INTERNATIONAL
CENTRE FOR
COMPLEX PROJECT
MANAGEMENT

SUBMISSION FOR THE AUSTRALIAN GOVERNMENT'S PRODUCTIVITY COMMISSION PUBLIC INQUIRY INTO PUBLIC INFRASTRUCTURE

February 2014

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The submission is prepared with support from the following institutions:

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ACKNOWLEDGEMENTS

This Submission has been prepared by the International Centre for Complex Project Management.

We also gratefully acknowledge the contributions of the following people (in alphabetical order):

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RECOMMENDATIONS

We recommend that the Australian Productivity Commission's submission to Australian Government include a recommendation to establish a specialist research centre to address the critical issue of managing and delivering complex infrastructure projects and programs. It is proposed that the activities of the research centre should leverage off the work already conducted and coordinated by ICCPM and its research partners, and concentrate on:

- Undertaking research to identify the systemic failures, impediments and causes of the sub optimal performance in delivering major projects and programs;

- Research, design, document and deliver practical, applicable and repeatable systems, tools and approaches that are solution based and end user targeted to address the identified failures and needs; and

- Design and document training and implementation pathways to ensure the research findings are targeted and aligned for ready adoption by end users.

1. INTRODUCTION

1.1 The Opportunity

The Australian Government has an unprecedented opportunity to take a leadership role to achieve improved productivity giving a competitive and co-adaptive advantage in securing and delivering major complex infrastructure projects. Through acting as an equity co-investor in a collaborative research and development effort, the Australia Government could significantly strengthen the existing partnerships between the public, academic and private sectors, in a way similar to the Treasury model recently instigated in the UK[1].

The Australian Productivity Commission 2013 Productivity Update highlighted that Australia's productivity performance has been poor over the past decade, even when compared to other developed nations[2]. It emphasised that impediments to innovation, technological improvement and reorganisation of production must be continuously reviewed and removed. In the resource and energy sector, which typifies many other sectors, the delivery of large and complex projects (such as the construction of infrastructure) is 40% more expensive in Australia than the USA[3].

Exacerbating Australia's poor productivity there has been a major increase in the value of the Australian dollar since 2007/8. The Australian Dollar (AUD) during the 1980s and 1990s traded in the region of $2.20 to the British Pound (GBP) and $1.55 to the US Dollar (USD). While it is now trading in a region about 70-80% of its pre GFC values - a band around $1.75-1.90 AUD to the GBP and $1.08-1.24 AUD to the USD[4] - it is still high in historic terms. Australian interest rates have also remained comparatively high compared to our trading partners with the Australian Dollar being a triple A-rated currency.

During the 1980s and 1990s arbitrage along with a strong, resource/energy-based currency and high interest rates combined to leave the UK largely de-industrialised. The Australian economy faces the same risk if it does not compete favourably and co-adaptively in the Pacific Century. The step change Australia faces is that 'its future economy may be typified by a relatively secure/safe, resource-based currency with comparatively strong interest rates and high wages'. The risk for the wider economy and industry is that a strong currency and comparatively high wages means that certain sectors become increasingly unproductive and uncompetitive when compared to other countries (e.g. the automobile industry). Whereas previously Australia could maintain productivity and competitiveness through a soft currency, high interest rates and relatively high inflation, this may no longer apply. Australia's future economy may, instead, need to focus more on becoming a high-end, value added Knowledge Enterprise Economy (KEE)[5] not dissimilar to the German (pre Euro) Deutschmark economy. If infrastructure is to be an important part and enabler of the future economy, significant investment is required to improve competitiveness and productivity.

Over the past two years there have been significant changes in the manufacturing and employment landscape, particularly with the announcement of the closure of the three car manufacturers – Ford, Holden and Toyota. Such unprecedented changes in the manufacturing and employment landscape places increased pressure on the government within a market-based economy to take strategic policy decisions to bridge the national productivity, employment, industry and public confidence gaps. The projected plant closures over the 2015 to 2017 period provide a short but important window to take action.

The successful funding and completion of core infrastructure projects is a cornerstone initiative to address these gaps, and one that has been announced by the Australian Government. From the documented evidence in Australia and overseas there is an urgent need to address the points of failure in successfully implementing infrastructure projects. If we are to capitalize on the dynamic congruence between national employment, productivity and social well-being in the current window of opportunity, timely action is required.

Large and complex projects and programs are a significant component of the Australian economy, not just in the infrastructure sector. They are a characteristic of all sectors, albeit at different scales, including defence and aerospace, health, IT and services, resources and energy and the public sectors. Improvements in the management of large projects in all these sectors provide a significant opportunity to improve productivity and Australia's international competitiveness[6]. Independent modelling suggests that a 10% improvement in the performance of delivered construction projects alone could lead to an increase in Gross Domestic Product by 2.5%[7](5).

1.2 The Collaboration

The International Centre for Complex Project Management (ICCPM) has been working extensively with the international community and with leading Australian research institutions (including the University of Adelaide, Curtin University, Queensland University of Technology, University of Sydney, University of Technology Sydney and CSIRO) to improve performance in the delivery of complex projects and programs. Over the past two years the consortium has invested over $2.5m of its own resources to frame future research aimed at developing solutions to complex challenges of national significance and importance.

Through these relationships there is an unprecedented opportunity to understand how a collaborative research approach can inform and influence Australia's ability to improve the cost, competitiveness and productivity of nationally significant economic infrastructure projects, together with improved social well-being, national productivity and international competitiveness. Critically, through such relationships and collaborative arrangements key research can be identified, designed and undertaken which results in targeted, practical solutions for end user needs.

Such research and the application and implementation of their findings is a critical element missing from the current infrastructure landscape. As a result, there is an urgent need for strategic intervention and assistance if we are to break out of the Australian sub optimal performance in managing complex projects.

The collaboration, into which the Australian government is invited to participate, is currently an ICCPM/Universities/industry initiative. It will provide Australian industry with a major opportunity to leverage competitive/co-adaptive advantage through the application of the research findings and strategic implementation strategies, tools and pathways.

The capabilities of a highly skilled and educated workforce can be improved through attention to system-level characteristics that improve project management approaches to achieving a competitive advantage. Understanding and addressing the contributing elements, interconnections and functions in complex project and program management will reduce costs domestically and improve our reputation and competitive advantage globally in competing for and completing large complex infrastructure projects.

Our analysis indicates that a $4.3 million dollar annual investment for seven years by the Australian Government would leverage $30.8 million dollars of resources from industry and research institutions, and, based on previous evidence, act to generate $210 million in economic benefits over the next 15 years. The model envisaged would create increased collaboration between the public and private sectors; a more collaborative approach to improving productivity and project performance; greater visibility and transparencies (including financial performance of and between projects); improved strategic decision making and taking, as well as value for money and management of risk (both shared between the private and public sectors)[8].

Critically, such an Australian Government investment in a proposed Research Institute would be catalytic, and some would say a necessity, to address the current points of failure in undertaking major infrastructure projects within Australia and to underpinning the accelerated investment in national infrastructure projects by the private and public sectors.

Greatly increased collaboration between government, industry, the finance sector and research institutions is an imperative at this time to improve infrastructure productivity and deliver socio-economic benefits for the nation. But to be effective it must also be done with the best research, knowledge and tools available to ensure a high degree of efficiency and effectiveness.

1.3 The International Centre for Complex Project Management (ICCPM)

ICCPM was established in 2007 as an international, independent not-for-profit company with the support of the Australian, Canadian, UK and US Governments and a number of international corporations. ICCPM works with governments, industry and academia to enable the better delivery of complex projects and programs encompassing nationally significant economic infrastructure investments.

Through well-developed international relationships ICCPM has access to significant resources to help address the Australian Government's cost, competitiveness and productivity issues. Existing international relationships include those with NASA, the UK Government's Major Projects Authority and National Audit Office, the UK Major Projects Association, the European Union's NETLIPSE (Network for the dissemination of knowledge on the management and organisation of Large Infrastructure Projects in Europe), the European's MEGA_PROJECTS (an action with the objective to understand how megaprojects can be designed and delivered more effectively to ensure their effective commissioning within the European Union), the Norwegian Government's Department of Finance (responsible for the Norwegian State Project Model for infrastructure) and the International Project Management Association.

ICCPM has delivered a number of international roundtable events and reports for government and industry including the report *"Complex Project Management – Global Perspectives and the Strategic Agenda to 2025"* (Appendix 1). Launched in Parliament House in Australia, in the Americas by the Australian Ambassador to the US and in Europe by the UK Cabinet Office Minister, this report sets out strategic and action recommendations for improving the performance of complex projects and programs. The report also charts an international research agenda and has been used as the cornerstone for framing the Australian national research initiative outlined in this submission.

2. INTERNATIONAL LESSONS LEARNED

We need to be open to understanding and learning the lessons from good and bad experiences from across the globe in responding to our own major project challenges. This is not just to ensure we are gleaning best practice knowledge, but importantly, so that we can seek to push beyond current best practice and extend our capacities to deliver the next generation of capacity in thinking, design, development and execution. This will only occur with increased knowledge through research, education and training and a new wave of dedication in both the public and private sectors to break the mould of sub optimal performance and delivery of the past.

2.1 Hitachi Rail Europe Ltd – Delivering High Speed Javelin Trains

As a once in a generation infrastructure project, High Speed 1 (HS1) was the UK's first major new railway in over a century. Hitachi's Class 395 became the first high-speed passenger train in the UK, launching a preview service six months ahead of schedule in June 2009. The high speed railway connects Central London through St Pancras International, East London through Stratford International, with Ebbsfleet International and Ashford International serving Kent in the southeast of England[9].

Using the world's best international expertise, the project was completed on schedule and under budget with every contract satisfactorily closed out within two months of completion of the asset[10]. "One of the most important factors [for success] was a radically different approach to the project financing structure in terms of designing and building the railway as well as the financing and risk transfer arrangements"[11].

Public Private Partnerships (PPPs) conceived as Private Finance Initiatives (PFI) – the form of PPP used most frequently in the United Kingdom – have not always been successful. In particular the PFI has 'become tarnished by its waste, inflexibility and lack of transparency'. Learning from this experience, the HS1 Train was financed by a leasing company (HSBC Rail) and managed by Hitachi applying a revised PPP model. The success of this project led the UK Government to replacing all its conventional Diesel High Speed Trains operating in the UK (equivalent to the Australian XPT – The Intercity Express Programme). This represented a significant, shared public and private equity and risks transfer aligning to the needs of passengers and providing contractual transparencies between partners. A consortium of Hitachi Rail Europe and John Laing PLC successfully closed this contract in July 2012 after securing over £2bn of private financing[12].

2.2 UK National Audit Office – Over-optimism in Government Projects

In December 2013 the UK National Audit Office (NAO) published the report *"Over-optimism in Government Projects"* (Appendix 2) to raise awareness, prompt discussion and action to address the issues, difficulties and underlying causes of a particularly persistent risk management problem: unrealistic expectations and over-optimism in government projects[13].

The report used the NAO's back catalogue of projects to illustrate the prevalence and consequences of over-optimism and identify the contributory factors. The figure below summarises the five factors contributing to over-optimism identified in the report.

Source: National Audit Office, 2013, Over-optimism in Government Projects

In addition to these five contributing factors, the report noted that:

- Ninety-five percent of government policies are delivered through major projects and hence successful project delivery is essential to the government delivering its promises and objectives.
- Historically, the majority of major projects in government have not delivered the anticipated benefits within original time and cost expectations. Major projects are frequently reported to be failing to deliver on expected outcomes.
- The challenges of delivering government projects are compounded by the endemic over-optimism which characterises decisions to commit to projects and the subsequent management of them. This undermines the likely success of a project, often leading to substantial cost overruns, delays in completion and failure to deliver the benefits.
- The UK Civil Service Reform Plan[14] recognises that the consideration of policy and the practical implementation of it need to be brought together – "too often policy draws from too narrow a range of views and evidence, and does not ensure that policy is capable of practical implementation" and "policy makers should have a clear understanding of what works based on robust evidence".

2.3 UK Government Gold Standard

The Gold Standard set by the UK Government is an important piece of international work with wide applicability for adaption and adoption.

"Project control is vital to successful delivery of projects and our gold standards and recommendations set out in this report mean the MoD and its industry partners should have a clear idea of what they are striving for to consistently deliver successful defence projects." Sir John Bourn, 20 May 2005[15]

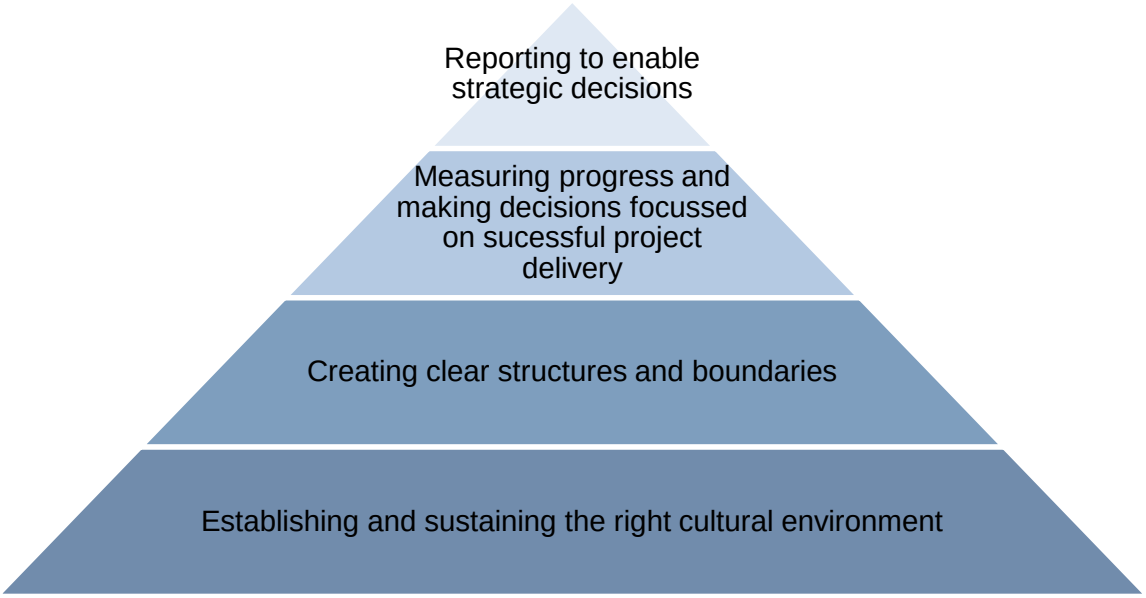
In collaboration with the Ministry of Defence (MoD), the National Audit Office are undertaking a series of studies to examine the complex cultural and systemic drivers which need to be managed for their high value defence equipment procurement projects to be delivered faster, cheaper and better. Each study[16] will:

- Examine practical evidence of how well a specific driver is being managed in the defence environment and explore how well that driver is addressed by overseas and commercial comparators.
- Compare current defence performance to a theoretical "gold standard" developed by the comparator work, against which no individual organisation is likely to perform consistently well in all areas.

The intention is to bring improvements in the defence acquisition performance and to help ensure all defence projects routinely adopt practices closer to the "gold standard"[17] (15).

The first of the series examines the effectiveness of project control on defence projects using four levels of gold standard good practice criteria. The figure below illustrates these four levels in a pyramid.

Figure 1: The Four Levels of Successful Project Control



Source: National Audit Office, 2005, Driving the Successful Delivery of Major Defence Projects

The key findings from the projects first study are[18]:

- More needs to be done to develop a supportive and open environment where staff can routinely report bad news as soon as it happens to provide early warning of problems.
- The MoD tends to towards optimistic performance setting of time and cost targets compared to private sector organisations that face similar challenges.
- The MoD uses the same set of tools and techniques for monitoring projects as similar commercial organisations but the balance between their use varies (e.g. more MoD teams uses the joint risk register).
- The MoD's newly implemented system for reporting system status is moving in the right direction and is likely to provide better, more timely and accurate management information. However, the MoD does not have a single consolidated reporting system such as that recently introduced by the US Department of Defence for reporting project status across all parts of the acquisition organisation

2.4 NETLIPSE - Lessons Learnt in Large Infrastructure Projects in Europe

There has been a strong analytical focus applied to the management and delivery of major complex infrastructure projects internationally in recent years, as typified by the detail provided in previous sections, particularly in the UK. A further example of this focus is the Network for the dissemination of knowledge on the management and organisation of Large Infrastructure Projects in Europe (NETLIPSE). It was a two year research programme which ran from May 2006 to May 2008 and was comprised of a network of member states, universities, research institutes, project delivery organisations and private consultancy companies.

The main objective of the NETLIPSE project was to set up an interactive and continuous network for large infrastructure projects (LIP) in Europe for the dissemination of experience and knowledge, specifically focussed on the management and organisational aspects of these projects. At the core of the project is the capture of knowledge that has been used to assess the quality of 15 LIPs that have been reviewed to identify best practices for other projects[19].

The results of the research are published in the book *Managing Large Infrastructure Projects*[20], with the best practices and lessons learnt categorised into the following eight themes:

1. Objectives and Scope

- Define the objectives in interaction with stakeholder
- Formulate a vision
- Translate objectives into scope, work packages and milestones
- Assess and authorise scope changes
- Use configuration management to assess the impact of scope changes
- Implement a variation procedure
- Organise adequate expertise to be able to deal with scope changes

2. **Stakeholders**

- Involve operators and industry
- Facilitate liaison with local stakeholders and critics
- Avoid mixed messages
- Reach consensus with stakeholders before tendering
- Enable the political branch to supervise the project
- Formalise responsibilities with client/sponsors
- Brand the project

3. **Financial Management**

- Use proper calculations to support decision-making
- Search for financing and funding possibilities
- Control costs and budget in relation to scope

4. **Organisation and Management**

- Address roles and responsibilities clearly: client/sponsor, project delivery organisation, contractors
- Design and implement structure for reporting and decision making
- Communication a project management policy
- Address and manage checks and balances within the project organisation
- Stay in control in a decentralised project organisation: quality management systems
- Work where the work is. Adapt the organisation to changing circumstances
- Invest in human resources and internal knowledge management

5. **Risks (Threats and Opportunities)**

- Position the responsibility for risk analysis within an independent group
- Do not forget to identify opportunities
- Share risk analyses with contractors and before tendering
- Include risks and risk reservations in cost estimations
- Use a risk database
- Rank and prioritise risks
- Make risk management part of regular management routines

6. **Contracting**

- Customise the contracting philosophy to the characteristics of the project and country
- Consider criteria other than price
- Allocate risk to the party best suited to carrying it
- Use incentives in the contract
- Equip contract managers with adequate expertise
- Cooperation is essential to a good contract

7. **Legal Consents**

- Link legal procedures and stakeholder management
- Map procedures and keep them updated
- Ensure legal expertise is available
- Communicate with authorities proactively
- Coordinate the consents and tender planning

8. Knowledge and Technology

- Be careful with experiments
- If new technology is applied, organise the management of innovation
- Organise expertise and knowledge exchange within the project organisation
- Connect with other organisations

2.5 Implications for Australian public infrastructure

The infrastructure scene in Australia, particularly when compared against projects such as the HS1 is not a positive one, as highlighted by the independent study commissioned by Infrastructure Australia. The report highlights that on average 48% of capital projects in Australia failed to meet their baseline time, cost and quality objectives[21]. Given the total public and private capital expenditure of $215bn and the assumption of 40% average cost overrun, the report concluded that the annual wastage of capital is about $30bn or 1.7% of GDP[22]. Through adopting a structured program of change and implementing the right strategies the report suggests that it is possible to improve project success by 10% in 1-2 years with a saving of $9bn/annum or 0.5% of GDP. Over a five year horizon, it is plausible to improve the success rate by 30% thus saving $17bn/annum or 1% of GDP.

If the economic value of infrastructure or return from the infrastructure is considered (assuming a nominal ROI of 5%) in addition to the cost savings perspective, then the potential annual return to the Australian economy as a result of project success rate improvement over five years could be 1.3% of GDP.

The lessons learned from the HS1 rail project are directly applicable to the Australian infrastructure landscape. For example, our research has indicated that for Australia to compete favourably as a future KEE infrastructure, investment in, amongst other things, very-high speed, integrated broadband networks provided by both fibre and microwave, is required. There is no 'one size fits all' and Australia is a market leader in both fibre optics and microwave technologies, e.g. WiFi. Infrastructure investment is also required in education, health, research, security and defence if Australia is to remain competitive across the board. Achieving this will require wider sources of access to equity and debt finance to improve value for money; increase the transparency of liabilities (created by large scale projects); enhance equity returns achieved by public and private investors; improve the productivity of Australian procurement processes, and leverage greater agility and cross-sector adaptability in the provision of services. The benefits of doing so extend to taxpayers and the revenue base as taxpayers become shareholders in infrastructure projects and receive a share in ongoing returns. By improving confidence in investment opportunities and shared returns, the Australian tax revenue base is strengthened within the global economy.

The work and findings of the UK NAO highlight the criticality of the role of government and the importance of managing the political and operational environment as well as management over optimism (managing expectations), which has been a hallmark of Australian infrastructure projects.

Accordingly, Australia needs to learn from the experience of the UK and other governments and address the key factors identified that lead to over optimism and, ultimately, project failure. The research program of the research centre, proposed by ICCPM in the

recommendations of this submission, will be based on a detailed study of international case studies, develop strategies and, critically, an education program to address the issues.

The NETLIPSE findings align closely with the results of ICCPM's review of Australian experience and the objectives of the ICCPM and its partners, as reflected through this submission. There exists the same set of drivers in Australia as there was in Europe, including a sense of urgency to break the sub-optimal performance. The research threads proposed for the research centre – tailored to Australian requirements, have been gathered through detailed workshop mapping with key industry partners and are additive to the work previously undertaken by ICCPM as part of the ICCPM Global Perspectives and the Strategic Agenda to 2025 Task Force Report[23].

Increasingly, the underlying parameters of designing, financing and delivering major complex infrastructure projects are very diverse and dynamic and, irrespective of the part government plays in the financing and construction of the projects, the Australian Government has the primary role in setting the strategic national direction and infrastructure framework that the private sector responds to. Importantly, this greatly influences the level of confidence within the private sector (onshore and offshore) to undertake project activities.

3. COMMENTS RELATED TO SELECTED ISSUES PAPER QUESTIONS

3.1 Global Views

Infrastructure Index

Investment in economic infrastructure varies dramatically across the globe. The *"Global Infrastructure Investment Index: Move from Risk to Reward"* report (Appendix 3), a regular publication by EC Harris, supports investors and asset owners in the evaluation of the potential opportunities and risks associated with each country.

The report analyses and ranks 40 countries according to their attractiveness as infrastructure investment locations based on the following key criteria:

1. Quality of existing infrastructure
2. Economic environment
3. Ease of doing business
4. Political/social environment
5. Availability of finance/financial environment

International Comparisons

EC Harris published *"The Global Built Asset Wealth Index Report 2013"* (Appendix 4) which demonstrates the distribution of the world's wealth in terms of the physical assets which contribute to a nation's productivity. The index illustrates the accumulation of buildings, infrastructure and machinery and equipment to unveil the economic divergence between 30 countries that represent 82 percent of global GDP. It also highlights how these disparities are predicted to evolve in future.

Key findings of the report[24] include:

- Total built asset wealth within the 30 countries is estimated at US$193 trillion in 2012 – this is equivalent to almost three times the US$68 trillion GDP of the same countries

in 2012. By 2022, built asset wealth is forecast to increase by 35 per cent in real terms to reach US$261 trillion.

- In 2012, the USA was the wealthiest nation in terms of built assets, with total wealth estimated at US$39.7 trillion. This is forecast to increase to US$47.2 trillion by 2022 – a rise of 19 percent.
- China is rapidly gaining on the USA and could become the owner of the world's biggest built wealth as early as 2014. For instance, by 2022 China is projected to have accumulated US$75.7 trillion in built assets.
- In Europe, built asset growth is expected to be subdued at around 2.7 percent over the next decade. In some struggling Eurozone economies, investment is forecast to fall short of asset depreciation, leading to a fall in the built asset stock.
- Despite rapid growth in emerging markets, built asset wealth per person still falls well short of that in developed economies. By 2022 China's built asset wealth per person will still be 61 percent lower than that of the USA.
- Singapore has US$156,000 in built assets for every citizen, making Singaporeans the wealthiest built asset citizens of all the 30 nations studied.
- The UK's built asset wealth of US$88,000 per person is 29 percent lower than that of other developed nations. This substantial gap suggests that the UK has significantly underinvested in built assets over many years.
- The fastest growth over the next decade is expected in the Middle East and Africa and in Asian economies as built assets are forecast to rise by 63 percent in both regions.
- This rapid expansion, combined with slower growth in the developed economies of North America and Europe, will allow these regions to continue to close the built asset wealth gap.

Intersection of Government and the Private Sector in Developing Public Infrastructure

In Western Australia, the State Government's economic rationalist reform agenda has seen a metamorphosis in infrastructure related agencies away from the design and construction of infrastructure assets to the effective management of much of this activity by private sector providers. This shift led to some unintended consequences including cost and time over-runs and assets that were not entirely fit for purpose. The design and construct contracts that were used tended to create adversarial relationships between agencies and the private sector suppliers. Following a number of poor performing projects, a Ministerial Report recommended that in the case of Main Roads WA in particular, the organisation seek to rebuild at least 25% of its design capabilities at a minimum so that it could be more than just a buyer of services, but a partner in the WA road industry. Recognition has developed amongst WA infrastructure-related agencies that there is a need to rebuild organisational capabilities as a basis for effective engagement with private sector organisations undertaking complex and often lengthy projects.

This building (or re-building) of appropriate organisational capabilities has taken a number of paths. One interesting angle is considering the type of contract used and the resultant activity boundaries of the organisation[25]. In something of a natural experiment, it was possible to consider the impact upon firm capabilities when agencies used 'make' or 'buy' options, dual modes (simultaneously making internally and buying from a supplier the same good or

service) and alliance modes (via alliance contracts). Alliance contracting as used by Main Roads WA and also Main Roads Queensland on occasion provided the greatest opportunities for learning and simultaneously removed a significant level of the conflict previously associated with design and construct contracts. These contacts were used only on the largest and most complex projects as they proved to be exceedingly resource intensive. However, they have provided the relevant organisations with a significantly enhanced capacity to engage with private sector providers and to deliver more innovative solutions – particularly in comparison to the options of straight outsourcing through tender arrangements or even attempts to complete some activity internally by bringing in qualified staff in an area.

In addition to acknowledging the complexity of contracts is the necessity of recognising the increasingly complex nature of projects[26]. Large or mega projects involve a wealth of stakeholders with different capabilities, perspectives and objectives. Building on the growing awareness of the need to attend to stakeholders, understanding who the important stakeholders are[27] and understanding their differing objectives is paramount otherwise, as noted earlier, there is a risk that assets are not entirely fit for purpose. This is compounded when managing projects that potentially span a change in government with concomitant changes in objectives and priorities. Being intelligent consumers of projects requires governmental and private sector bodies to understand more astutely some of the systemic project management considerations. For example, understanding the impact a 'change of mind' or 'series of late approvals/information' has on the overall project schedule beyond the direct costs; or recognising the complexities that emerge when projects straddle more than one jurisdiction increasing the number of stakeholders and associated objectives.

Furthermore, language can be a significant barrier impeding progress and resulting in sub-optimal project conclusion. Through using processes such as group support systems, issues relating to risks, objectives, and competences can be surfaced in an environment that promotes openness through the provision of anonymity and attends to the need to be as productive as possible as all stakeholders have competing pressures. As such a common understanding and agreed way forward can be jointly produced increasing both ownership and robustness.

3.2 Provision of Public Infrastructure – Project Governance

An independent study commissioned by Infrastructure Australia in 2013 found that poor project governance is the main cause for the high failure rate of 48% of Australian capital projects[28] and yet there has been a lack of research on the topic. Improvement in project governance over a five year period could result in significant improvement of project success rates (estimated to be by 30%) adding significant value to the Australian economy estimated to be 1.7% of GDP/annum. Additionally, delivery of complex infrastructure projects also involves governance arrangements between owners and construction contractors/service providers and requires careful consideration of institutional governance of inter-organisational projects which is often poorly managed[29]. Therefore, project governance is one of the core research themes proposed by ICCPM.

3.3 Risk

Our research indicates that for large complex projects such as public infrastructure, project-specific technical risks are usually understood, but "emerging environmental, social and political risk, which are just as important as technical factors" are less understood[30]. In

addition, the way in which these risk factors interact at the system level is insufficiently understood[31].

Research on large international infrastructure projects[32] indicates that scoping, financial projections and funding decisions are consistently biased by a powerful combination of optimism bias (psychological bias: tendency to underestimate schedule and cost, and to use the best possible scenario as a baseline) and strategic misrepresentation (political bias: project champions jockeying for position in order to secure access to a restricted funding pool). The 2013 bankruptcy of BrisConnections, operator of Brisbane's Airport Link toll road, illustrates these factors at play: the technical challenges of delivering the infrastructure were well understood and managed, but the funding and financing of the project were based on over optimistic assumptions about traffic and revenues.

There is a difference in the nature of complexity faced by greenfield developments as opposed to projects that augment existing facilities or networks. Greenfield developments face high uncertainty and ambiguity due to their newness (directional complexity) – for example, the complexity of the proposed High Speed Rail link between Brisbane and Melbourne is illustrated by the Phase 2 report (2013)[33] which details the technical, physical, strategic, organisational and financial issues associated with the creation of large scale transformative infrastructure.

Additions to existing systems usually transform existing capabilities by adding new functionality to the system (structural complexity) – for example the roll-out of the National Broadband Network adds to existing infrastructure, but by adding new functionality it also transforms how the system is used, and the availability of alternative and emergent technologies impacts roll out options and schedule[34].

One of the challenges of delivering large complex projects, greenfield or additions, is limited repeatability: "repeatability is the key to driving performance improvement over time, but it doesn't exist in major programmes. Elements are repeatable [and] past experience of repeatable elements counts but you can't assume every programme will be a repeat of the past and therefore straightforward"[35]. To our knowledge there have been no systematic comparisons of greenfield developments versus additions to existing systems for large complex projects and this creates a void in the knowledge and the capacity to devise corrective actions.

False Assumptions about the Nature of Risk in Large Projects

The Issues Paper[36] demonstrates through its language some of the prevailing risk paradigms (risk thinking) that hold ineffective risk practices in place.

An example is the statement "In principle, risks should be allocated to the party best able to manage them":

- The allocation of risks to specific parties has a seductive logic and to some extent it might be useful to have one entity accept a lead role in managing a recognised source of risk. However in complex projects most risks of significance are driven by multiple inter-related factors involving multiple stakeholders. The only possible effective approach is to collaborate.

- The assumption should be that the management of risks requires a collaborative effort to understand and respond to those risks and to maximise outcomes. This assumption is independent of the type of project and type of contractual relationship, although such factors clearly do impact on how best to collaborate.
- The same logic applies to maximising outcomes through finding and taking opportunities. It is relatively rare for significant opportunities to lie within the province of one project stakeholder.
- The concept of risk transfer is widely used to justify specific forms of contractual relationship and specific contractual clauses. However while risk transfer can be appropriate (for example by paying a fee to an insurer) in complex projects the transfer of most forms of risk is simply a re-shaping of risk and may have perverse unintended outcomes that are not visible at the time.

Accordingly, government(s) should re-think their approach to risk management in projects, in consultation with organisations such as ICCPM and the Australian Risk Policy Institution (ARPI).

Government Enforcement of Ineffective Risk Practices

Governments tend to use the application of professional standards as a way of assuring quality and performance in projects. This is the case for risk, where ISO31000 (for example) is often used as a minimum benchmark for risk management practice.

The challenge is that almost all infrastructure projects (let alone "major" projects) are too complex for ISO31000 and similar approaches to be effective. It is a guide (rather than a standard) and at best is a guide to "accepted practice" in risk management. It is not best practice, especially for complex projects.

A more effective approach to risk management in complex projects is required. In essence, this is because it is the risks not in risk registers that lead to project failure. Being better at filling in risk registers is not the answer, if only because the risks that matter are often too complex, subtle, sensitive to deal with or emergent (not yet visible) to be in a risk register.

For major infrastructure projects, as with other highly complex projects, effective performance in the face of uncertainty requires a paradigmatically different approach where:

- Contractual arrangements require, support and reward collaborative risk management behaviour between stakeholders, to better understand uncertainty and how best to deal with it as a whole.
- Suppliers and other key stakeholders are held to account for the quality of their risk management work from first principles, rather than their adherence to a standard.
- There is widespread use of systems thinking methods and tools to better analyse the root causes of complex threats and opportunities.
- Internally generated risks (such as inadequate resourcing of project teams) are recognised as root causes of risk and are dealt with accordingly.

3.4 Cost of Construction

Should Cost Modelling

In many industries it is widely recognised that the cost of the product is an important strategic factor that should be decided by management rather than by designers. However, in the UK construction industry the prevailing, traditional approach to cost estimating and modelling consists of a bottom-up cost estimate based on the proposed design, followed by a value engineering exercise to bring this cost estimate closer to a pre-set development budget. As a result of this reactive 'design pricing' approach, construction projects are frequently characterised by a costly re-design process and design program overruns.

This traditional approach to delivering projects in the construction industry is progressively being replaced by a proactive, top-down form of cost analysis that influences the entire development process from the start: Should Cost Modelling. This cost modelling methodology revolves around establishing key commercial success criteria and efficiency ratios for all asset components, allowing the resources to be allocated where they generate the greatest value before the design commences. Should Cost Modelling has the potential to revolutionise construction cost estimating and design methodologies. It can also help to challenge the prevailing misinterpretation of project, cost and commercial management practice in the construction industry as one that delivers buildings, as opposed to broadly understood value, to their clients[37].

A research paper prepared by EC Harris, *"Should Cost Modelling. The Strategic Tool for Maximising Return On Investment for the Construction Industry"* provides further detail on this new cost modelling method (Appendix 5).

Project Cost Estimation

Cost blowouts are often not about poor project management or about the impact of the external world on projects. Very often, cost estimates could be much better even at early stages of projects. Cost biases such as over-optimism are well known phenomena and the use of simplistic approaches including "single point estimates" is surprisingly common.

Applied as a routine element of project governance, the rigour of tools and methods such as Real Options Analysis and Monte Carlo Simulation can significantly reduce the likelihood that biases remain hidden or are significant. Such approaches may be applied at portfolio, program and project level. Despite this, the use of such techniques is often not mandated or even expected.

Given the relatively low cost and investment required, it seems obvious that as a matter of public policy the use of appropriate cost estimations tools should be considered mandatory through the life of major public projects[38].

Loss of Productivity Due to Rework

The typical structural and process complexity and multiple interdependencies that exist between components in large complex projects can contribute to psychological and semantic noise, which can lead to ineffective decision-making, waste, and errors being made. Once an error is identified then a cycle of rework commences. The rework cycle provides the foundation for understanding the dynamics associated with project productivity and

performance[39]. Rework is a significant cost issue for complex projects and an important area for proposed research for infrastructure projects.

3.5 Workforce Issues

Workforce Planning

The productivity submission document alludes to shortage of skilled labour to carry out construction projects which was felt by the mining industry as well. The mining industry also faced high turnover rates. Strategies are therefore required not only to source labour but also develop and retain hired labour.

It has been widely recognised that a lack of available skilled labour is adversely impacting the productivity of day-to-day operations in many projects and is threatening the viability of future projects[40]. Workforce planning is required to ensure that the right people are available at the right place and at the right time to execute project planning with the highest level of quality. Such planning requires development of a predictive systemic model for workforce supply and demand and determines workforce planning and development strategies to close the gap between supply and demand forecasted shortfalls of labour. As projects become complex in nature there is a propensity for employees to be subjected to varying job demands and constraints. In order to work towards increased productivity and improved product quality there needs to be an exchange for better conditions of employment for workers and a work-life balance to ensure a healthy, happy and productive workforce.

Recognition also needs to be given to the need to assess the return on investment for sustaining specific skill sets in Australia for once in a generation projects. For example, if specialist tunnel boring capabilities are required for a 'one off' project then Australia needs to accept the reality of importing that capability ensuring we maintain maximum productivity for the overall project investment. In retrospect, a similar argument may well have been made for certain aspects of the NBN rollout.

Global Construction Disputes

EC Harris publishes the *"Global Construction Disputes: A Longer Resolution"* report (Appendix 6) on the construction disputes market. The 2013 report found disputes to be taking longer to resolve and the causes are linked to many different factors, including:

- Disputes that are not settled through negotiation tend to indicate a polarisation of interests, and are likely to only contain the most complex of issues;
- Multi-geography, mixed cultures and the need to consult and engage with head offices can prolong the time it takes for a dispute to be concluded;
- Projects are increasing in complexity and so the issues that are material to the dispute can be equally as complex, and therefore need appropriate time to consider the issues.

3.6 Procurement Strategy, Agreements and Contracts

Although Australia, through State Governments and at the Commonwealth level, has developed effective means for managing procurement strategies these have not always been productively delivered. The risks and costs have tended to remain with the Commonwealth/State governments and taxpayers and the benefits and opportunities

accrued by the private sector. At the same time, many existing public service bodies, for example the New South Wales Public Service Commission, seek to transfer or outsource non-core competencies to the private sector, such as road building and rail track maintenance. In previous transfers of this type, linkages between authority and responsibility; shared and understood opportunities, safety and risks have become blurred. For example, the report into the UK Potters Bar Train Crash, 10 May 2002, recommended that there was a need to 'improve the safety culture within the industry' and specifically between public, private and contracted enterprises[41]. The report also concluded that:

"[Public Service organisations / agencies]…should get together with the industry to examine ways in which they can help…identify any barriers to progress, which they should seek to minimise. Such barriers might include placing requirements on the industry that divert it away from this path or reverse progress ([including] inspection and enforcement policies, the relationship between safety improvements and the possibility of legal proceedings, performance targets and contractual penalties). This partnership approach to enhancing safety culture in the industry should lead to a better understanding of the complementary benefits to business and safety"[42].

Research has indicated that there are four main knowledge competencies that organisations need to manage: non-core; core; competitive/co-adaptive[43] and strategic. Effective collaborations facilitating reflective and ongoing learning need to enhance strategic and competitive/co-adaptive competencies whilst insuring that core knowledge remains efficiently exploitable. In complex projects and programs involving a synthesis of government, private, public, financial and research practice, particular attention needs to be paid to[44]:

- Extensive early market engagement between all sectors to establish key design factors including: the equities involved; the structure of the deal; the length of the contract; workforce requirements; physical locations and identifying the minimum technical requirements;
- Competitive and Co-Adaptive dialogue between partners built upon mutually declared transparencies and the need to know; to share and to use information between potential partners – supported and enabled by Government (State/Commonwealth/Treasury).
- A facilitated, intensive period of reflective dialogue to enable the separate streams from government, commercial, technical and financial organisations be developed and run in parallel.
- An allocated period for collaborative strategic thinking and planning, including the nomination of senior leadership responsibilities, the specification of protocols for effective working together and the use of strategies designed to enhance dialogue.
- Development of collaborative networks and real time connections through digital innovation to assist internal and external communications and to build reflective capacity into the emerging partnership entity.
- Early identification and specification in the project for:
    - Individual equity shares (including for the taxpayer);
    - Mutual and individual opportunities and risks;
    - Complementary benefits to business and safety;

- Enabling project adaptation (over time), e.g. building capacity / space into designs to allow for future expansion / alternative usage;
- Supporting SMEs;
- Growth and productivity opportunities and;
- Value for money

Additionally, research (by University of Sydney, Curtin University and UTS) has shown that current procurement strategies tend to encourage under-pricing, particularly in the construction industry and which was evident over the period 2011-2013 when there was a spate of bankruptcies of medium-to-large Australian construction contractors. Under-pricing can be a successful strategy for companies 'needing-to-work' but leads to: false competition between 'best providers', rather than for 'best designs'; disguised costing (hidden in subsequent contract changes); lack of transparency and ultimately, to bankruptcies and monopolies. None of these are in the interests of developing successful long term partnerships that will productively deliver value for money over time to the government, public and private sectors.

Infrastructure projects exhibit both complexities in the procurement mechanisms to be used to deliver the infrastructure as well as complexity of the infrastructure itself. Further, some aspects of an infrastructure can be more complex than the others (for example, it is more complex to predict volumetric usage of a road infrastructure compared to designing the road itself). To guide in the selection of an appropriate contracting mechanism applicable to different aspects of a complex infrastructure project both these complexities should be taken into account.

Lewis & Roehrich (2009) have classified infrastructure projects according to infrastructure complexity and procurement complexity (in a 2 x 2 matrix) which can guide the selection of suitable contractual mechanisms for complex infrastructure projects[45]. Table 1 shows examples of projects that exhibit these different complexities.

Table 1: Procurement Complexity Space

		Performance Complexity	
Infrastructural Complexity	High	**III**	**IV**
		Limited Scope High Technology IS (Broadband)	Operational & Training IS Different Operating Conditions (Surveillance Aircraft)
	Low	I	II
		Simple Service Stable Demand (Waste Collection)	Consultancy Knowledge Intensive (Policy Documents)
		Low	High

Source: Adapted from Lewis & Roehrich 2009, page 128

Successful partnerships can be guided and informed by contract but cannot be run by or through this institution. Existing procurement authorities do not necessarily have the *core* and *strategic* competencies to allow them to lead and successfully manage complex, multi-faceted, lengthy projects[46]. A significant element of our proposal will be to provide the education, training and tools enabling the public sector to undertake the leadership and management roles expected of them, including:

- Enabling public sector procurement organisations to act as both classification and design authorities – with an emphasis upon life-cycle costs (from end-to-end) and designs being 'fit-for-purpose';
- Increasing the amount of design carried out in collaboration and reducing the amount in competition (so adding to the overall costs of the project);
- Developing strategies for replication between designs and projects so that knowledge, information and designs may be shared, across sectors;
- The discouragement of excessive design development by encouraging bidders to concentrate their efforts on producing functional, replicable designs which are adaptable across sectors;
- Improved scrutiny of project preparation including the time to develop strategic partnerships and to reflect upon suitable designs;
- Undertake extensive pre-market engagement;
- Provide specification, selection and award criteria, terms and conditions and timescales.
- Contract Notice and a full due diligence pack for the bidders invited to participate in dialogue.

To deliver the type of shared equity partnership arrangements envisaged in Australia will require an up-skilling of both the public and private sectors – with an emphasis upon leadership, design, classification and shared responsibilities. Improving the productivity of major infrastructure projects will, in itself, act to up-skill the Australian public and private sectors. Infrastructure projects similarly improve productivity that, combined, should enable a win-win – and the development of competitive export models for global application.

The proposed shared equity partnership (SEP) model (based upon research at the University of Sydney and UTS) works by enabling Government, public, private, financial and industry sectors to be collaboratively brought together. It is underpinned by mutually shared and understood opportunities and risks.

4. CURRENT AND PROPOSED RESEARCH INVESTMENT

4.1 Research Challenge Areas

Through an extensive series of workshops, industry consultation and research focus meetings in Sydney, Brisbane, Adelaide, Canberra, Melbourne and Perth, ICCPM and its partners have invested in excess of $2.5m to consult, glean and document the key challenges and research needs facing industry and governments in designing and delivering complex projects including infrastructure.

These needs have been collated to form seven key challenge and delivery areas:

1. Integration and alignment of team and teams of teams' performance
2. Leading and managing complex projects and programs
3. Contextualised and tailored knowledge capture, access and dissemination
4. Project scoping and critical assumption testing
5. Benefits realisation, accountability and innovations
6. Complex project contracting and procurement
7. Optimising governance, decision making and risk management for customers and suppliers.

Of equal importance to delivering new tools and techniques in support of the challenge areas is the need to design and conduct a major education and training program to ensure the key research learning is captured and imbedded within industry and government.

4.2 Projected Benefits

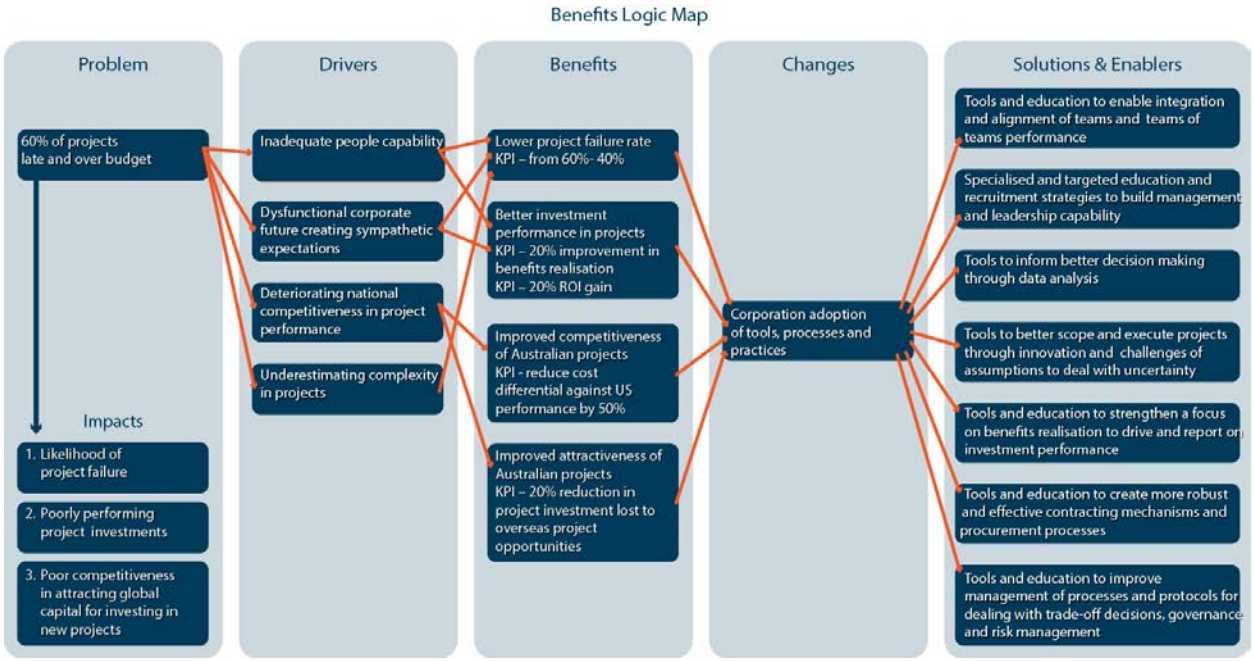
Estimated impacts of the proposed research centre initiative have been developed in collaboration with research institutions, industry end users and other key stakeholders. In aggregate terms the initiative is projected to achieve a risk adjusted and direct economic benefit of $210 million between its inception on 1 July, 2014 and 30 June, 2029[47]. This does not include the significant spill-over benefits that will flow from participant's enhanced capability and reputation that will give participants a competitive advantage when it comes to large international projects.

This provides an 18-fold return on investment to the Australian Government. In addition there will be significant spill over benefits in the form of improving Australia's competitive position in the delivery of complex projects, a significant focus on professional development, including the completion of 40 PhD's to help build the future workforce needed to support major and complex projects.

The following table further illustrates the tangible performance improvements that are achievable by a research centre, which has the Australian Government as a collaborative partner. The Benefits Logic Map outlines the investment rationale for financial support for research on complex projects by proposed investors, stakeholders and partners.

The underlying rationale is that through the development and delivery of tools, techniques and education to managers of complex projects and programs, the performance of such projects and programs can be improved. By doing so the direct implications are: a reduction in failures, an improvement of the investment performance of complex infrastructure projects and programs, and to make the Australian project investment landscape more attractive to the global investment community as well as managers of complex projects and programs. In turn, these will lead to direct and measurable productivity gains for the Australian Infrastructure Sector and therefore the broader Australian economy.

Benefit Logic Map



Source: Tywoniak, S. (2014)

Research Structure and Projected Budget

In establishing a specialist research centre, we propose a research investment structure which is similar to the current Cooperative Research Centre (CRC) program. This structure would allow co-investment from the Australian Government, industry and research Institutions.

The research centre budget has been prepared with a strong focus on the leverage of the core Australian Government funds through the strong commitment by other core collaborative partners. This represents both a financial commitment and importantly a call and commitment to action from partners through implementing the outcomes from the research centre

The initial funding schedule has been prepared for a seven year period. We consider that within this period the research centre and the structures and collaborative arrangements connected with it should be able to make a significant positive impact across the critical identified areas of need. We recommend that the research centre operations, together with the impact and influence of its projects and programs be reviewed after year five with the view of assessing the appropriateness for funding for a further term.

Given the urgency of the need for this research, we feel that this investment should be made outside the regular research funding scheme. ICCPM has worked with its partners from research institutions, industry and some government departments to develop a comprehensive research program that is ‘shovel ready’. Should the Australian Government support the proposed initiative, we will seek to include other specialist research institutions and profession bodies such as the SMART Infrastructure Facility, the Australian Risk Policy Institute and the Australian Institute of Project Management.

Financial Year Ending	Australian Government	Academic Institutions	ICCPM/ Industry	Non Cash	Total
2015	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
2016	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
2017	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
2018	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
2019	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
2020	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
2021	4,300,000	1,000,000	1,200,000	2,200,000	8,600,000
Total	30,100,000	7,000,000	8,400,000	15,400,000	60,200,000

5. CONCLUSION

The Australian Government has an unprecedented opportunity to take a leadership role in bringing a transformational change to the Australian infrastructure and major projects landscape through joining with ICCPM and its partners to improve productivity and establish a competitive and co-adaptive advantage in securing and delivering major, often complex, infrastructure projects and programs.

By building on national and international experience and acting as an equity co-investor in the collaboration to establish a research centre, Australia has an opportunity to strengthen significantly the existing partnership between the public, academic and private sectors, in a way similar to the Treasury model recently instigated in UK.

ICCPM and its research partners stand ready to implement a comprehensive national research agenda through a specialist research centre in support of Australia's infrastructure investment. Such an initiative will be the catalyst to break the cycle of sub optimal performance in major project and program delivery and provide a new suite of knowledge, tools and capacities to underpin a period of infrastructure led economic growth and productivity for our nation.

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17 February 2014

APPENDICES

Appendix 1: ICCPM Report “Complex Project Management – Global Perspectives and the Strategic Agenda to 2025”

Appendix 2: UK National Audit Office report “Over-optimism in Government Projects”

Appendix 3: EC Harris (2013), Global Infrastructure Investment Index: Move from Risk to Reward

Appendix 4: EC Harris (2013) The Global Built Asset Wealth Index Report

Appendix 5: Chomicka, B. (2013), Should Cost Modelling. The Strategic Tool for Maximising Return on Investment for the Construction Industry

Appendix 6: EC Harris (2013), Global Construction Disputes: A Longer Resolution

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