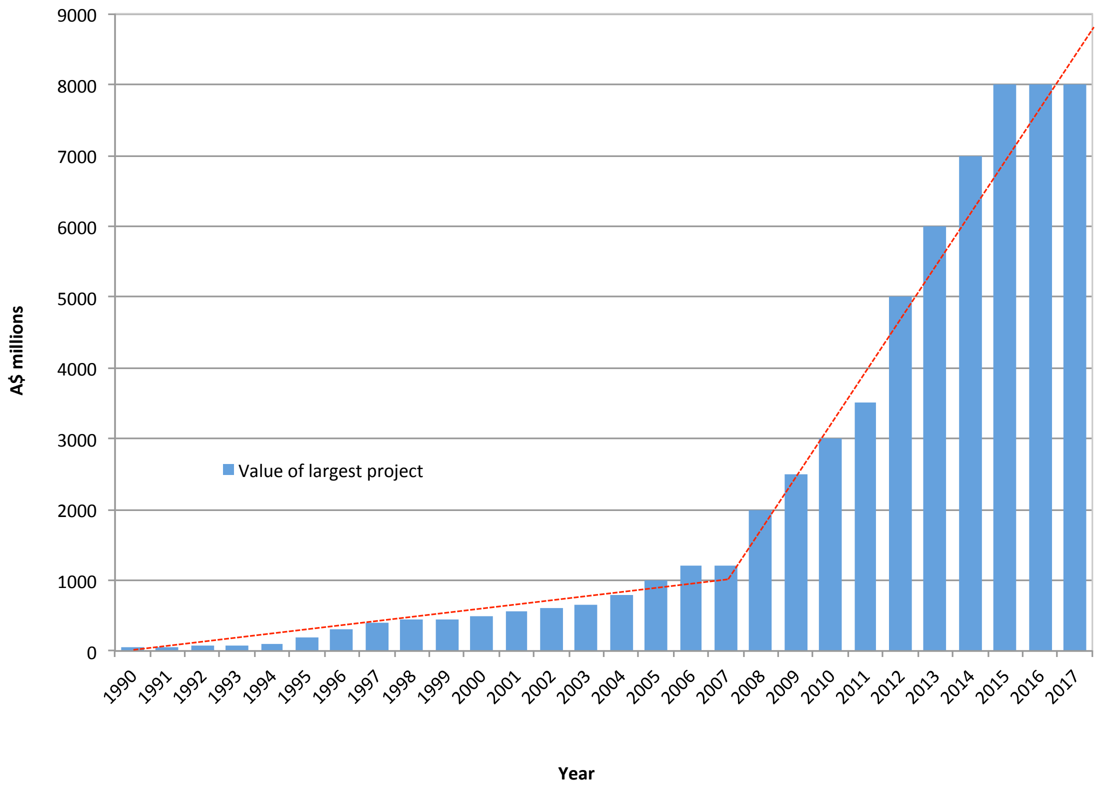

Figure 1: Value of the largest infrastructure project tendered in Australia, 1990–2017

Although project values have increased, the principal contractors for these projects have not been as successful financially as they are when delivering contracts in their traditional range of A$50m–A$250m. In fact, there is reliable evidence to show that contractors operating in the Australian marketplace have consistently failed to deliver their tendered financial targets on the majority of mega projects since 2000. Now that the Australian infrastructure sector has grown and evolved to become one of the world's most sophisticated markets (Siemiatycki 2009), there is a pressing need to understand the problem of these continuing financial failures from the contractor's perspective.

While contractors have theoretically developed expertise in delivery, been governed by astute directors, employed the best leaders, paid top salaries, and developed dependable systems, the industry has delivered disastrous financial outcomes and their results on mega projects have continued to erode shareholder value.

The risk of financial failure on mega projects is more significant than is generally realised and will continue to increase unless some form of corrective action is taken.

Many explanations have been put forward for the financial failure of mega projects. Some of the factors that have been studied include a lack of collaboration between the contracting parties (Alam, Kabir and Chaudhri 2012); weak project governance (Willems 2014); inequitable risk transfer in contracts (Ng and Loosemore 2007); inferior risk management practices (Kangari and Riggs 1989); deficiencies in project time and cost management (Garemo, Matzinger and Palter 2015); poor productivity (Kumaraswamy and Chan 1995); design problems and design-induced rework (Love *et al*. 2008); industrial relations disputes (Productivity Commission 2014); legal issues and claims (Kumaraswamy 1998); optimism bias (Flyvbjerg 2006 and 2007); and strategic misrepresentation (Wachs 1990).

While the lessons learned from project failures are known to be documented and distributed internally within contracting organisations, financial failures on mega projects occur repeatedly. The existence of failures is generally internalised to avoid negative impact from the media, the stock exchange (if publicly listed) and shareholders. In other words, lessons learned are held closely by senior project leaders and are generally not openly distributed, even internally. Intellectual property associated with such learnings is rarely shared externally to benefit the wider industry.

Conducting research into the performance of the construction industry depends heavily on the availability of financial data at both company and project level. Duffield (2008) notes that it is difficult to obtain reliable financial results from past and current mega projects, largely because of the lack of cost information and the commercial-in-confidence nature of the actual project data held by contractors. This problem limits the ability of all industry participants to learn from past mistakes and make future improvements.

STUDY AIM AND METHODS

The aim of this study was to examine the hypothesis that the risk of financial failure when delivering mega projects in Australia will increase as projects become larger and more complex, and to test whether this risk can be significantly reduced by changing the way people are selected for project teams.

The research undertaken for this study is based on a combination of personal industry experience, supported by actual project data from contractors and one-on-one conversations with the senior executives who have delivered most of the mega projects in Australia since 2000. The cooperation of these executives enabled invaluable open-book access to confidential data for the explicit purposes of this study. As a result, the research has allowed the actual final profitability of all the mega projects delivered in Australia in the road, rail, water and social infrastructure sectors since 2000 to be calculated and analysed.

As there is virtually no information in the public domain on project financial performance from the contractor's point of view, the purpose of collecting financial data was to establish an accurate baseline for what has actually occurred on mega projects. As much information as possible was obtained from original sources, namely through internal management reports and personal communications with executives and project directors from Australian contractors.

To triangulate the data with personal observations, focus group sessions were conducted with a mix of contractor and client executives. Project leaders with direct profit and loss accountability on Australia's largest infrastructure projects were also interviewed, which helped to validate the results of the financial analysis. The results from the interviews provided the material for the construction of a project delivery maturity model. This model identifies five stages of maturity between 'business as usual' and best practice for the key factors that influence project financial performance.

From the project delivery model, a project leadership maturity model was created to develop an understanding of how individual performance relates to project performance. These two maturity models allowed a new type of personnel selection model to be developed and tested on live projects in the Australian construction industry between 2011 and 2016. The results revealed a good correlation between the model outputs and project financial performance, with the potential to effect a significant change in contractors' financial performance.

THE AUSTRALIAN INFRASTRUCTURE MARKET

Between 2001 and 2015, Australian infrastructure construction activity more than doubled in value, mainly due to sharp increases in the construction of transport, water and energy infrastructure. Although the value of transport construction has decreased since its peak in 2013–2014, overall infrastructure activity has remained high, with A$23b in engineering and construction activity occurring in 2014–2015 (BITRE 2016). Figure 2 shows the inflation-adjusted value of infrastructure construction activity since 1987.

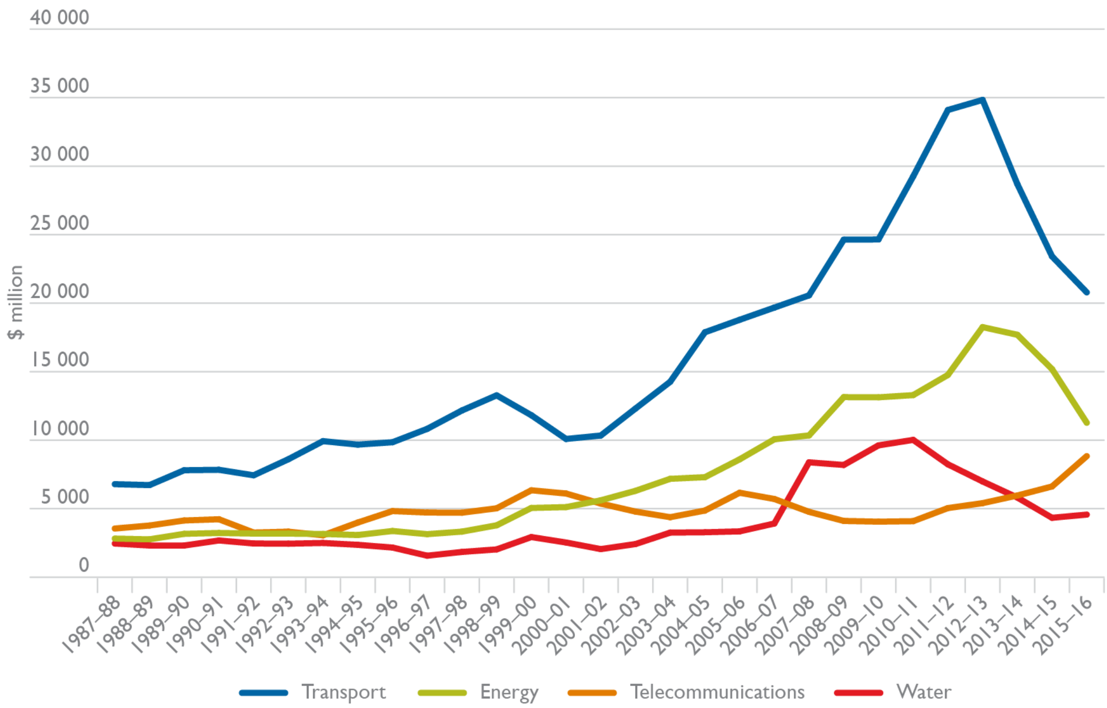

Figure 2: Infrastructure construction activity in Australia

According to the Productivity Commission (2014), the money spent on public sector construction projects has been equivalent to more than 2% of GDP since 2008. Much of this has involved roads, subdivisions, bridges and electricity infrastructure. There has also been a significant amount of investment in water infrastructure such as desalination plants and social infrastructure such as hospitals.

By far the largest source of revenue generated in the Australian construction industry comes from engineering construction in the resources sector, which accounted for an estimated 46.3% of the total revenue of A$327b in 2014–15 (Kelly 2014b). Since then, this sector has contracted somewhat as the global demand for minerals has declined and major developments have reached completion. The second largest sector is the residential building market, with 23.3% of total revenue, and public engineering construction (mainly road, rail and telecommunications projects) is third with 14%.

Estimates of future expenditure on infrastructure range from an estimate made in 2014 of A$80b (Infrastructure Australia 2013a) to an overall project pipeline of approximately A$400b for the period between 2010 and 2020 (IPA 2007). Figure 3 is a forecast made by BIS Shrapnel (2016) which extends the horizon of future road and rail mega projects out to 2025. This shows that the value of work that will be delivered in 2019 will be almost four times the previous two peaks in 2009 and 2011.

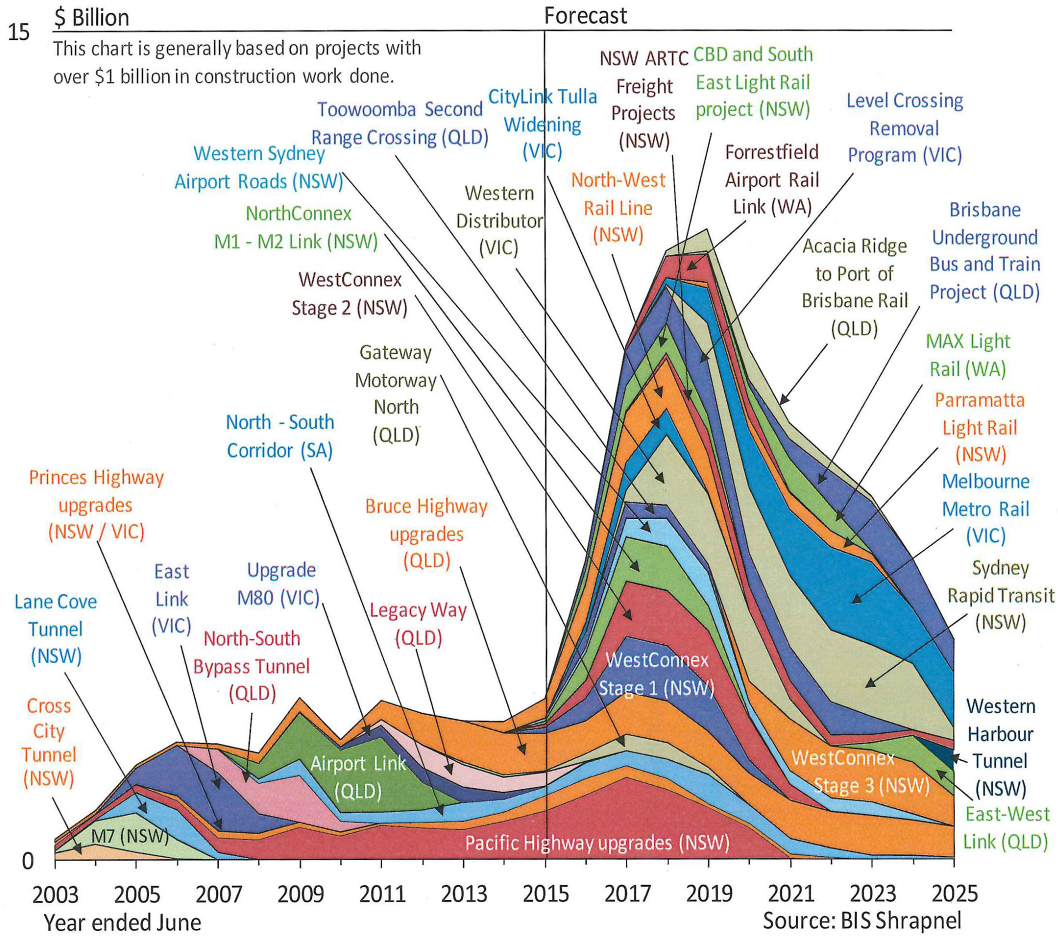

Figure 3: Major road and rail projects in Australia 2003-2025

TIER 1 CONTRACTORS AND MARKET CONSOLIDATION

In order to understand the Australian construction industry, it is necessary to look at the contractors that operate in it. Mega projects are generally undertaken by Tier 1 engineering and construction contractors, which are defined in this study as those with annual average revenues greater than A$1b. These contractors operate mainly, but not exclusively, in the infrastructure sector. They have been involved in 86% of the completed mega projects studied and are expected to be involved in at least 82% of the mega projects in the pipeline between 2016 and 2025. 'Involvement' in this context means either being the head contractor for a project or a participant in a project joint venture.

Cimic (formerly known as Leighton Holdings), Lend Lease and John Holland are the three main players in the Australian infrastructure construction market, especially where large and complex projects are concerned.

A process of consolidation within the industry has been occurring since 1983, when Thiess was brought into the Leighton Holdings group. Leighton Holdings made its next acquisition in 2000 with the purchase of 70% of John Holland, which was then a privately-owned company. In 2003, John Holland acquired Transfield Construction; two years later it bought the assets of Walter Construction after its German parent company, Walter Bau AG, filed for bankruptcy.

Leighton Holdings increased its stake in John Holland to 99% in 2004 and finally moved to 100% in 2007. In 2015, the infrastructure construction business of Thiess was merged with Leighton Contractors to create a new entity called CPB Contractors. At the same time, John Holland was divested to China Communications Construction Company Ltd (CCCC), a company that is 64% owned by the Chinese government.

Lend Lease also has merged several operating entities into a single brand. In 1999 Lend Lease commenced by acquiring the project management company Bovis from P&O, but its expansion through acquisition largely rests on the purchase of Valemus Group in 2011. Valemus Group itself was created from a merger of Abigroup, Baulderstone and Conneq (formerly Bilfinger Berger Services).

Figure 4 shows how these contracting entities have progressively consolidated since the early 1990s. This process of consolidation has meant that of the eight companies that existed in 1993, only three survive today. Moreover, three companies that were Tier 1 contractors in their own right (Thiess, Baulderstone and Abigroup) no longer exist as separate brands in the construction sector. While Cimic continues to use the Thiess brand in Australia and internationally, its activities are entirely confined to contract mining.

For an explanation of why the Tier 1 companies have consolidated, it is necessary to look at the increasing size and number of mega projects. As projects become larger, contractors must increase their size, capacity and buying power to match them. Larger projects offer contractors the prospect of greater profits as a result of economies of scale, which is also a stimulus for consolidation. However, the combination of increased risk transfer and the 'win at any cost' competitiveness that emerges during bids for mega project frequently leads to financial failure, as this study shows.

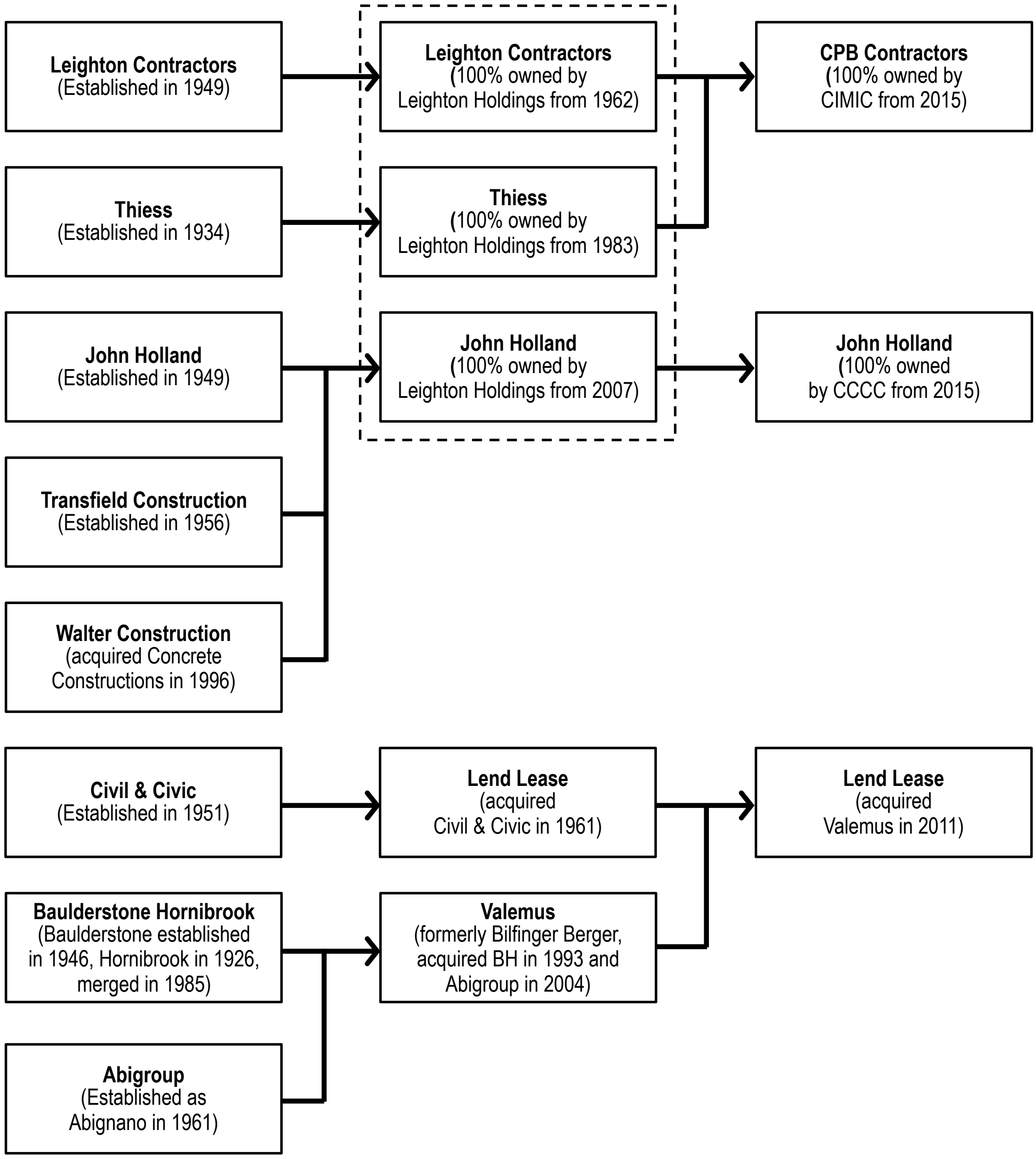

Figure 4: Consolidation of Tier 1 contractors in Australia

PROJECT DATA

Approximately 250 infrastructure projects were initially identified as potential candidates for investigation as part of this study. The sources of information for this data set were IPA (2007), Duffield (2008), Jefferies and McGeorge (2009), Duffield and Xu (2010) and the researchers' own personal data base of project information which has been collected over several years.

The method applied to select the projects for study is crucial to establishing an unbiased test of the relative performance of the projects in the sample (IPA 2007). Accordingly, a sieve approach was adopted for project selection as shown in Figure 5.

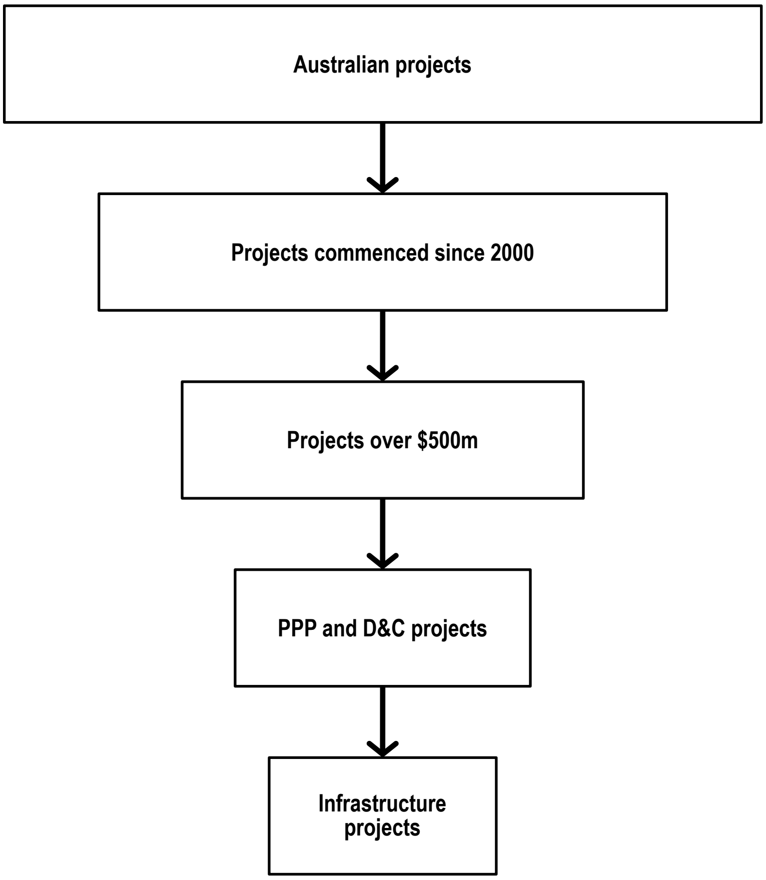

Figure 5: Project selection method

The sample selection method used the following five criteria:

Criterion 1: Projects completed in Australia. This criterion was chosen because of Australia's international position as a leader in the delivery of public-private partnership (PPP) projects (Siemiatycki 2009).

Criterion 2: Projects commenced after 2000. This date was chosen because it corresponds with a sustained period of above-average growth in individual project size. It also provides a selection of projects undertaken before and after the global financial crisis of 2008. Cost data for these projects also appeared to be more reliable than for projects commenced before 2000.

Criterion 3: Projects with a significant capital cost, as these are the ones that are at greatest risk of financial failure. The cut-off value for mega projects was A$500m. A separate group of minor projects with contract values less than A$500m was also examined for comparison purposes, but it was found that most minor projects are financially successful and were therefore excluded from this study.

Criterion 4: Projects procured via PPP and design & construct contracts. These were chosen because they pose the greatest risk for financial failure from the contractor's viewpoint and because they involve significant risk transfer from the client to the contractor. Two managing contractor projects were also included for comparison purposes. Alliance projects were omitted from the project sample because of the 'cost plus' nature and low risk profile of alliancing.

Criterion 5: Projects for private and public sector clients in the road, rail, water and social infrastructure sectors. These sectors were chosen because they involve mature technologies and relatively proven construction methods. Projects in the information technology, telecommunications, energy and resources sectors were excluded because their technical characteristics and risk profiles cannot easily be compared with those in the chosen sample.

The resulting sample of 50 projects is comprehensive and representative of contracts awarded to Tier 1 infrastructure contractors since 2000. Of these, 28 are completed projects (with commencement dates from 2000 to 2015), while 22 are current projects (with commencement dates from 2015 to 2020).

Figure 6 and Figure 7 respectively show these completed and current mega projects in timeline format, ordered by commencement date.

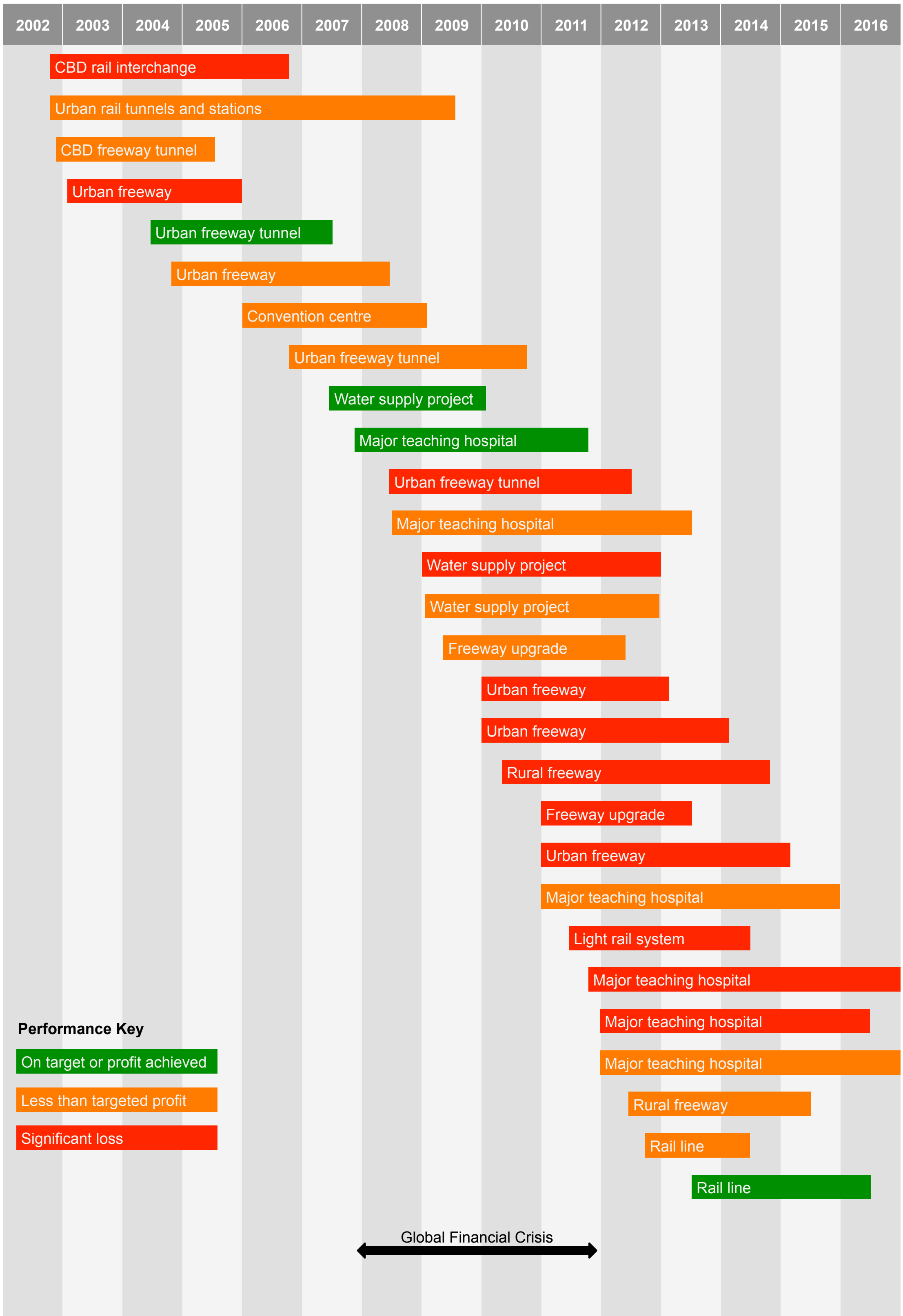

Figure 6: Completed projects timeline

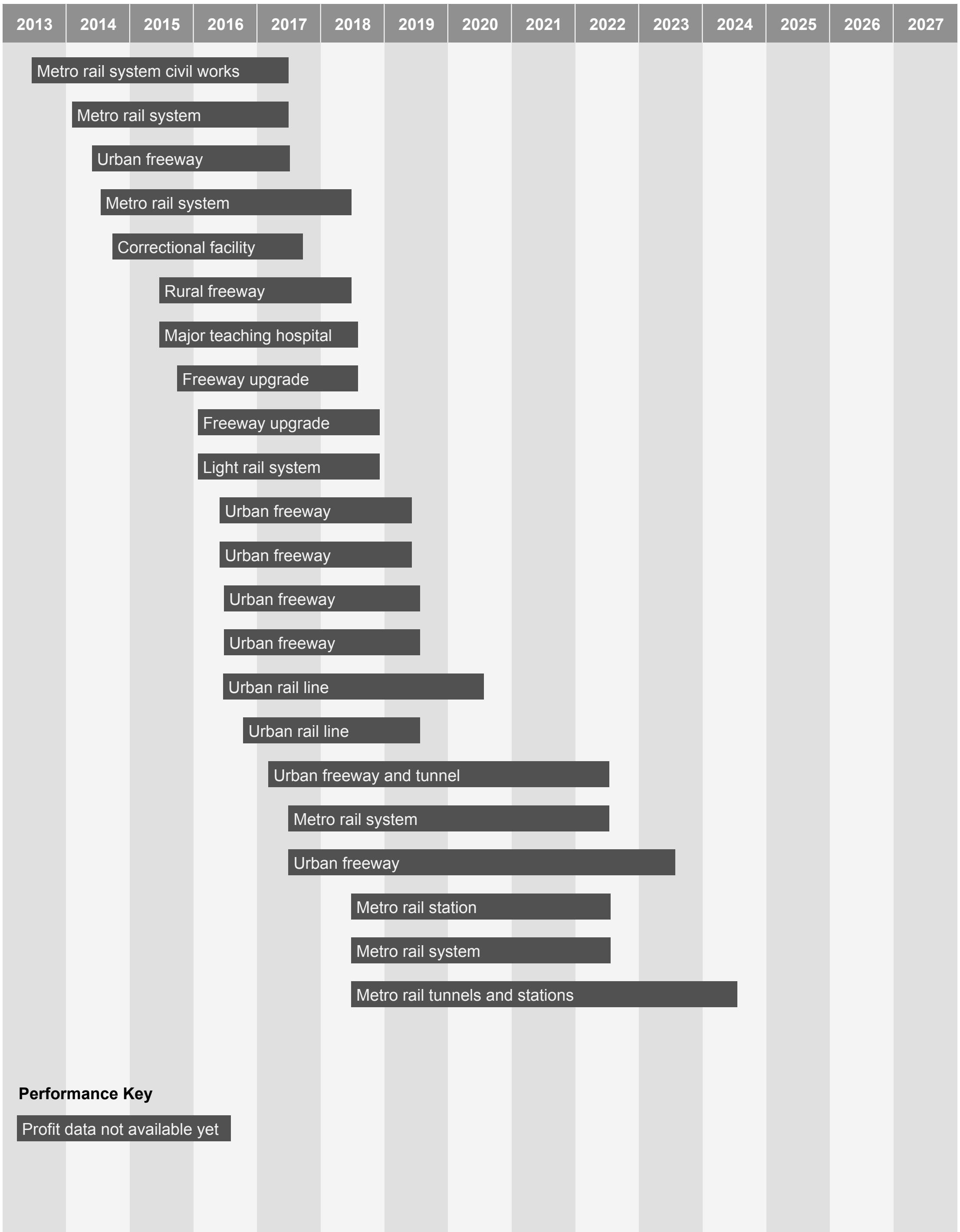

Figure 7: Current projects timeline

Table 1 and Table 3 respectively summarise the profit outcomes on the completed and current mega projects. The project names and exact contract values in these tables have been anonymised in order to protect the confidentiality of the data.

In the tables and the analysis that follows, the term 'tendered profit' is the gross project profit that the contractor expected to make on the project at tender time. 'Final profit' is the gross project profit that the contractor actually achieved at project completion.

The net profit is the difference by which the contractor's final loss or profit varied from the tendered profit. For example, if the tender estimate allowed for a profit of 10% on a project and the contractor achieved 10%, then the net profit is reported as zero. If only 5% was achieved, the net profit is negative 5%. Losses are shown in red and enclosed in brackets.

The reason for expressing changes in profits in this way is that the continuous disclosure obligations of Australian corporations law require companies to declare all market-sensitive events such as contract wins and extensions to the Australian Stock Exchange. Since the profit margin in each contract is included in the price declared to the exchange, share investors have a reasonable expectation that these profits will be achieved and value the stock accordingly. Contractors also factor their profit expectations into the overall costs of running the business, making investment decisions and managing staff numbers, while corporate lenders use profit performance to decide whether to extend lines of credit, so failure to achieve a tendered profit margin presents a real and significant business risk.

Completed Projects

Table 1: Performance of completed projects

Project ID	Contract value band (refer Table 2)	Tendered profit (A$m)	Tendered profit (%)	Final profit (A$m)	Net profit (A$m)	Net profit (%)
1	1	67	10%	(110)	(177)	(26%)
2	2	84	7%	84	0	0%
3	2	70	7%	20	(50)	(5%)
4	4	315	9%	(1,200)	(1,515)	(43%)
5	1	35	6%	11	(24)	(4%)
6	1	33	7%	(120)	(153)	(31%)
7	1	40	8%	38	(2)	(0%)
8	3	251	11%	40	(211)	(9%)
9	1	54	9%	(20)	(74)	(12%)
10	2	124	8%	(25)	(149)	(9%)
11	2	100	9%	100	0	0%
12	1	90	9%	95	5	1%
13	1	60	9%	0	(60)	(9%)
14	1	40	6%	(240)	(280)	(39%)

Project ID	Contract value band (refer Table 2)	Tendered profit (A$m)	Tendered profit (%)	Final profit (A$m)	Net profit (A$m)	Net profit (%)
15	1	79	8%	15	(64)	(6%)
16	1	68	9%	25	(43)	(6%)
17	1	59	7%	45	(14)	(2%)
18	2	140	8%	50	(90)	(5%)
19	2	196	12%	120	(76)	(4%)
20	1	85	10%	(230)	(315)	(37%)
21	2	161	11%	(90)	(251)	(17%)
22	5	483	10%	(1,050)	(1,533)	(31%)
23	3	200	10%	65	(135)	(6%)
24	1	66	10%	66	0	0%
25	2	137	7%	(200)	(337)	(18%)
26	1	83	10%	(170)	(253)	(31%)
27	2	131	12%	30	(101)	(9%)
28	2	77	7%	(30)	(107)	(10%)
Total	**–**	**3,328**	**9%**	**(2,681)**	**(6,009)**	**(16%)**

Current Projects

To forecast the final profit and net profit for the current projects, the completed projects listed in Table 1 were divided into six bands and the average net profit percentage was calculated for each band, as shown in Table 2.

Table 2: Profitability forecast for current projects based on averages of completed projects

Band	Contract value range (A$m)	Net profit (%)
1	500-1,000	(14%)
2	1000-2000	(8%)
3	2000-3000	(8%)
4	3000-4000	(43%)
5	4000-5000	(31%)
6	5000-6000	(37%)

These averages were then used to derive the dollar value estimates for net profit and final profit for the current projects, as shown in Table 3. Interestingly, this resulted in a significantly higher estimated average loss for current projects (28%) compared with the actual average loss for completed projects (16%).

Where the tendered profit for current projects is known, it is also shown in Table 3. For projects that have not yet been awarded, a tendered profit of 10% was assumed.

Table 3: Performance of current projects

Project ID	Contract value band (refer Table 2)	Tendered profit (A$m)	Tendered profit (%)	Final profit (A$m)*	Forecast net profit (A$m)*	Forecast net profit (%)*
29	1	40	8%	(32)	(72)	(14%)
30	1	46	8%	(36)	(82)	(14%)
31	5	450	10%	(944)	(1,394)	(31%)
32	5	500	10%	(1,356)	(1,856)	(37%)
33	1	65	10%	(28)	(93)	(14%)
34	1	38	7%	(40)	(78)	(14%)
35	1	40	8%	(32)	(72)	(14%)
36	3	297	11%	84	(213)	(8%)
37	4	407	11%	(1,195)	(1,602)	(43%)
38	6	550	10%	(1,492)	(2,042)	(37%)
39	2	135	10%	23	(112)	(8%)
40	4	320	10%	(1,065)	(1,385)	(43%)
41	1	45	9%	(27)	(72)	(14%)
42	3	270	9%	(1,029)	(1,299)	(43%)
43	1	90	9%	7	(83)	(8%)
44	1	90	9%	7	(83)	(8%)
45	1	72	12%	(14)	(86)	(14%)
46	2	96	8%	(3)	(99)	(8%)
47	2	92	8%	(3)	(95)	(8%)
48	1	59	9%	(35)	(93)	(14%)
49	1	89	9%	(53)	(141)	(14%)
50	2	94	8%	(3)	(98)	(8%)
Total	**–**	**3,884**	**10%**	**(7,265)**	**(11,149)**	**(28%)**

* estimated values

DATA INTERPRETATION

To determine whether there are any patterns that can be discerned from this data, the correlations between profitability and contract date, contract value, market sector, location, procurement model and contractor size were studied in detail. A selection of these results is presented below.

Revenue vs Profitability

Figure 8 shows that the cumulative expenditure on mega projects since 2000 will reach almost A$77b by 2020, while Figure 9 provides a cumulative plot of the profitability of mega projects from 2000 to 2020.

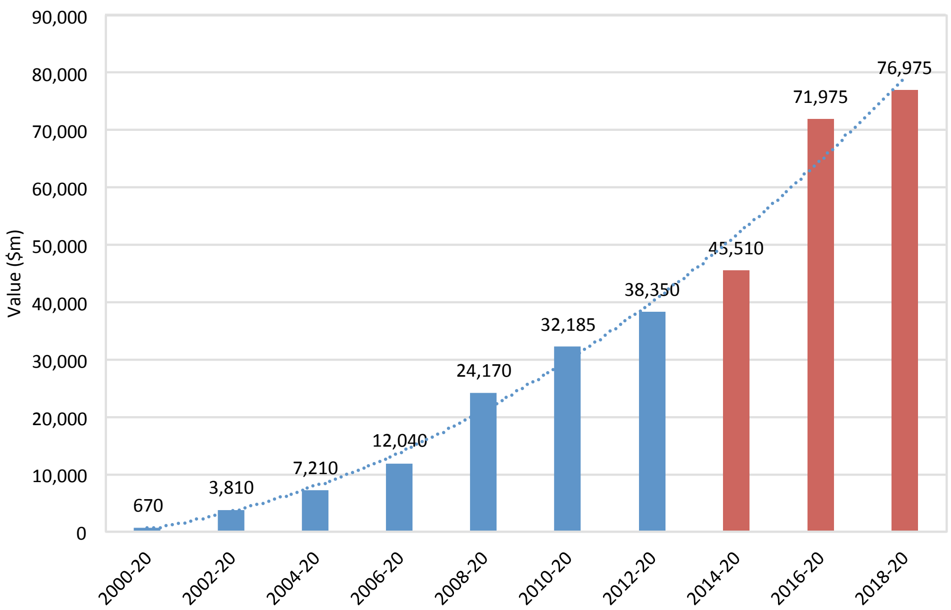

Figure 8: 2000–2020 completed and current expenditure: 2 year interval, cumulative

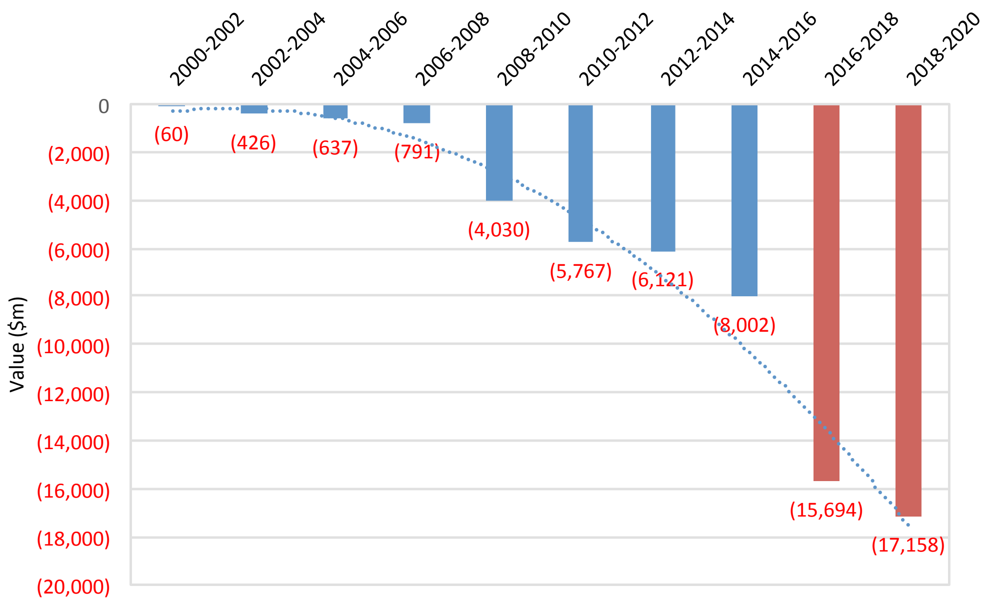

Figure 9: 2000–2020 completed and current projects profitability analysis: 2 year interval, cumulative

The inverse correlation between project value as shown in Figure 8 and profitability as shown in Figure 9 does little to provide confidence in the ability of contractors to make a profit from delivering the pipeline of mega projects between 2016 and 2020. If the trend of financial performance observed on completed projects continues, the combined losses of contractors could reach approximately 28% by 2020. The real outcome could be worse than this, because for most of the period between 2005 and 2012, the Tier 1 contractors were earning above-average profits from their other activities in the contract mining, oil and gas and telecommunications sectors, which cushioned their balance sheets from the losses being incurred on infrastructure projects. If the losses on the scale forecast by this study are realised, there could be a further massive wave of consolidation among Tier 1 contractors in the following years.

Projects by Market Sector

Figure 10 shows the market share of completed (2000–2015) projects across the four industry sectors that are the subject of this study, while Figure 11 shows the corresponding market share of current (2015–2020) projects.

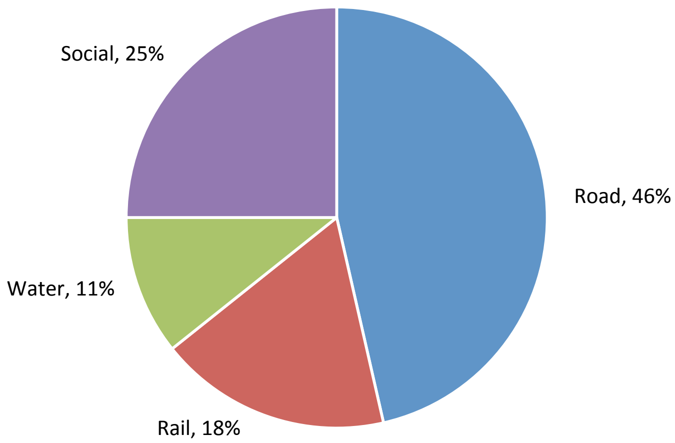

Figure 10: 2000–2015 completed projects by market sector

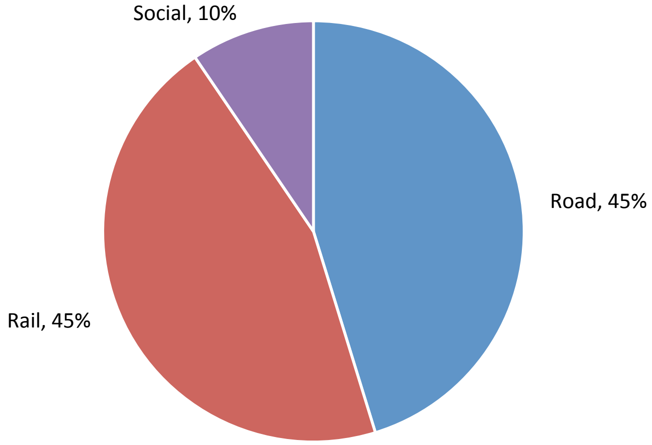

Figure 11: 2015–2020 current projects by market sector

Interestingly, there are no mega projects in the water sector forecast to 2020. This is partly because the desalination plants built between 2000 and 2015 are sized to provide capacity for many years into the future and partly because the end of the drought in 2010 replenished water storages in eastern Australia. Similarly, the large teaching hospitals built around Australia in the same period would appear to have satisfied the demand for major health facilities, which accounts for the decline in the proportion of social infrastructure.

Projects by Procurement Model

Figure 12 shows the market share of completed (2000–2015) projects by procurement model, while Figure 13 shows the corresponding market share of current (2015–2020) projects.

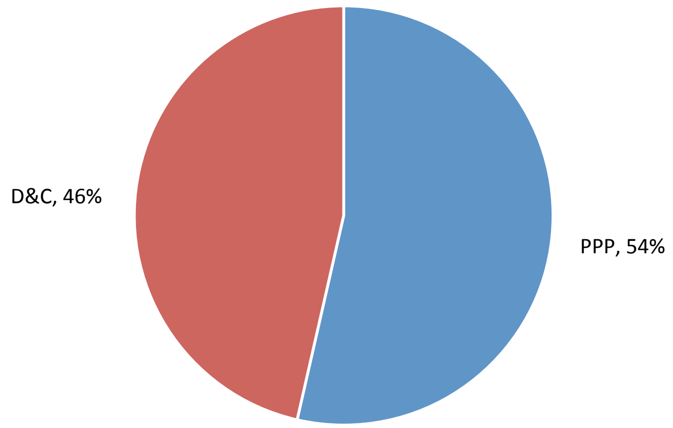

Figure 12: 2000–2015 completed projects by procurement model

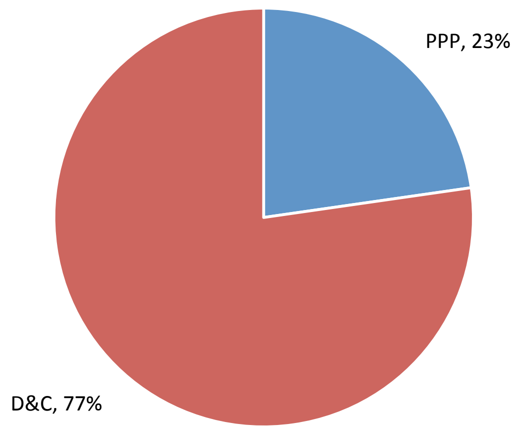

Figure 13: 2015–2020 current projects by procurement model

This data shows that the proportion of PPP contracts will fall to 23% of the total by 2015–2020. This is because there are fewer current mega projects being delivered in Victoria, which has been a champion of PPPs since their inception in the early 2000s. Conversely, more projects are being delivered in New South Wales, where the government has prioritised the design & construct model.

OBSERVATIONS

The data on the financial failure of mega projects is alarming. The financial outcomes on the 28 completed projects sampled ranged from a 1% profit to a 43% loss. Clearly the downside potential of delivering mega projects far outweighs the opportunity to exceed the original expectations. Another way to view this statistic is that the average gain for profitable projects was 0.13%, whereas the average deficit for loss-making projects was minus 18%.

Only 14% of projects achieved or bettered their tendered profit margin, with the best improvement being an insignificant A$5m. This is in stark contrast to the 7% of projects which each lost more than A$1b. Although there was a difference in the proportions of PPP (54%) and design & construct (46%) projects in the sample, both failed to achieve their tendered profits by a similar margin.

The average loss across all completed mega projects since 2000 is 16%, which suggests that each project destroys its original 9% profit margin plus a further deterioration of 7%. In dollar terms, this represents an average loss of A$215m for every completed mega project (based on an average project size of A$1.32b) since 2000. The actual individual project losses ranged from A$2m to A$1.5b. In total, this translates into an almost unbelievable A$6b loss to the balance sheets of the contractors involved.

This problem is particularly pertinent to the Australian infrastructure industry, given the extent and magnitude of the financial losses that could affect the industry. Mega projects contribute approximately 50% of a Tier 1 contractor's revenue and profit for any given year, therefore any change in their financial forecasts has a dramatic impact on corporate profitability.

Approximately A$40b of current mega projects that fit the criteria for this study are planned to be delivered between 2017 and 2024. As noted above, the contractors delivering mega projects have lost A$6b from their balance sheets since 2000. Based on an average 16% loss and a A$40b project pipeline, corporate losses on mega projects will continue to be significant. The exact amount will depend on the performance of the contractors and what proportion of the A$40b pipeline is delivered through the design & construct and PPP procurement models but, if current trends continue, corporate losses on these projects since 2000 could potentially reach A$17b.

If anything, it seems likely that the trend of losses will accelerate because the same tier of contractors are operating in the market, they are being managed by the same group of executives and they are being pressed by their clients to accept greater levels of project risk than ever before. As of mid-2017, the signs from current mega projects seem to confirm this. For example, one of the stages of the Sydney Metro Northwest rail project has reportedly forecast a loss of A$200m or 40% of its contract value, while one of the stages of the WestConnex motorway project has forecast a loss of A$100m or 20% of its contract value.

PROJECT LEADER INTERVIEWS

The observations from the data analysis were somewhat unexpected and suggested that something other than contractual risk transfer and technical factors could be causing mega projects to fail financially. One possibility is that the calibre of the people who lead and undertake these projects may be one of the determining factors of financial performance.

In the Australian construction industry, the pool of leaders with experience in mega project delivery is quite small. These leaders tend to move readily between employers, based on the attractiveness of projects and the rewards offered to them. In most cases, the accountability model of Australian contractors allows executives to bid and deliver projects without any direct consequences. The actual results may not be known until months or even years after the commencement of the mega project, by which time the project leader will have moved elsewhere. Therefore, there is a possibility that repeated financial failures are the result of the same group of people making the same mistakes.

The context and subtlety of these observations led to the next step in this study, which involved detailed interviews with key construction industry executives to understand their views as to why projects are failing to deliver their expected profits.

Leaders at project director level and above were interviewed individually to collect their personal observations of the causes of project financial failure. A focus group made up of project leaders from both clients and contractors was also convened to gather information from participants who were not available to participate in the one-on-one interview format. Notes of all the responses were recorded and transcribed before being given to the participants to seek their comment and permission to use as part of this study.

As Figure 14 shows, approximately 75% of the interview participants were in roles that have accountability for profit and loss either at the business unit or project level, for example general managers, operations managers and project directors. These are the roles that have the direct ability to determine financial outcomes on projects. The other 25% were chief executives and chief operating officers, who have accountability for corporate financial performance but typically have no involvement at project level.

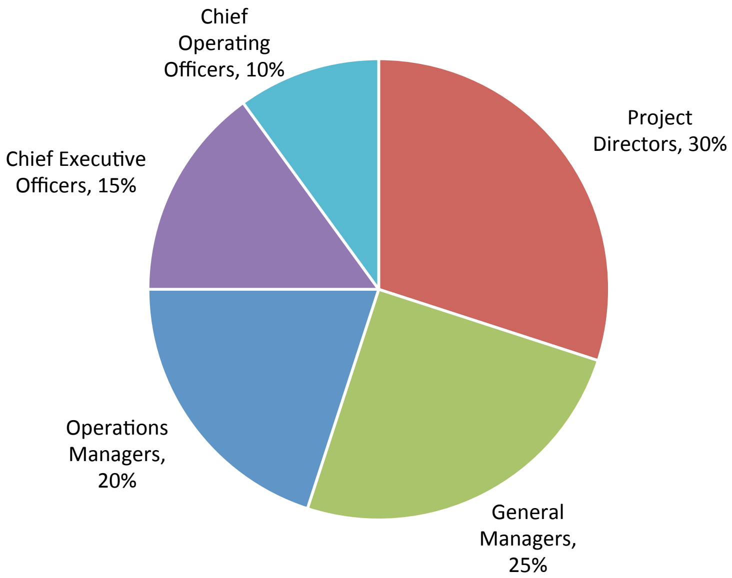

Figure 14: Interview participant diversity

The interviews covered a broad range of topics, including people and team selection, leadership, governance and accountability, team culture, design and engineering, client relationships, inclement weather, industrial relations, latent conditions, ego and optimism bias. As well as responding to the questions put to them, interviewees were given the freedom to voice subjective opinions and feelings on any other aspect of project delivery. The interviews yielded a rich collection of qualitative information that helped to resolve the focus of the study on to people factors and leadership. Although not all of the information could be used, this provided the basis for the construction of a project delivery maturity model as shown in Table 4.

The first step in creating this model was to extract from the interviews observations that would help define the key project delivery factors. A strong consensus was observed among the interviewees on which factors were the most relevant to mega projects. The result is a model that summarises five levels of maturity in project delivery. Each level represents the adoption of an increasingly comprehensive and effective set of related solutions for addressing the reasons why financial failure occurs on mega projects. As well as informing this study, the model can also help project leaders in the construction industry to identify performance gaps, establish performance targets and define achievable paths for improvement for future projects.

The information gathered from this part of the study is obviously subjective, but extremely insightful when considering the decision making environment for project leaders. When taken in context with the project data, the results of the interviews confirmed that people and leadership are indeed highly significant factors in the success or failure of mega projects.

While this conclusion helped to progress this study, it raised two other questions, namely whether there is a way to optimise the process of selecting project leaders and teams, and whether they can be tested during the delivery phase to ensure they remain the right people for their roles.

Table 4: Project delivery maturity model

Factor	Level 1 Foundation	Level 2 Basic	Level 3 Value adding	Level 4 Mature	Level 5 Best practice
People and teams	People are selected for project teams on the basis of availability, without regard to project-specific selection criteria. Poorly performing individuals are rarely terminated.	Project-specific selection criteria are identified but not fully documented or consistently applied when forming project teams.	Selection criteria are documented, widely understood and consistently applied. External candidates are sought if existing people do not meet the criteria.	People are selected for key roles on their ability to innovate and add value as well as their technical competency.	All key roles are filled by people with superior skills. Career progression and succession are embedded in project organisation plans.
Leaders and leadership	Focus on achieving short-term objectives and external requirements. Use of authority to suppress alternative views. Avoidance of conflict and challenge.	Adherence to leader's own personal value system. Focus on efficiency and compliance with standards. Efforts to improve technical procedures and techniques.	Adherence to value system collectively agreed with project team. Pursuit of results and outcomes rather than efficiency only. Proactive solutions to problems. Management of complexity and diversity of views.	Increased understanding of complexity, system connections and unintended consequences of decisions. Ability to play different roles in different contexts.	Process and goal oriented. Ability to work with both chaos and order. Mentoring and development of other potential leaders. Creation of 'win-win' relationships and outcomes.

Factor	Level 1 Foundation	Level 2 Basic	Level 3 Value adding	Level 4 Mature	Level 5 Best practice
Team culture	Minimal accountability expected of team members. Relationships are cordial but superficial. Collective sense of mission is limited. Individuals are unable to repeat their past achievements.	Commitment to reasonable standards and achievement but team members resist being pushed out of their comfort zone. Few deep, enduring relationships.	Strong focus on results and moderate focus on relationships. Competitive environment directed to achievement of external goals.	Solid level of focus on results and a satisfying focus on relationships. Team members are committed to being successful and are willing to work hard to achieve at higher levels.	Unified sense of mission and purpose. Team members are fully empowered and aligned with the project goals. They have high standards and provide each other with candid and frequent feedback.
Design and engineering	Design and engineering outputs meet the project requirements but processes for development are not standardised. Cost and/or finish dates often vary from forecasts.	Processes, services and outputs are managed efficiently to satisfy specified requirements, standards, and objectives. Status of the design work and the delivery of services are visible to management at defined points.	Processes and services are well characterised and understood, and are described in standards, procedures, tools, and methods. Specific processes are tailored to suit the particular project.	Quality of processes and outputs is measured across the project. Objectives are based on the needs of the client and stakeholders. Feedback from construction teams supports improved decision making in design.	Processes are continually improved to provide agile and innovative design. Designers are able to continually respond to changing project priorities and objectives, and contribute to managing process improvement.

Factor	Level 1 Foundation	Level 2 Basic	Level 3 Value adding	Level 4 Mature	Level 5 Best practice
Risk management	Recognition exists that risks need to be managed, but risk management processes are fragmented and inconsistently applied.	Risk analysis is conducted early in the project but is not carried over from bidding to delivery as a continual management process. Uncertainties in project program, cost and benefits are not accurately quantified.	Defined risk analysis and management process, with efforts appropriate to risk significance. Some sources of risk are not accurately quantified in terms of probability and consequence.	Clear accountability and ownership of risks. Risks are monitored and evaluated as part of the project management process. Risks that affect the whole project are quantified and well understood.	Risk management underpins all decision-making throughout the project. Ability to mitigate risks and realise opportunities is enhanced by innovative forecasting and analysis methods.
Client relationships	Client requirements are understood and documented at the start of the project. Subsequent client issues are managed reactively as problems or opportunities are identified.	Interfaces with relevant functions within the client's organisation are defined and understood. Client relationships are managed from a technical perspective. Sharing of knowledge and data with the client is limited to monthly reporting.	Principles of client engagement are widely understood and accepted. Project governance is carried out jointly. Client organisation is engaged with project team at multiple levels of responsibility and accountability. Executives provide active and informed support.	The client's business drivers are known and used to inform decisions that determine the balance of risks and benefits across the delivery of the project.	Client engagement is embedded in the contractor's culture and client management processes are optimised to respond to dynamic changes in client needs and preferences.

MODEL TESTING AND VALIDATION

The culmination of this study is a model that is designed to reduce the risk of financial failure when delivering mega projects by ensuring that each role on a project is filled by the best person for the job at every stage of the project's life cycle. The model developed for this purpose is called the ‘A+ model’. The term ‘A+’ comes from a management philosophy pioneered by Meg Whitman, the former President and CEO of eBay between 1998 and 2008. In essence, this philosophy says that achieving extraordinary performance requires every member of a management team to be a star performer; in other words, an ‘A+’ person.

Creation of the A+ model was based on the outputs of the project delivery maturity model and a correlation of the performance of project leaders and teams with the financial performance of the projects to which they are assigned. It was first developed at a leading Australian Tier 1 contractor in 2011 and then tested on 17 different construction projects over five years from 2011 to 2015 inclusive. It was initially applied on projects that were already in varying stages of completion, ranging from 25% to over 60% complete. As newer projects commenced, it was applied from project inception onwards.

Although the A+ model is not the first model to have been developed to select people for their roles in an organisation, it differs from conventional human resources models in that it is focused precisely on the connection between individual performance and project performance, rather than the broader relationship between an organisation and its employees. The aim of the A+ model is to provide criteria for choosing leaders and team members in a way that will ensure a reliable prospect of financial success. The criteria are based on individual levels of previous achievement, measured against a range of role-specific key performance indicators that can be correlated with superior financial outcomes.

As a precursor to creating the personnel selection model, a project leadership maturity model was developed to define the attributes of average, good and exceptional performance in individuals. The attributes defined in this model were based on a combination of the project delivery maturity model and the interviews with industry executives and leaders. The industry leaders contributed to the interpretation of the project delivery model, which was necessary for the project leadership model to be populated with measurable performance indicators. The model is shown in Table 5.

The congruence between the project leadership model in Table 5 and the project delivery model in Table 4 provided sufficient confirmation that this model would be an appropriate tool for studying and rating the performance of project leaders and team members.

Table 5: Project leadership maturity model

Key performance indicator	A- (average performance)	A (good performance)	A+ (exceptional performance)
Profit	Has achieved at least 1x green sheet profit on two of previous three projects	Has achieved average of at least 1x green sheet profit across previous three projects	Has achieved average of at least 2x green sheet profit across previous three projects
Time	Has delivered two of previous three projects on or ahead of practical completion date	Has delivered previous three projects on or ahead of practical completion date	Has delivered previous three projects an average of 4 weeks ahead of practical completion date
Quality	Cost of defects-related rework exceeded 15% of profit margin	All defects resolved before end of defects liability period	Has achieved zero or minimal defects at practical completion date
Safety	LTIFR[3] >1.0 or an improvement notice received from a statutory safety authority	LTIFR = 1.0 with no improvement notices	LTIFR <1.0 with no improvement notices
Environment	EIFR[4] >1.0 or an improvement notice received from a statutory environmental authority	EIFR = 1.0 with no improvement notices	EIFR <1.0 with no improvement notices
Client and stakeholder engagement	Has received no negative feedback from client or stakeholders	Has received positive or complimentary feedback from client	Has received positive or complimentary feedback from both client and at least one external stakeholder
Project value	Has had sole accountability for projects or work packages up to A$100m in value	Has had sole accountability for projects or work packages up to A$200m in value	Has had sole accountability for projects or work packages over A$200m in value
Project experience	Has at least 5 years' experience at project manager level or above	Has at least 10 years' experience at project manager level or above	Has at least 15 years' experience at project manager level or above

[3] Lost Time Injury Frequency Rate (Australian Standard 1885.1 – 1990)
[4] Environmental Incident Frequency Rate

Key performance indicator	A- (average performance)	A (good performance)	A+ (exceptional performance)
Project diversity	Has held role of project manager or senior project engineer on at least two different project types	Has held role of project manager on at least three different project types	Has held role of project manager on at least four different project types
Team size	Has managed project teams up to 20 people excluding subcontractors	Has managed project teams up to 50 people excluding subcontractors	Has managed project teams over 50 people excluding subcontractors
Optimism	Personal level of optimism or pessimism depends on external circumstances and events	May be optimistic or pessimistic depending on the circumstances, but is able to envision and communicate optimistic outcomes	Capable of inspiring optimism in others without becoming unrealistic about the possible outcomes of actions and events
Lessons learnt	Has applied project-related processes, procedures or techniques in conformance with company requirements	Has championed incremental improvements in project-related processes, procedures or techniques	Has championed 'step change' improvements to company-wide processes, procedures or techniques

Development of the A+ model progressed through several stages. To begin, an experienced selection panel comprising five executives of the Tier 1 contractor involved were asked to assess all the project managers and project directors in the organisation on their past performance in project delivery. In addition to financial outcomes, the assessment also considered a range of key performance indicators as shown in the project leadership maturity model presented in Table 4. The performance indicators for project leaders were written so that they aligned with the key performance indicators for the business as a whole.

From the resulting assessment, each project leader was assigned one of three ratings:

- A+ for exceptional performance (coded green)
- A for good performance (coded amber)
- A- for average performance (coded red).

The principal aim of the model was to create teams with only exceptional leaders, recognising that an average or even a good leader would not be able to deliver success on a complex mega project.

Project managers also assessed their direct reports in terms of performance against their key result areas in their position descriptions, and rated them according to a similar system. This was repeated down the reporting line until every person in every project team, right down to graduate engineers, had been assessed and assigned a rating. At first, it was thought that variations in different leaders' interpretation of the guidelines might introduce excessive variability into the ratings. However, ratings of the same individuals by different project managers proved to be consistent enough to give objective results. One manager who was involved in the implementation described the rating system in these terms: ‘An A+ person is someone you would take with you to the next job; an A- person is someone you wouldn’t hire again’.

The results were plotted on a series of colour coded organisation charts which showed at a glance which positions were held by which rating. Targets were established for each reporting level. To simplify the analysis, only three reporting levels were considered. This was considered appropriate for project delivery organisations, which are typically flat in nature. The targets are shown in Table 6. The ultimate objective was to achieve these targets for all project teams, all functional support teams and the business as a whole.

Table 6: Team composition targets

Level	Role	Target
1	Project Leader	= A+ person
2	Direct reports to Level 1 (i.e. the project leader)	>70% A+ people
3	Direct reports to Level 2	>50% A+ people
–	Entire team	>60% A+ people

The A+ model was evaluated by comparing how well projects scored on their A+ targets with their financial performance, as measured by comparing the actual profit margin with the tendered profit margin (in the Australian construction industry, this is colloquially called the ‘green sheet’). This measure is a way of expressing the actual profit margin as a multiple of the tendered margin. For example, if a project has a tendered profit margin of A$10m and achieves A$20m, this is expressed as ‘2x green sheets’, while A$30m is ‘3x green sheets’ and so on. A loss is reported as zero.

As soon as a project score fell into the amber or red zones, the project organisation was re-examined. Project leaders were reviewed at the beginning of every quarter and if a leader was given an A or an A- rating in two consecutive quarterly reviews, he or she was replaced. Project leaders in turn were responsible for removing or redeploying underperforming staff to ensure their teams achieved the targets.

The A+ model was extensively tested on a total of 17 projects ranging from A$10m to A$1b in value over a period of five years from 2011 to 2015 inclusive. The results are provided in Table 7, which shows the correlation between the ratings provided by the A+ model and the financial performance of these projects as measured by the profit multiplier. The project names have been anonymised to protect the confidentiality of the data.

Table 7: A+ model ratings and project performance

Project type	Team A+ percentage			Rating (A+, A or A-)	Profit multiplier at 100% complete
	25% complete	50% complete	75% complete		
Minerals processing plant	39%	72%	100%	A+	200%
Renewable energy	38%	76%	83%	A+	100%
Health care	78%	78%	78%	A+	600%
Ground remediation	67%	67%	67%	A+	800%
Training centre	57%	65%	65%	A+	150%
Commercial offices	64%	64%	64%	A+	200%
Port infrastructure	64%	64%	64%	A+	200%
Greenfield rail line	29%	62%	64%	A+	100%
Telecommunications	19%	61%	63%	A+	200%
Light rail depot	63%	63%	63%	A+	200%
Freeway widening	61%	61%	61%	A+	100%
Rail upgrade	43%	51%	55%	A	150%
Health care	38%	31%	42%	A	0%
Museum	40%	35%	41%	A	0%
Rail substation	14%	19%	41%	A	(100%)
Rail interchange	21%	26%	38%	A-	(300%)
Renewable energy	42%	28%	35%	A-	(300%)

As Table 7 shows, there is a strong correlation between the rating and the profit multiplier. The A+ average is 259%, the A average is 50% and the A- average is negative 233%. That is, a great team can produce 2.5 times the green sheet profit, an average team returns half the green sheet profit and a poor team loses an average of 2.3 times the green sheet profit.

Limitations of the Model

Notwithstanding the observed success of the interventions based on the model results, it is not always possible to create an A+ team for every project. Many factors may contribute to this inability such as project location, timing, availability of resources, relationships, bureaucracy, organisational politics and so on.

Although a maturity model has been established to select key people, instinct can still play an important role in personnel selection and team building. In addition, the model and its outputs need to remain confidential within the organisation. If the model is not kept confidential (at executive level) then the culture of the business could be negatively impacted.

Many elements affect the success of a project. While the A+ model is a powerful tool for managing a project, it should not be considered the only way to build a high performing team.

CONCLUSIONS

Market Competition and Consolidation

There is a significant disconnect between client and contractor perceptions of how the Australian construction market operates, especially when clients are concerned about the costs of project delivery.

Australian public sector clients think that Tier 1 contractors make excessive profits from mega projects (Productivity Commission 2014), yet the contractors' annual reports generally show net profits after tax of only 3–4% and there is ample evidence of losses as high as A$1.5b on mega projects. In fact, Australian contractors make most of their money from projects that are either less than A$500m in value or procured using models other than PPPs and design & construct contracts.

Competition between Tier 1 contractors in the decade from 2005 to 2015 has had the effect of forcing consolidation in the market, which is another sign of declining rather than excessive profits. A widespread view exists in the public sector that the solution is to attract major international contractors to Australia, which will supposedly restore competition and cut the costs of building infrastructure. Some international contractors have indeed been attracted to Australia, but have generally not been successful and some have closed their operations. Moreover, when it comes to wanting a 'safe pair of hands' to deliver mega projects, public sector clients continue to prefer the same Australian Tier 1 contractors.

Although governments may think that engaging with international contractors is the solution to a lessening competitive environment in Australia, they fail to understand (or care) that the local contractors are losing money and therefore they must either increase their pricing or go out of business, leading to an overall contraction of the industry.

Risk Allocation and Management

The principle of 'risks should be allocated to the party best able to manage them' is generally held to generate the most efficient risk allocation, the lowest costs to the project and the greatest value for money for the client. The Australian experience is that governments consistently ignore this principle and try to transfer as much risk as possible to contractors. This is partly because governments are strongly motivated to achieve budget surety and partly because their legal and technical advisors promote an adversarial approach to contracting.

While this continued emphasis on transferring more risks may benefit the public sector, it does continuing damage to the construction industry as projects become larger and private sector losses become increasingly unsustainable.

The benefits of developing collaborative project relationships have been already been recognised by the financiers of PPP projects, and the next step would be for them to influence more equitable approaches to risk allocation and sharing. This is where the adoption of a hybrid PPP/alliance procurement model would be beneficial because both parties could equally manage the risk together for the best results.

Another approach that would manage both client and contractor risk more effectively is project packaging. This involves breaking up a mega project into smaller self-contained projects, with a view to distributing work across a larger number of contractors. This reduces the level of risk borne by any one contractor and promotes greater competition by Tier 2 construction companies. This study indicates that the optimal contract size is likely to be less than A$500m in value.

Subcontracting

Subcontract market conditions can have an impact on cost, time and labour productivity. In a buoyant economy, resource shortages at all levels of a project are inevitable. If head contractors resort to letting subcontracts to unproven and inexperienced firms, this can delay the project and require more engineering and procurement hours to manage it.

The availability of subcontractors becomes even more critical when the economic cycle moves upward, as it has in New South Wales and Victoria in 2017. Untested subcontractors can add significant risk to the financial success of mega projects. Even when the Australian market is stable, there is a continuing shortage of subcontractors that have the capacity to deliver large packages on mega projects.

Time Management

Clients' assumptions of delivery timelines are often highly optimistic, which places unnecessary pressure on contractors. The adverse consequences of late commencement and unrealistic timelines cascade through projects, creating a reactive environment and reducing the time for leaders to properly plan, innovate and collaborate. When time is short, contractors are unable to develop improved methods and are forced to revert to conservative and traditional ways of construction. These problems become magnified down the supply chain as subcontractors are forced to do the same.

One way to overcome this is to provide more contingency in the contract program. This allows sufficient time to select an A+ leader and source an experienced team, which reduces the contractor's exposure to liquidated damages, minimises industrial relations pressures and provides more time to innovate through collaborative design.

Cost Planning

The key to improving the accuracy of cost planning is having senior engineering estimators with experience of complex projects of similar size, type and location and who therefore can allocate reasonable contingency amounts. The chief difficulty that contractors have in tendering for mega projects is determining what amount of contingency is appropriate and how to remain competitive, which supports the use of alternative procurement models.

Collaboration

Projects whose clients adopt a 'hands-off' approach to delivery have a high probability of failure. Conversely, projects where there is a common understanding of the project requirements and a willingness to resolve problems jointly allow the client and contractor to build a stronger commercial relationship as well as to mitigate the risks that arise from uncertainties in project delivery. Achieving this means that the client needs to be 'in the tent' with the contractor. Having intermediaries between the client and the contractor, such as client-side project managers who frustrate the contractor's efforts to secure cooperation, should be avoided if possible.

Design

Design is a common contributor to project failure. Designers consistently over-design. The consequences are increased costs associated with redesign, delays to the contract program and reduced engagement from the project teams. Similarly, project leaders often fail to consider the financial consequences of scope changes. A solution is to put in place a competent commercial team from the beginning of the project to monitor the cost of scope changes and provide advice to the design manager.

Rework

Fast-tracking of projects can significantly erode project performance, as demonstrated by the Brisbane Airport Link project which is an alarming example of how costs and delays can escalate out of control. Insufficient detailed engineering was done prior to construction starting and work packages were released before they were complete, which led to many engineering changes and errors that held up the work, reduced productivity, required significant rework and generated ripple effects leading to delay and disruption throughout the entire project supply chain. While some overlap of design and construction on a mega project is feasible and indeed desirable, rework needs to be strictly controlled within a contingency allowance.

Industrial Relations

Industrial relations disputes are higher in the construction industry than in most other industries and have the potential to contribute to contractors' losses on mega projects. Knowing that head contractors risk substantial liquidated damages as a result of delays, unions routinely use the commercial risk faced by contractors as a lever to secure benefits for their members. Building in program float, as referred to above, can alleviate some of the pressures and risks associated with industrial relations.

Knowledge Transfer Between Projects

It is very difficult for contractors to share lessons on financial failures. They have no wish to reveal sensitive information that could reflect poorly on their competency or their stock market valuations, and see no commercial advantage in doing so. This explains why the contractor's perspective is found so infrequently in the literature on project performance. However, lessons learned from previous projects can be very helpful in improving processes. This openness and honesty can be difficult, but it is clearly invaluable in ensuring continuous improvement in planning and delivery.

People and Leadership

The qualitative aspects of human psychology are just as relevant as technical factors when studying the causes of mega project failure. This research suggests that although the technical and material aspects of a project can and do reduce project profitability, losses through human behaviours are very significant.

Contrary to conventional wisdom, complex projects seem to require leaders with a 'cowboy' type approach. Such leaders discard a significant amount of the prescriptive processes that exist in construction projects and introduce experimentation and curiosity. This is in sharp contrast to the conventional belief that complex projects are made up of numerous simple tasks and therefore can be strategically reconfigured into a series of manageable portions. In other words, a complex project is still complex, regardless of how a leader tries to break it up and simplify it.

Because outcomes are unpredictable in a complex context, leaders need to focus on creating an environment from which good things can emerge, rather than trying to bring about predetermined results and possibly missing opportunities that arise unexpectedly. The ability of a leader to manage uncertainty and ambiguity across a large range of situations and relationships is one of the selection criteria in the A+ model described in this study. One of the possible reasons why A+ leaders are successful is that they intuitively consider all of the opportunities in a complex project as well as the risks, and concentrate their efforts on the opportunities which then neutralise the risks.

OPTIMISM BIAS

This study suggests that while optimism bias is an observable phenomenon and has a significant influence on the accuracy of forecasting in the planning and pre-procurement phases of mega projects, it is not a proven cause of financial failure.

In the private sector, there is considerable professional status to be gained from delivering a mega project. The glamour and prestige are difficult for contractors and consultants to resist. Executives believe that if they can win and deliver mega projects, it will elevate their businesses to the highest level in the industry. This can be quite dangerous as it obscures rational thinking and proper analysis of commercial risks and returns.

In many cases, the accountability model of Tier 1 contractors allows executive decision makers to avoid any career consequences when mega projects fail. The actual results may not be known until years after the commencement of the project and by then there are plenty of technical issues or other people to blame for failure.

Compounding the problem is the tendency for leaders to attach importance to stretch targets on mega projects. While this is intended to increase team motivation, it can also encourage leaders to skew their forecasts toward unrealistic outcomes. When these forecasts become the basis for remuneration and bonuses, the practice can push employees to take greater risks.

THE A+ MODEL

Until now, the construction industry has lacked a practical model that captures the process of building, skilling and motivating a team to deliver financial success. The A+ model developed as part of this study offers a solution to this problem.

The selection and monitoring of teams is the key to avoiding financial failure, with the leader offering the highest and immediate benefit to project performance. The correlation between the A+ model outputs and the financial outcomes from the projects studied provides validation that it can be used to structure and maintain teams that will deliver outstanding performance against all key result areas on a project, not just financial performance. During the testing of the model, other improvements were observed in the form of reduced sick leave, reduced lost time injuries, closer client engagement and better stakeholder engagement. Its scalability has been demonstrated by the diversity of sizes and types of projects that were used for testing.

The success of the A+ model does not suggest that contractors fail to recruit capable leaders; it does show, however, that leaders' performance ratings can change over time, individual performance reviews are often not linked to organisational reviews and tough decisions to replace underperforming people are often delayed by optimism bias, all of which have a detrimental effect on project outcomes.

Although the A+ model is in an early stage of development, the results of this study suggest that implementation of the model across the A$40b pipeline of future Australian construction projects could result in an improvement from the current 14% of projects achieving a minimum of their tendered profit to at least 70% of projects meeting or exceeding their tendered profit, with other non-cost benefits accruing as well.

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