Innovation for Infrastructure Projects

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For:

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Foreword

Governments seek to achieve better Value for Money (VfM) through their investments in infrastructure projects. This may include social, economic and environmental benefits that can be achieved through these types of projects. Today, governments are trying to utilize a number of different strategies to achieve better outcomes. Promoting innovation and new ideas is one strategy that is gaining popularity in today’s economic environment.

There is a significant amount of anecdotal information that suggests that innovation is the underpinning driver that leads to enhanced outcomes across different kinds of projects. The importance of infrastructure in economic development is acknowledged through research and practice. Current thinking often argues that investing early in project modelling and design will bring remarkable outcomes if there is a focus on the whole of life costing and VfM.

In this research we discovered how innovation is produced and captured in major projects in Australia and how innovation may arise in design, project management, finance and procurement and other areas. To achieve this we gathered and analysed the thoughts and views of industry experts in the fields of telecommunication, rail transport and health care building projects. Popular beliefs about innovation associate it with high technology, research, and development investment programmes. The industry practitioners in our case studies broadened this view to include soft aspects of innovation such as network and relationship building, team work issues, management of stakeholders, the way personnel are managed within the organisation as well as early stage governance of projects. They also indicated that over time accumulation of small improvements would come to have large impacts on performance.

This study is an early important step in opening up a new area of research to help industry and agencies to better understand how to pursue better value for money by undertaking and embracing innovative ideas, activities or practices.
Executive summary

As a part of the Commonwealth Department of Infrastructure and Transport’s SMART infrastructure award program, The University of Melbourne has undertaken a study on how to quantify the benefits of design innovation on service outcomes and sustainability through the use of different procurement techniques (including PPPs and collaborative contracts) and a competitive bidding process. The objective of the study is to quantify the value proposition relationship between an early investment in design and the economic and service outcomes that are delivered over time. Using a grounded theory research approach the study has:

- undertaken a detailed critique of international best practice;
- conducted an industry based workshop where three diverse but successful projects have integrated innovation into different areas of their project management practices;
- compared the findings from the literature and industry workshop with the current proponent selection process recommended by Infrastructure Australia.

The findings show that:

1. Current definitions of innovation are incomplete.
2. Innovation is more than only investing in Research and Development (R&D) or high technology aspects.
3. Contracts and procurement strategies have significant impact on the stimulation of innovation.
4. The way project management is structured has a significant impact on innovation drivers.
5. Current Australian practice does not include innovation in processes, especially in proponents and project selection stages. It frequently deals with innovation on a qualitative basis.
6. Some approaches of the agile project management methodology seem to be applicable in the context of major infrastructure projects.
7. ICT projects often innovate through step changes as developed by small independent teams. Purchasing of Intellectual Property and takeovers of small organisations is a common approach for achieving innovation in larger organisations.
The case studies investigated identified the following underlying concepts to achieve innovation:

1. Innovation is more than just design innovation. There are other aspects of innovation such as: teams; governance; vision; learning space; procurement; measurement and environmental drivers.
2. Network alliances as well as business structuring were two main areas in which the case study projects were shown to be more innovative.
3. Investing in softer issues, such as the areas of people management and early parties involvement, can come to have significant impacts on the results.
4. Innovation is not necessarily expensive and radical. Often the accumulation of incremental improvements may lead to significant outcomes in project delivery.
Introduction

This report demonstrates the value\(^1\) of design innovation\(^2\) in major infrastructure projects in Australia. The study upon which the report is based adopted a grounded theory research methodology to develop a framework for considering and evaluating innovation in infrastructure project initiation. The research process included:

- A review of international literature to establish current practices and to identify the key design drivers in assessing Value for Money (VfM)\(^3\) and to critically review the associated predictive framework.
- Establishment of a theoretical framework for enhanced evaluation of design value based on a gap analysis between current Australian practice and the claimed benefits from design innovation. This evaluation included consideration of the complexity of innovative financing and new procurement methods (Alliancing & Public Private Partnerships - PPPs). Particular note is made of the Canadian approach where contract price is sometimes given and the overall tender evaluation is undertaken on the basis of the value offered by bidders.
- Evaluation of the developed framework through direct feedback from individual organisations (grounded theory), and a review of three case studies in a workshop environment.
- Critique of the developed framework via industry soundings.

Anticipated benefits from a refined model for evaluation of design value through innovation include:

- improved overall economic productivity derived from the use of the infrastructure delivered
- greater transparency in how innovation and sustainability is assessed and thus the likelihood for reduced bidding cost
- a greater level of confidence that real value is achieved associated with investment in innovation and/or sustainability on major infrastructure projects.
1 Value is used in this report as a broad concept that incorporates both market, social and environmental measures of the benefits of a project. Value varies depending on the types of projects and different perspectives: government, private, client, contactor or community. Value can be measured in monetary terms if a competitive market is used but it also applies in non-market or hedonic situations.

2 Design innovation here refers to the broader issues associated with every aspect of the creation of an infrastructure project including innovation in design itself, procurement, governance, management, construction, delivery and operation.

3 Value for Money refers to achieving maximum efficiency or benefit subject to available resources. It does not necessarily imply the least cost solution. In a conceptual sense it can be defined as the ratio between functional performance (FP) and resources consumed (RC).
Literature review

This section reviews the literature on innovation and infrastructure procurement and delivery. In particular it deals with the definition of innovation and the influence of different aspects of innovation on contracts and agile project management.

Innovation definition and areas of innovation

There are many definitions for innovation but the most common is from The Oslo Manual (OECD, 2005) which defines innovation as follows;

"An innovation is the implementation of a new or significantly improved product (good or service), or a process, new marketing method, or a new organisational method in business practices, workplace organisation or external relations”.

The minimum requirement is that each of these changes must be new or significantly improved in an organisation (OECD, 2005).

Innovation is defined as the channel through which improved knowledge is applied to economic processes. It is known as the engine of long-term economic development (BIS, 2011). There are a wide range of studies that show there is a positive correlation between investing in innovation and productivity improvement (BIAC, 2004; Commonwealth of Australia 2009; Cutler 2008; Fagerberg et al 2009b; Fagerberg et al 2010; OCED 2005, 2007; Rosenberg 2004). In The World Bank Report, innovation has been selected as the twelfth most important criteria for assessing a nation's competitiveness (World Economic Forum, 2012).

There are several categorisations of innovation based on different studies. An example is Spitzer’s categories at IBM (Spitzer, 2007) as listed under ‘innovation types’ (left hand column) in Table 1. These categories have been adopted and applied in the context of infrastructure projects in this report. They are presented against a related definition with examples from infrastructure and IT projects. Spitzer’s framework is the most comprehensive categorisation of innovation that was found in the literature.
<table>
<thead>
<tr>
<th>Innovation types</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business structuring</td>
<td>It is the first step in any kind of business and it’s known as the main building block of each business.</td>
<td>Business development, option development, selection of options, project initiation, project planning, project strategizing.</td>
</tr>
<tr>
<td>Management system</td>
<td>It is all about how the organisation tries to manage and organise itself. In other words it is a means to achieve an end in business objectives.</td>
<td>In-house, outsource, centralized, decentralized, and integrated, enterprise.</td>
</tr>
<tr>
<td>Design</td>
<td>It is a process when intelligence and creativity come together to solve a problem in an efficient way.</td>
<td>Physical design, architectural design, engineering structuring, material design, uses of technology.</td>
</tr>
<tr>
<td>Project management style</td>
<td>Project management is the discipline of planning, organising, securing, managing, leading, and controlling resources to achieve specific goals.</td>
<td>Agile, lean, iterative, incremental, and phased approaches.</td>
</tr>
<tr>
<td>Construction</td>
<td>It consists of any activity which is done to construct the project.</td>
<td>A special way of pouring concrete, prefabrication, new and innovative construction materials.</td>
</tr>
<tr>
<td>Procurement</td>
<td>It is all about contracting and logistics and the arrangement of resources.</td>
<td>The Internal, external, mechanism of purchasing, PPP, Alliance contracting.</td>
</tr>
<tr>
<td>Network and alliances</td>
<td>It is about the management of relationships, personnel, and stakeholders.</td>
<td>The project’s team working, hiring experts, relationships with clients and suppliers.</td>
</tr>
<tr>
<td>Financial arrangement</td>
<td>How clients provide money for their project.</td>
<td>Your own money, loan, debt, private money, equity.</td>
</tr>
<tr>
<td>Customer experience (service)</td>
<td>What the clients do for the customer to meet their needs and ensure their satisfaction.</td>
<td>Customer response (robotic response machine), 24 hour service, stakeholder engagement.</td>
</tr>
<tr>
<td>Process</td>
<td>Any process that is in place associated with planning or delivering projects.</td>
<td>The Contractor selection process, payment process, bidding and tendering process, clarification and verification process in tendering, documentation process; for example on-line documentation.</td>
</tr>
<tr>
<td>Product</td>
<td>It could be the project itself or any by-product of the project.</td>
<td>Specific train lane, automatic pay toll in highway construction, GIS-based traffic management in road construction.</td>
</tr>
</tbody>
</table>
Innovation requirements

Innovation may not necessarily happen spontaneously. There is a vast literature on how to promote and produce innovation in an organisation and the reasons for the lack of innovation (see for example Harvard Business Review 2013, Tidd and Bessant 2009). Innovation requires many elements to be successful. Based on the readings, the single most important point appears to be the involvement and support of a CEO. Some of the elements that need to be developed in an organisation or project are:

- Appropriate organisation structure.
- Key individuals with the appropriate skills and experience.
- A vision for organisation wide involvement in innovation.
- Effective team work.
- Managing tensions between existing processes and the challenge of change.
- A focus on customer requirements and satisfaction by rigorous observation of customers.
- Promoting a creative climate.
- A blame free environment that accepts mistakes and challenges traditional processes.

Innovation and adoption into infrastructure

There is a significant amount of anecdotal information that suggests innovation is the underpinning driver that leads to enhanced outcomes in different kinds of projects. The importance of infrastructure in support of economic development is acknowledged through research and practice. Current thinking often argues that investing early in project modelling and designing will bring remarkable outcomes if there is a focus on the whole of life costing and VfM.

In this research we discovered how innovation is produced and captured in Australian major projects and how innovation may arise in design, project management, finance and procurement and other areas. To achieve this we gathered and analysed the thoughts and views of industry experts in the field of telecommunication, rail transport and health care building projects. Popular beliefs about innovation associate it with high technology and R&D, investment programmes. The industry practitioners in our case studies broadened this view to incorporate soft aspects of innovation such as networking and relationship building, team work issues, management of stakeholders, the way personnel are managed within the organisation as well as early stage governance of projects.
They also indicated that accumulation of small improvements would come to have large impacts on performance over time.

Innovation is a key value driver in the 21st century and believed to be one of the ways to survive in the current turbulent economic environment. Innovation, as a research subject itself, has received attention in recent years due to its impact on economic development and productivity improvement (BIS, 2011; Commonwealth of Australia 2009; Cutler 2008; OCED 2007). Investing in innovation leads to higher international competitiveness and faster national economic growth (Fagerberg et al 2009a; World Bank, 2003, 2008, 2009). However, although the effects of innovation on the overall economy have been demonstrated over recent years, there remains a need for a practical approach to evaluate the benefits of innovation at the project level.

A clear definition of what is meant by innovation and how the outcomes of innovation can be evaluated is a sensible starting point.

**Infrastructure and innovation**

The importance of infrastructure in support of economic development has been fully recognized and acknowledged through research and practice. Infrastructure is determined by The World Bank as the second measure for assessing a nation's competitiveness (World Bank 1994, 2006; World Economic Forum 2012).

Globalization and the Global Financial Crisis have put more pressure on governments and organisations to find new ways to get a better Value for Money through their investments. In fact, taking advantage of innovative and new ideas is a response to this fast changing economic environment.

Prior work has documented the impact of investing in R&D practices on innovation (BIS 2011; OECD 2005) and other research has raised the importance of “high tech” in producing innovation in projects (Flamm 2010; Hardie & Newell 2011; Leiringer 2006; Rose & Manley 2012). There are also studies that have focused on establishing the relationship between investing in innovation and the overall economic development at regional or national levels (NESTA 2009). Researchers have also tried to study innovation in the context of procurement (Silber 1981; Tawiah & Russell 2008). Although these studies have documented remarkable outcomes they have focused on the application of high technology to innovation. This study considers how innovation can be produced and applied in the context of infrastructure projects by capturing the thoughts and views of industry experts and practitioners.
In Australia the need for infrastructure is increasing due to demographic changes, population growth and migration (Teo et al. 2011). Infrastructure has been introduced by government as one of the key drivers of its productivity program (Albanese 2011). Infrastructure Partnership Australia has reported that more than $300 billion dollars will be required over the next 10 years (from 2007) to respond to this increasing need for infrastructure in Australia (IPA 2010). This amount of money itself shows the importance of infrastructure in Australia’s economic future. Because of this governments are becoming aware of the need to achieve best Value for Money and recognise the importance of innovative ways of designing, implementing and delivering infrastructure projects. Public Private Partnership (PPP) and Project Alliancing vehicles to deliver infrastructure projects are responses to this need.

The influence of contracts on innovation

There are different procurement approaches required to deliver different types of projects. Each approach has its own characteristics and suitability for specific types of projects. For example structuring the delivery of road projects is quite different from building a hospital or education facility. Infrastructure procurement guides and manuals present different approaches such as design and build, PPP, Alliancing, Build Own Operate Transfer (BOOT) or traditional project delivery methods. It is been stated that PPPs, Project Alliancing and early contactor involvement increase the opportunity for innovation (CEID 2010). PPPs and Alliancing by definition involve different parties and provide an opportunity for sharing risk. This may lead to a greater opportunity for innovation. Those approaches which share the risk in a justifiable manner will give more flexibility for innovation (CEID, 2010). A competitive bidding (or investment decision making) process can be a way to encourage contractors to introduce innovative ideas.

Research in the UK to identify innovation stimulants in Private Finance Initiative (PFI) projects showed that a key advantage for PFI was the ability to bring innovation to project delivery (Eaton et al. 2006). Tawiah and Russell (2008) discussed the procurement method (PPP, Alliancing, BOOT etc.) as a potential opportunity for infrastructure innovation. They proposed a framework in the project evaluation process which could be used as a means to assess project innovation at very early stages of the procurement mode selection process. They demonstrated the relationship between innovation and procurement methods by proposing a framework to assess the level of innovation achieved in projects (Tawiah & Russell 2008). In choosing specific types of procurement methods there are several motivations for clients such as project scope, project type, urgency, risk transferring, budget boundaries, political consideration and many other things. Innovation is not always one of these consideration and sometimes is missing (Davidson 1998).
Particular methods of infrastructure delivery such as PPP, PFI and Project Alliancing enhance the potential of innovation happening because they incorporate mechanisms for risk sharing which promote the introduction of innovation in infrastructure projects.

The Victorian Department of Treasury and Finance recently updated Partnership Victoria Requirements (DTF 2013) to reflect reforms to the PPP model introduced following industry and practitioner consultation. The updated requirements are responses to today’s more dynamic economic environment and ensure that they are practical and relevant. The new version of the requirements mentions that “The Victorian Government is committed to delivering services efficiently and in new and innovative ways that prioritise the community’s needs”. These changes are intended to encourage ongoing innovation from industry but there still remains a lack of detail on how to achieve them. Another improvement in this update is the introduction of a new tool called Scope Ladder which is to be used alongside the Public Sector Comparator (PSC) to assess public interest impacts together with potential VfM improvements (DTF 2013).

**Agile project management (APM) and innovation**

The management style and culture in an organisation can promote or discourage innovation. Approaches which tolerate different ways of thinking and new ideas provide a fertile environment for innovation. Softer management styles that focus on team building, collaboration, quick response and customer satisfaction can promote innovation. One of these management styles is agile project management (APM) which is used effectively in IT projects.

Agility is the ability to balance flexibility and stability. In other words it can be referred to as the ability to both create and respond to change in order to profit in today’s ever changing economic environment (Highsmith 2002, 2004).

"APM is a set of values, principles, and practices that assist project teams in coming to grips with this challenging environment“. APM tries to uncover better ways to deliver products by valuing:

- Individuals and interactions over processes and tools
- Working (products) over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan
There are five important phases in APM:

1. Envision: determine the product vision and project scope, the project community, and how the team will work together.
2. Speculate: develop a feature-based release, milestone, and iteration plan to deliver on the vision.
3. Explore: deliver tested features in a short timeframe, constantly seeking to reduce the risk and uncertainty of the project.
4. Adapt: review the delivered results, the current situation, and the team’s performance, and adapt as necessary.
5. Close: conclude the project, pass along key learnings (lessons learned), and celebrate.

**Relevance of agile to major infrastructure projects**

Some infrastructure projects have unique requirements and restrictions therefore some project management systems may not be applicable. Further research is required to determine the applicability of agile project management methodologies to infrastructure projects. As an example, one of the industry case studies reviewed (which used an agile approach) believed that flexibility was necessary in scope management. However, others believed we should not change “holding to clear scope”.

A comparison of agile and traditionally managed projects may help to uncover which approaches may improve performance. Some studies have tried to compare traditional project management approaches with agile methodologies but large infrastructure projects have their own characteristics which need to be considered. Table 2 is a comparison of these characteristics applied to general projects and infrastructure projects in particular.
Table 2: Comparison of characteristics of agile, traditional and infrastructure projects

| Characteristics of managing agile, traditional and infrastructure projects |
|---|---|---|
| **Agile** | **Traditional** | **Infrastructure** |
| Team focused | Task oriented | Other than traditional project characteristics, infrastructure projects characterised as: |
| Just-in-time | Structure | • Longevity |
| Flexible | Requirement | • Multiple interfaces, stakeholders, parties |
| Collaborative | Predictable | • Interdependencies |
| Transparent | Documentation | • Complex nature |
| Adapt | Plan | • Large investment |
| Volatile | Schedule | • Special financial arrangement |
| Iterate | Process | • Value for money |
| People | Tools | • Political related issues |
| Communication | Conform | • More externalities (such as environment) |
| Flat | Stable | • Social and community matters |
|  | Waterfall | • National priorities |
|  | Hierarchical | • Higher risks |

Discussion and conclusions on agile

It is not necessary to apply every agile management strategy to an infrastructure project however concepts such as individual interaction, customer collaboration, transparency in communications and other people related issues are relevant to infrastructure projects. Common areas of innovation in the three case projects reviewed are applicable (see Table 3). For example, getting the right group of people, encouraging open communication channels, early engagement of parties, collaborative environments, an interactive bidding process, regular and on-going meetings, flexibility for future changes, welcoming change and lessons learned are all distinct signs of an agile approach. However, further study and research is necessary to determine how agile project management approaches can be developed and applied to infrastructure projects other than IT. One potential area for research could be the quantification of benefits due to an agile methodology in infrastructure projects.
For organisations that are already practising the agile approaches, for instance Microsoft, Apple or GE, a further step could be to consider their business models. These successful companies take advantage of the ideas from experts all around the world. These businesses through their unique organisational and management structures have expanded their teams of innovation experts to harvest and apply innovative ideas from around the world (Immelt et al. 2009).

**Measurement methods**

Companies that are involved in new product development use a variety of methods to assess the potential benefits of innovation. For example, pharmaceutical companies are constantly engaged in the design and development of new and innovative medicines. Consumer products companies such as Proctor & Gamble or Unilever generate new products in order to maintain their market dominance in groceries. These companies engage in formal new product evaluation processes with tools such as Risk Assessment Matrices and Day’s RWW screen (Day 2007). These tools can be adapted to the different stages of managing an infrastructure project.

There is no specific method available currently for embracing innovation in infrastructure projects but several generic approaches need to be considered:

1. Conceptual frameworks: in this method the main focus is on stage consideration (identification, realization and evaluation) of a project. Methods used in marketing product development could be adapted.

2. Quantitative approach: used when benefits can be assessed quantitatively and some metrics such as time, cost and revenue can be used as evaluation criteria.

3. Qualitative approach: when there are valuable benefits which are difficult to measure; the best way to assess them is surveys of clients, customers and users. For example experts’ and practitioners’ viewpoints may be accepted as a basis for evaluation. A customer experience survey is another application that can be qualitative in nature.
4. A Combination of quantitative and qualitative approaches: sometimes there are several aspects of projects which can be assessed quantitatively whilst some of them can only be evaluated qualitatively. This kind of assessment could result in more reliable outcomes if there is a focus on whole of life cost benefits analysis. The method is basically used for performance measurement and time, capital cost, operational cost, productivity, efficiency, and energy consumption are usually assessed in this method. Table 3 summarises the characteristics of these measurement approaches.

Table 3: Different methods for benefit evaluation

<table>
<thead>
<tr>
<th>Method</th>
<th>Example of use</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual</td>
<td>Benefit Realisation</td>
<td>Staged consideration through some form of framework</td>
</tr>
<tr>
<td>Quantitative Method</td>
<td>Project Success</td>
<td>Time and cost, KPIs</td>
</tr>
<tr>
<td>Qualitative Method</td>
<td>Customer Experience</td>
<td>Opinion surveys of users and experts</td>
</tr>
<tr>
<td>Quantitative / Qualitative Method</td>
<td>Performance Evaluation</td>
<td>Time, capital costs, operational costs, productivity, efficiency, effectiveness, energy usage, economic ratios (ROI, BCR, NPV), benchmarking such as PSC in PPP projects, revenue</td>
</tr>
</tbody>
</table>

In terms of economic and financial evaluation there are several methods which can be used in different situations based on the intended accuracy, available time and information, types of projects and many other considerations. Some of these methods are briefly introduced in Table 4 (DTF 1996).
### Table 4: Financial and economic analysis methods

<table>
<thead>
<tr>
<th>Analysis type</th>
<th>Brief description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost benefit analysis (CBA)</td>
<td>Captures all the costs and benefits of an investment that can be expressed in monetary terms. It can also include those socio-economic factors that can be measured in monetary terms.</td>
<td>Comparing different alternative options in terms of costs and benefits.</td>
</tr>
<tr>
<td>Financial analysis</td>
<td>Uses measures which capture effects of time and interest rates and shows the results of proposals for budget impact analysis. It usually ignores externalities and socio-economic impacts.</td>
<td>Comparing different alternative options in financial terms.</td>
</tr>
<tr>
<td>Sensitivity analysis</td>
<td>Used to test optimistic and pessimistic scenarios by assessing the effect of changes in variables on results.</td>
<td>Used when there is uncertainty with investments.</td>
</tr>
<tr>
<td>Cost effectiveness analysis (CEA)</td>
<td>Used when benefits are not expressed in monetary terms but in physical units while costs are expressed in monetary units. It usually compares costs of different options with similar physical outputs. It is a judgment-based analysis and is rarely used as the sole decision-making criterion.</td>
<td>Useful in areas where benefits are easier to be quantified in physical terms such as health, workplace and safety and education. For example numbers of lives saved per unit of cost.</td>
</tr>
<tr>
<td>Socio-economic impact analysis</td>
<td>Considers all significant socio-economic costs, benefits and risks including those impacts which can be translated to monetary values, physical units and those that can be simply described.</td>
<td>A method which is useful for infrastructure and asset-based service investment evaluation.</td>
</tr>
<tr>
<td>Distributional impact analysis</td>
<td>Used when evaluation includes an assessment of who ‘gains’ and who ‘loses’ in the community as a whole.</td>
<td>Useful again in public and infrastructure projects evaluation.</td>
</tr>
<tr>
<td>Weighting and scoring</td>
<td>A method which is used to integrate all identified costs and benefits of investment to provide an integrated measure.</td>
<td>Used for aggregation of all impacts based on judgments of the importance of the impacts.</td>
</tr>
</tbody>
</table>
For financial analysis different measures may be used such as NPV, NPC, NPVI and so forth. Some of these measures are summarised in Table 5 (DTF 1996).

**Table 5: Financial and economic measures and metrics**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net present value (NPV)</td>
<td>Represents the sum of the present values of the cash outflows (costs) and cash inflows (benefits) of an investment.</td>
</tr>
<tr>
<td>Net present cost (NPC)</td>
<td>A way of representing negative NPV.</td>
</tr>
<tr>
<td>Net present value per unit of capital invested (NPVI)</td>
<td>Measures the net present value of an investment per dollar of capital invested.</td>
</tr>
<tr>
<td>Equivalent annual cost (EAC)</td>
<td>Converts the NPV into annual real expenses over the life of the project.</td>
</tr>
<tr>
<td>Internal rate of return (IRR)</td>
<td>The discount rate by which the net present value is zero.</td>
</tr>
<tr>
<td>Benefit cost ratio (BCR)</td>
<td>Ratio of present value of cash inflows (benefits) to cash outflows (costs).</td>
</tr>
<tr>
<td>Payback period</td>
<td>A simple measure of evaluation which indicates the period of time required for cash flows for the investment to repay the original capital investment.</td>
</tr>
</tbody>
</table>
A detailed review of current Australian proponent selection and project management practice: Innovation inclusion

Selecting the successful proponent to undertake a project is obviously critical to project outcome. In this section we compare current Australian practice with other international approaches in order to explore areas for improvement.

Project proponent selection: Infrastructure Australia

Figure 1 details the framework developed by Infrastructure Australia that is used by bidders as a guideline for making submission. There are 7 stages in this framework. Proposal evaluation happens in the 7th stage. A thorough evaluation of the proposed solution with robust economic analysis and delivery assessment is required from potential bidders (Infrastructure Australia, 2012). Each proposal should prepare a detailed report of the economic methodology used including all parameters, values, assumptions and algorithms including the following:

1. Submit robust and objective cost benefit analysis, supported by strong evidence.
2. Consider as many monetised economic costs as possible.
3. Consider non-monetised benefits and costs.

The framework emphasizes the importance of non-monetised benefits and costs but does not include innovation and its impacts explicitly (Infrastructure Australia 2012). A report by Infrastructure Australia (endorsed by the Council of Australian Governments – COAG 2012), clearly stated a need to establish innovation KPIs for projects. They also noted that limited opportunities for innovation is an indicator of unsuccessful strategies (COAG 2012).
### Figure 1: Infrastructure Australia’s reform and investment framework

<table>
<thead>
<tr>
<th>Core element</th>
<th>Stage and purpose</th>
<th>Early stage</th>
<th>Real potential</th>
<th>Threshold and, if all issues are addressed, ready to proceed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic Alignment</strong></td>
<td>Proposal supports infrastructure Australia’s strategic priorities and aligns with state plans.</td>
<td>- Goals of the proposals are identified and align with state or regional strategic plans.</td>
<td>- Proposals economic, social and environmental goals quantified.</td>
<td>- Confirmed benefits delivered by preferred option are aligned with goals (e.g., benefit profiles and a benefits realisation plan).</td>
</tr>
<tr>
<td><strong>Problem Evaluation</strong></td>
<td>Problem being addressed is well understood and constrains achieving intended goals. The costs of the problem and potential benefits are presented and supported by evidence.</td>
<td>- Current and future problem described Describe what the problem will become in future if it is not addressed.</td>
<td>- Scenario analysis completed over reasonable time horizon demonstrating problems will persist or emerge under plausible scenarios.</td>
<td></td>
</tr>
<tr>
<td><strong>Option Assessment</strong></td>
<td>Strategic analysis and cost benefit analysis to access the viability of the options.</td>
<td>- Option assessment not required in submission.</td>
<td>- Option evaluation criteria to measure performance against the goals of the proposal.</td>
<td>- Whole of life costs, service delivery outcomes and engineering design optimized during development of the preferred option (e.g., value engineering)</td>
</tr>
<tr>
<td><strong>Solution Evaluation</strong></td>
<td>Detailed business case for the preferred option including cost benefit analysis, strategic fit and deliverability (including cost, risk and procurement).</td>
<td>- Solutions not required in submission.</td>
<td>- Sensitivity analysis of shortlisted options to confirm choice of preferred option is robust.</td>
<td>- Detailed delivery outcomes, including cost recovery targets maximised considering all potential revenue streams.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core element</th>
<th>Stage and purpose</th>
<th>Early stage</th>
<th>Real potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem Identification</strong></td>
<td>Identify the problems that may hinder the achievements of goals.</td>
<td>- Economic, social and environmental costs estimated qualitatively.</td>
<td>- Quantified economic, social and environmental impact of the identified problem, supported by data (e.g., Surveys, studies, performance against key performance indicators).</td>
</tr>
<tr>
<td><strong>Problem Assessment</strong></td>
<td>Gather data rich evidence that demonstrates the problems and allows the biggest problems to be prioritised.</td>
<td>- Examined back to goals within the state or regional strategy.</td>
<td>- Analysis presented that demonstrates the root cause.</td>
</tr>
<tr>
<td><strong>Problem Analysis</strong></td>
<td>Analyse the extent of problems and the root causes.</td>
<td>- Explained of why the problem can’t be solved without Government intervention.</td>
<td>- Solution Section</td>
</tr>
<tr>
<td><strong>Option Generation</strong></td>
<td>Develop a full range of possible solutions to address the issue including reform and investment proposals.</td>
<td>- Specific solution options are not required in submission.</td>
<td>- Proposal supports infrastructure Australia’s strategic priorities and aligns with state plans.</td>
</tr>
<tr>
<td><strong>5. Option Generation</strong></td>
<td></td>
<td></td>
<td><strong>Proposal will make a positive contribution to infrastructure Australia’s strategic priorities.</strong></td>
</tr>
<tr>
<td><strong>6. Option Assessment</strong></td>
<td>Strategic analysis and cost benefit analysis to access the viability of the options.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>7. Solution Evaluation</strong></td>
<td>Detailed business case for the preferred option including cost benefit analysis, strategic fit and deliverability (including cost, risk and procurement).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core element</th>
<th>Stage and purpose</th>
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<th>Real potential</th>
<th>Threshold and, if all issues are addressed, ready to proceed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. Option Generation</strong></td>
<td></td>
<td></td>
<td>- Option evaluation criteria to measure performance against the goals of the proposal.</td>
<td></td>
</tr>
<tr>
<td><strong>6. Option Assessment</strong></td>
<td>Strategic analysis and cost benefit analysis to access the viability of the options.</td>
<td>- Option assessment not required in submission.</td>
<td>- Comprehensive list of reform and investment options identified (reduce demand, improve productivity, increase supply)</td>
<td></td>
</tr>
<tr>
<td><strong>7. Solution Evaluation</strong></td>
<td>Detailed business case for the preferred option including cost benefit analysis, strategic fit and deliverability (including cost, risk and procurement).</td>
<td>- Solutions not required in submission.</td>
<td>- Sensitivity analysis of shortlisted options to confirm choice of preferred option is robust.</td>
<td>- Detailed delivery outcomes, including cost recovery target maximised considering all potential revenue streams.</td>
</tr>
</tbody>
</table>

**Figure 1: Infrastructure Australia’s reform and investment framework**

**Core element**

- **Strategic Alignment**
  - Proposal supports infrastructure Australia’s strategic priorities and aligns with state plans.

**Problem Evaluation**

- Problem being addressed is well understood and constrains achieving intended goals. The costs of the problem and potential benefits are presented and supported by evidence.
  - Understanding causes allows effective and targeted solutions to be created.

**Problem Identification**

- Identify the problems that may hinder the achievements of goals.

**Problem Assessment**

- Gather data rich evidence that demonstrates the problems and allows the biggest problems to be prioritised.

**Problem Analysis**

- Analyse the extent of problems and the root causes.

**Option Generation**

- Develop a full range of possible solutions to address the issue including reform and investment proposals.

**Option Assessment**

- Strategic analysis and cost benefit analysis to access the viability of the options.

**Solution Evaluation**

- Detailed business case for the preferred option including cost benefit analysis, strategic fit and deliverability (including cost, risk and procurement).
Project proponent selection: International practices

UK practice

Innovation is one of the key elements in United Kingdom’s infrastructure procurement route map (Figure 2). For example, Innovative Contractor Engagement is a new approach that was used by the London Underground to reward contractors sufficiently so as to bring innovation into early stages of design. This Innovative Contractor Engagement (ICE) approach has several key features such as contractor short listing based on ability to innovate, protect contractors’ intellectual capital related to their own innovations, sharing the value of innovative ideas from losing bidders and revision of the requirement in tender documents to include the benefits of innovative ideas (HM Treasury 2013).

Figure 2: UK’s infrastructure procurement route-map: Overview

It can be seen that in the UK innovation is appreciated in infrastructure investment and bidders are encouraged to propose their new and innovative ideas.
Canadian practice

Innovation is also a key criterion in Canadian infrastructure delivery submissions. Innovation submission by proponents is reviewed as one of the main steps in the evaluation process in Canada (Infrastructure Ontario 2009). The Canadian government requires that Innovation-related issues are included in request for proposal documents. Protecting bidders’ intellectual capital, accepting or rejecting innovation ideas in submissions are some of these innovation related subjects.

An evaluation of several infrastructure Requests for Proposal tenders (RFP) in Canada concluded that Canada acknowledges the importance of innovation in infrastructure delivery. It is considered one of the key selection criteria.

Comparison of proponent selection practice - Analysis

In choosing project proponents different factors are usually considered including economic analysis, options analysis, cost benefit ratio, risk management issues, funding and financial arrangement, and contracting and delivery method. These considerations are usually practiced in bidding and tendering processes and are included in bidding documents. One of the important stages in a projects lifecycle is to promote and evaluate innovation very early in the tendering selection process.

Infrastructure Australia’s submission guidelines currently have no explicit consideration of innovation when different proponents are asked to submit their proposals (Infrastructure Australia 2012). However, as discussed, in Canadian and UK practices innovation is clearly included as one of the key elements in tender documents.

Notably none of these proponent selection arrangements consider project management style. Later in this report we expand a Telco example that clearly demonstrated that project management can assist in achieving value. Can similar approaches be used for other major infrastructure?
Conclusions from current innovation literature research

1. Current definitions of innovation are incomplete as they do not consider all the measures for innovation in major projects. The following considerations need to be taken into account when evaluating innovation:

- Innovation is more than only investing in R&D or applying high technology. It has a broader meaning which can include business structuring, management systems, design, project management styles, construction, procurement, networking and alliances, financial arrangements, customer experience, processes, products, services and many other alternate approaches.

- Innovation has four main characteristics: newness, capability of making change, possibility of being implemented and creating value.

- Innovation does not need to be radical. Often accumulation of continuous incremental improvements can come to have large positive impacts.

2. Innovation is not necessarily expensive. There are some aspects for investment which can lead to improved outcomes by spending little amounts of money or time. Early project governance, managing people effectively and having a vision for change as well as accepting a "no blame" environment are not expensive but have been critical for successful project outcomes.

3. Contracts and procurement strategies are areas for innovation that have great impact on the stimulation of innovation. Strategies with mechanisms for sharing risk such as Public Private Partnership (PPP) or Project Alliancing can act as innovation drivers in infrastructure projects.

4. Current Australian practice does not give tenders due credit for the innovation they offer in their bids.

To address the above mentioned issues an industry workshop was planned to evaluate innovative projects and their outcomes and this is presented in detail in the Appendix to this report. A summary of the findings are presented here.
Industry workshop

Methodology

The investigation involved a grounded theory approach using three case study projects in an industry workshop environment. The combination of a grounded theory method and multiple case studies has been undertaken and tested previously by researchers (Fernández, 2004). Grounded theory is a method in which rather than beginning with a hypothesis the first step is data collection via different methods and then analysing data to drive a theory out of a real set of data (Branney & Strauss 2006). The advantage of a case study method is the availability of good sources of real data and information to incorporate into research and analysis (Yin 2009) suggests that multiple case studies allow comparison and analysis of similarities and differences between cases. This method enables researchers to use a wide range of data sources such as interviews, workshops, expert opinion, and personal observations along with what could be gained from a literature search (Karen 2003).

The cases were drawn from current Australian infrastructure projects that claimed to foster innovation or had change and sustainable outcomes or sought to deliver enhanced productivity together with a variety of ownership structures (public, private and PPP). The case projects were selected from different industry fields (ICT/telecommunication, rail transport and health care infrastructure projects).

Case projects

The portfolio of case studies included three projects:

The first case was a major change management project to customise and improve customer experiences with a call center involving robotic response and the associated ICT networks and distribution routes. It is a private sector company practising an agile project management method with a focus on in-house resources using different technical teams.

The second case was a landmark infrastructure project in Victoria which expands the rail network throughout the metropolitan and regional areas. It is a state and federal government funded project aiming at removing major bottlenecks in Victoria's rail network. It practises a mix of alliance and design and build contracts with a focus on appropriate work packaging.
The third case was construction of a very high-tech health facility building with new and innovative equipment, instruments and tools for research purposes. This project is funded by the federal and state governments with additional funds from equity investors and some other sources. It has a PPP structure and there are a few national and international banks involved in financing it. The architectural design team is led by an international design company in partnership with local companies.

**Case projects characteristics**

Table 6 compares the characteristics of the three case projects to illustrate how these different projects consider innovation. These results are the outcomes from discussions with industry experts.

**Table 6: Comparison different characteristics of three case projects**

<table>
<thead>
<tr>
<th>Project type Characteristics</th>
<th>Engineering-heavy construction projects</th>
<th>High-tech health care projects</th>
<th>ICT-tele com projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility for Change (e.g. Scope of project)</td>
<td>Least flexibility for change</td>
<td>Semi-flexible</td>
<td>Fully flexible</td>
</tr>
<tr>
<td>Appetite for Risk Taking</td>
<td>Very low</td>
<td>Medium/Low</td>
<td>High</td>
</tr>
<tr>
<td>Pace of Change in the industry field</td>
<td>Slow</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>What is VfM for these projects</td>
<td>Low cost and on time delivery, low risk, high benefits, high quality</td>
<td>On time and budget, low operating costs, client satisfaction</td>
<td>High customer satisfaction, high quality and operating efficiency</td>
</tr>
<tr>
<td>Value Measurement Criteria</td>
<td>Cost, time, price, degree of risk</td>
<td>Costs/client</td>
<td>Market growth</td>
</tr>
<tr>
<td>Perspective on Risk</td>
<td>Risk averse</td>
<td>Highly risk averse</td>
<td>Risk taker</td>
</tr>
<tr>
<td>Degree of Risk Consideration or Measurement</td>
<td>Prefer to avoid or minimize risk</td>
<td>Research platform to manage risk</td>
<td>Ready to accept consequences even of failure</td>
</tr>
<tr>
<td>Deliverables</td>
<td>Use of asset</td>
<td>Service and asset</td>
<td>Service</td>
</tr>
</tbody>
</table>
Participants and workshop

There were 20 participants in the workshop including the project managers from the three case study projects together with independent industry experts and researchers. The workshop was a full day event that was structured in an interactive environment and went through three steps of group discussion on five open ended questions followed by consolidation of findings and a plenary session. Having several independent industry experts on hand was very helpful to keep a balanced discussion among the participants and researchers and necessary for the consolidation of findings. The workshop provided a safe space to discuss industry experiences on how innovation is produced and captured in major projects in Australia and how innovation may arise in design, project management, finance and procurement and so forth. The workshop tried to:

- Capture views and thoughts of industry experts on how innovation is produced in major Australian infrastructure projects.
- Gain understanding of best practice and areas for improvement from these major projects.
- Arrive at a consolidated view of current project innovation practices.

After introductory speeches, all participants were then asked to break into three Project Groups to specifically discuss innovative practice related to their own projects. Participants were given a list of five questions and were asked to speak freely about current innovative practices they have in their projects. Further detail is provided in the appendix.

It is evident from the results that what is believed by industry experts is a little different from what is found in the literature. Table 2 illustrates the findings of the discussion on open ended questions in the workshop. Despite the early notion that these case projects may be very different, several areas of commonality were observed by one of the industry experts who led the discussion in the workshop.

The participants’ views and thoughts were summarized under eight common themes and in the following section a brief explanation of each theme is presented (see Table 3).

The first theme identified was the effective use of teams to promote and facilitate innovation. The industry experts believed that a team of people with a range of experience and skills is really needed to provide a collaborative environment. They also discussed the role of cross-functional teams to deal with complexity and uncertainties. The industry experts stated that all parties should be engaged from project inception to facilitate the establishment of a high performance team environment.
The second theme identified was governance. With governance the industry experts pointed out that the business case should be challenged from day one to assess its suitability and also to find out if there were any other options available. Having a mechanism for risk sharing, holding to a clear scope and keeping alternative solutions until late stages of project documentation were other issues related to this theme.

The third theme was vision, where the experts recommended three important points: flexibility for future changes, accepting mistakes, and welcoming changes. For example, changing the scope when it is required was one of the comments put forward by the participants. Taking advantage of technological advances to visualise the outcomes was also discussed.

The fourth theme concerned the creation of an environment for learning. This was encapsulated in the broader meaning of the term "learning space" meaning the creation of a learning environment (Senge 1997). They discussed the need for a space to learn continually with a focus on local and international lessons learned in order to be more efficient and to prevent repeated mistakes.

The fifth theme was related to measurement. This involved measuring the benefits and outcomes of the project. They emphasised the importance of making investment decisions based on real facts rather than promises and by having a bottom-up measurement system in place. This is basically the future direction for this research study.

The sixth theme was concerned with using new and alternative procurement methods to achieve better results. The main concerns with new procurement methods were the issues of risk sharing and defining logical and clear boundaries in the early stages of projects.

The seventh and second last theme revolved around environmental issues. These were seen as not only significant to their projects but were of wider social concern involving legacy issues. Industry participants were well aware that their own infrastructure projects would have a significant impact on future generations.

The last theme discussed was the framework or tool that might be used to facilitate innovation evaluation. This theme forms the direction for the next stage of this research.
### Table 7: Areas of innovation and innovative practices in Australian infrastructure projects

<table>
<thead>
<tr>
<th>Innovation themes</th>
<th>Innovative practices</th>
</tr>
</thead>
</table>
| **Teams**         | A range of skills and experience across public and private, industry and community sectors  
|                   | Appropriate skill set  
|                   | Required expertise  
|                   | Cross functional team to deal with complexity and uncertainty  
|                   | Open communication channels - Engagement of all parties as a team from day one  
|                   | Collaborative environment focusing on the best solution  |
| **Governance**    | Early stage governance: evaluate benefits from day one by challenging the business case  
|                   | Hold to a clear scope  
|                   | Risk sharing between clients and contractors  
|                   | Having alternative and competitive decisions in place until late stages  
|                   | Interactive tendering process: providing assistance for clarification such as workshops, electronic data room or even paying a portion of bidding cost to contractors  
|                   | Doing some parts of job in parallel if possible, for example, getting approvals in parallel with procurement  
|                   | Regular and continuous planning and control such as weekly meetings  
|                   | Provide a research platform to capture all ideas and past experience before and during tendering process  |
| **Vision**        | Flexibility for future changes  
|                   | Accepting mistakes  
|                   | Welcoming change: changing scope when required and possible  
|                   | Taking advantage of new technology to visualise the outcomes  |
| **Learning space**| Providing a space to learn continuously  
|                   | Lessons learned: considering local and international experience  |
| **Measurement**   | Promoting bottom-up measurement  
|                   | Making decisions based on real facts rather than promises  |
| **Procurement**   | Logical boundaries  
|                   | Risk sharing  
|                   | Work packaging  |
| **Environment drivers** | More than cost: Legacy and Sustainability (making decisions for the future)  |
| **Framework or tool** | Next Step: for future research  |
Conclusion, findings and areas for improvement from the workshop

The workshop covered a broad ranging series of topics around innovation. Each of the projects work shopped had its own perspectives on innovation but all collectively agreed that innovation is more than just design innovation or new technologies. The industry participants stated that by investing in non-technical aspects of innovation such as networks and relationships, teams, stakeholder engagement and the way personnel are managed within the organisation, better project outcomes are achievable. One of the agreed areas for improvement and investment was early stage governance that is related to business structuring. Other governance related examples were: benefits evaluation, risk sharing, holding to a clear scope and the early challenging of the business case.

The other important point is how these case study projects try to capture and evaluate innovation in their practices. Two projects used a traditional bidding and tendering process but they tried to incorporate innovation at the proponent selection stage. The other case study used an agile project management approach to encourage innovation. One of the important characteristics of an agile method is its high level of flexibility in managing projects which enables practitioners to quickly respond to a project’s changing needs.

What is generally referred to as innovation in the literature is more about R&D practices or technical aspects of innovation such as design innovation. However, from what was found in the workshop it became evident that innovation includes a broader concept. Innovation does not always need to be radical. Often accumulation of incremental improvements leads to an enhanced result which is perceived in the literature as better value for money. Notably, this was the first study of its kind which used a methodological approach that sought to collect real data and information about on-going projects within an innovation context. In fact, these results provide compelling evidence that by looking at incremental improvements in our projects we would be able to enhance our performance over longer period of time. These small improvements usually accumulate over time and would come to have large impacts.

Clearly, regardless of the barriers to achieving innovation, these case study examples have demonstrated that some projects still deliver excellent innovative outcomes. The challenge is to facilitate excellent outcomes for more projects and to ensure the project management process implemented captures the approach consistently.

To consider how one may ensure that the best practice identified is incorporated into a typical major project a detailed review of Infrastructure Australia’s current practice is critiqued against not only the case study results but also project management processes from similar international jurisdictions.
A review and comparison of results from the literature, workshop and local current practice

This section compares the results from the literature review, industry workshop and current Australian practise. Table 8 presents the summary of this comparison. From this comparison, two solutions can be proposed. Current Australian practise does not include the concept of innovation as part of infrastructure project management.

Table 8: Literature, workshop and current practices highlights

<table>
<thead>
<tr>
<th>Comparison of innovation issues highlighted</th>
<th>Literature</th>
<th>Workshop results</th>
<th>Current practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of innovation</td>
<td>An innovation is the implementation of a new or significantly improved product (good or service), or a process, new marketing method, or a new organisational method in business practices, workplace organisation or external relations. Innovation is defined as the channel through which improved knowledge is applied to economic processes. It is known as the engine of long-term economic development.</td>
<td>Innovation is more than just design innovation. Accumulation of incremental improvements can lead to better outcomes.</td>
<td>Innovation needs to be clearly defined in the context of infrastructure with reference to concepts such as value added, value for money, improved productivity.</td>
</tr>
<tr>
<td>Areas of innovation</td>
<td>Business structuring, management systems, design, project management styles, construction, procurement, networking and alliances, financial arrangements, customer experience, processes, products, services and other alternate approaches.</td>
<td>Teams, governance, vision, learning space, procurement, environmental drivers.</td>
<td>Potential areas for innovation in infrastructure need to be further studied.</td>
</tr>
<tr>
<td>Topic</td>
<td>Literature</td>
<td>Workshop results</td>
<td>Current practices</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Benefits of innovation</td>
<td>Productivity improvement, added value for money, overall impact on national economy.</td>
<td>Generally all participants were aware of the benefits of innovative ideas but no study was done specifically with regards to this in the workshop.</td>
<td>It is acknowledged that innovation can benefit the organisation and society as a whole but there are not any benefits referred to in current practices related to infrastructure projects.</td>
</tr>
<tr>
<td>Innovation risks</td>
<td>It has always been referred to as one of the main concerns. Sensitivity analysis or what-if scenarios are proposed to deal with risk.</td>
<td>This was not discussed in the workshop.</td>
<td>In current practice sensitivity testing is a key element of risk and uncertainty assessment</td>
</tr>
<tr>
<td>Innovation evaluation</td>
<td>Macro level evaluation, evaluating investment in R &amp; D practices, number of patents, investment in new technology, evaluating the capacity and capability of organisation to innovate.</td>
<td>This was discussed as one of the important stimulants that can promote innovation. It was also stated that there is a real need for bottom up measurement systems for project evaluation.</td>
<td>This is not explicitly considered in the proponent selection process but in agile project management there is a method to quantify the benefits of innovation.</td>
</tr>
</tbody>
</table>
The comparison of innovation issues highlighted in Table 8 suggests that there are two possible solutions to consider with regards to the introduction of innovation in infrastructure projects:

1. Applying the agile project management approach
2. Proposing possible changes to current infrastructure selection methodology to make it more suitable for incorporating innovation.
Development of an enhanced project management process to specifically incorporate assessment of innovation

Because innovation is not explicitly included in submission guidelines by infrastructure Australia there are some possible areas for improvement and modification including:

- What is the clear definition of innovation in the context of infrastructure (those practices that add more value for money such as application of new technologies)?
- How to incorporate innovation in selection of proponents.
- How to protect, reward and encourage bidders to bring forward new ideas.
- To identify the barriers that impede full configuration of innovation.
- Techniques for quantification of the potential benefits and disbenefits of innovative solutions or ideas.
- How to consider the associated risks with innovation when evaluating the solution.
- Recommendation on how to incorporate the findings.

The possibility of these changes being incorporated into submission guidelines and other related issues are now discussed.

The current Infrastructure Australia Reform and Investment Framework is presented in Figure 1. A proposed modified version of this framework is presented below (Figure 3) and with the recommended addition shown in blue at the bottom of the figure (item W). The details related to solution evaluation are provided in Table 9. Table 9 is a modified version of Infrastructure Australia’s Template 7 with the inclusion of innovation as a criterion.
Figure 3: Proposed change to the reform infrastructure investment framework

- **Strategic Alignment**
  - Goal Definition
    - a - Goals identification and alignments with state / regional strategic plan
    - b - Proposal prioritization with state / regional plans
    - c - Proposal assessment against contribution to infrastructure Australia’s strategic priorities
    - d - Economic, social and environmental goals definition and alignment with state goals
    - e - Integration demonstration across stakeholders and infrastructure sectors
    - f - Confirmation of alignment between benefits delivered and goals

- **Problem Evaluation**
  - Problem Identification
    - g - Describing current and future problems
    - h - Completions of scenario analysis
    - i - Linking back problems to goals with economic, social and environmental costs estimations
    - j - Quantification of problems impacts and demonstrating root causes
    - k - Explanation of why the problem cannot be solved without government interaction

- **Solution Evaluation**
  - Option Generation
    - l - Defining option evaluation criteria to measure performance against the goals
    - m - Providing a comprehensive list reform and investment options identified
    - n - Generation of a short list of viable options
    - o - Rapid BCR preparation for shortlisted options
    - p - Describing shortlisted options adequately
    - q - Cost estimation for shortlisted options (bottom-up)
    - r - Preparing contingency allowance for risk profile
    - s - Submitting robust and objective cost benefits analysis (supported by strong evidence)
    - t - Considering as many monetised economic benefits and costs as possible
    - u - Considering non-monetised benefits and costs
    - v - Considering issues of risk and uncertainty (sensitivity analysis)
    - w - Submission of innovation and its impact analysis
Template 7 is about proponent evaluation and selection. Based on the literature review and the expert industry workshop, we propose to add an innovation submission criterion (criterion number 6, Table 9). Assumptions and inputs related to this criterion are included but not limited to what is proposed under criterion 6 in Table 9.

**Table 9: Modified infrastructure template 7 with innovation inclusion**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Assumptions / Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demand modeling, assumptions and results</td>
<td>Outline the key drivers of demand, and describe the situation 'without' the initiative, i.e. the base case, including future works and associated capital, maintenance and operating costs.</td>
</tr>
<tr>
<td>2. Land use, population and employment forecasts</td>
<td>What land use, population and employment forecasts have been used and where have they been sourced from?</td>
</tr>
<tr>
<td></td>
<td>What is the range of projections over the period forecast and used in the economic appraisal? What are the annual employment and residential growth rates implied by these land use forecasts? What are the factors that will affect the likely outcome given the demand drivers identified?</td>
</tr>
<tr>
<td></td>
<td>If specific land use forecasts have been undertaken for the proposal what is the difference in terms of number of jobs and residents compared to the base case land use in the last year the forecasts are produced for?</td>
</tr>
<tr>
<td></td>
<td>Has there been any redistribution of jobs and residents and if so, what are the assumptions underpinning this redistribution?</td>
</tr>
<tr>
<td>3. Demand modeling outputs</td>
<td>What demand model was used to generate the forecasts and who undertook the demand modeling?</td>
</tr>
<tr>
<td></td>
<td>What time period was modeled (for example a one hour AM peak on an average weekday, 24 hour period on an average weekday, etc.)</td>
</tr>
<tr>
<td></td>
<td>What expansion factor was used to translate the period of the day modeled into a daily observation?</td>
</tr>
<tr>
<td></td>
<td>What sources informed this expansion factor?</td>
</tr>
<tr>
<td>Criteria</td>
<td>Assumptions / Inputs</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3. Demand modeling outputs (continued)</td>
<td>What expansion factor was used to translate the daily observation into an annual observation? What sources informed this expansion factor and / or what logic underpins it? Does the model calculate new or &quot;generated&quot; trips (as opposed to using a fixed trip matrix)? How does the demand model deal with the issues of induced demand?</td>
</tr>
<tr>
<td>4. Economic model parameters - costs</td>
<td>First year of construction / Last year of construction. State real discount rates used (if not 4, 7 and 10%), and the basis for any variation from these standard discount rates. State appraisal period in years, and basis for its selection. Remaining life of the initiative at the end of the appraisal period. Describe the basis for estimating all capital costs (for both base and project cases). Confidence level: are the construction costs P50, P90, P95? What is the basis for this estimate? What is the magnitude of contingency included in capital cost estimates (as a % of total costs)? What rate of escalation has been assumed over the construction period? What is the profile of the capital cost spend, for example: year 1 – 10%, year n – X%. Who were the capital cost estimates prepared by? Have they been independently verified? Describe the initiative's outturned costs ($M, nominal, undiscounted) Economic costs: Describe and justify any adjustments made to the initiative's outturned costs to generate an economic project cost. Economic cost - $M, real, undiscounted; and $M, real, discounted (using a real 7.0% discount rate). Residual value - State the size of the residual value, economic lives of the assets included in the residual value and the methodology used to generate it (see note above for methodology). Maintenance costs - Describe the basis for estimating all maintenance costs, including growth rates over time (for both base and project cases). Are the maintenance costs P50, P90, P95? What is the basis for this estimate and who prepared the maintenance cost estimates?</td>
</tr>
<tr>
<td>Criteria</td>
<td>Assumptions / Inputs</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------</td>
</tr>
</tbody>
</table>
| 4. Economic model parameters - costs (continued) | Replacement - Is there a need to replace or refurbish major components of the infrastructure / rolling stock during the appraisal period? If so, how are these replacement or refurbishment costs captured?  
Operating costs - Describe the basis for estimating all operating costs, including growth rates over time (for both base and project cases). Who were the operating cost estimates prepared by? Have they been independently verified? |
| 5. Economic model parameters - benefits | Benefits ramp up - Describe how benefits ramp up over the construction period, i.e. year 1 = 35%, year n = X%. What source and/or assumptions inform this ramp up?  
Benefit components - Describe the basis for estimating each benefit component, including growth rates over time.  
Cost and benefit time streams - Attach an appendix showing the time stream for each benefit and cost component ($M, real, undiscounted).  
Generalized trip cost - (GTC) this has been calculated on an origin – destination (OD) basis within the demand model, or using aggregate outputs from the demand model?  
Value of travel time:  
Commuter travel - What is the value of travel time used for this initiative? Does this value differ between modes? Is this value based on resource cost or willingness to pay?  
Business travel - Has a specific value been applied to business travel? If so, what was this value?  
Growth - Has any rate of escalation been applied to these values?  
Source - What are the sources for the values used and any assumptions incorporated into the value of travel time?  
Weightings - Describe the weightings which have been used to calculate the generalized trip cost.  
Wait / Access / Egress - What weighting has been applied to egress time? What is the source for this?  
Transfer - What transfer penalty has been applied? What is the source of this? |
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Assumptions / Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Economic model parameters - benefits (continued)</td>
<td>Boarding penalty - Has a boarding penalty been applied during the demand modeling and / or economic appraisal? If so, what is the magnitude of this boarding penalty (minutes) and how does it differ between modes?</td>
</tr>
<tr>
<td></td>
<td>Benefit parameters - List the value and source of all benefit parameters relevant to the appraisal. For example decongestion; Vehicle Operating Costs (for all classes of vehicles); Crash costs etc.</td>
</tr>
<tr>
<td></td>
<td>Related initiatives - Are the benefits and costs closely related to, dependent upon or potentially influenced by another initiative(s)? If so, explain how that has been accounted for in the BCR.</td>
</tr>
<tr>
<td>6. Innovation submission</td>
<td>Innovative Idea - list innovative ideas and propose a plan to implement them.</td>
</tr>
<tr>
<td></td>
<td>Costs/Benefits - list all costs and potential benefits associated with innovative ideas including monetized and non-monetized. Use the main economic model assumptions (such as: discount rate, appraisal period, time stream, basis for estimating, confidence level, contingency, escalation rate, ramp up and so forth) to show how the innovative ideas may affect the evaluation results.</td>
</tr>
<tr>
<td></td>
<td>Risk and uncertainty - list the risks related to the idea and propose a plan to manage them.</td>
</tr>
</tbody>
</table>

By adding criterion 6 to Template 7 it is necessary to include a section in the submission guidelines to provide the following information:

- A clear definition of innovation in the context of infrastructure.
- What can be considered as innovation with supporting examples?
- A disclaimer clause that innovative ideas may be rejected or accepted in full or partially accepted with modifications.
- Information on how a proponent’s intellectual property is protected and how they are rewarded for their innovative ideas even if they are not selected.

All the above mentioned points are summarized in Table 10:
Table 10: Required information for innovation submission by proponents

<table>
<thead>
<tr>
<th>Innovation submission:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>In order to encourage, reward and protect bidders for their innovative ideas the following information is provided:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>“An innovation is the implementation of a new or significantly improved product (good or service), or a process, new marketing method, or a new organisational method in business practices, workplace organisation or external relations”. The minimum requirement is that each of these changes must be new or significantly improved to the organisation (OECD, 2005).</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Impacts of innovation:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Innovative practices may happen in two main forms: radical change and incremental improvement. Radical changes are often based on breakthrough technology and knowledge advances and usually require considerable amounts of time and money. Incremental changes are small improvements in current practices which usually lead to better outcomes. Most of the time accumulation of these continues with small changes bringing remarkable outcomes.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Core characteristics of innovation:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>When talking of innovation, care should be exercised about its characteristics to get the right meaning of innovation. Innovation has four main characteristics including:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Newness: the practice should be new or significantly improved at least to the organisation</td>
<td></td>
</tr>
<tr>
<td>Being implemented: it is more than just proposing a new idea, it must be implemented or be planned for implementation</td>
<td></td>
</tr>
<tr>
<td>Making change: by implementing it something will change, in other words it has some effects on organisations or projects</td>
<td></td>
</tr>
<tr>
<td>Creating value: the main purpose of implementing new ideas is adding more value or improving efficiency.</td>
<td></td>
</tr>
<tr>
<td>To put it together, innovation is more than just investing in R&amp;D practices or new technology. It can happen in different ways from managing people to design innovation or financial practices. Innovation does not necessarily require spending too much money, sometimes practicing innovative activities may only take a small expenditure or a little more time than usual.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The client’s right to accept or reject innovation submission:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The client is totally authorised to reject, accept or accept with further negotiation any submitted innovation in any proposal.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bidders’ right in proposing innovations:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The intellectual property of proponents for their innovative ideas is fully recognised by the client even with losing bidders rewarded for their ideas if they will be used by the client.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Types of Innovation:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>Definition</td>
</tr>
<tr>
<td>Business structuring</td>
<td>The first step in any kind of business and it is known as the main building block of each business.</td>
</tr>
<tr>
<td>Innovation</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Management system</td>
<td>How the organisation tries to manage and organise itself. In other words it is a means to achieve an end in business objectives.</td>
</tr>
<tr>
<td>Design</td>
<td>A process when intelligence and creativity come together to solve a problem in an efficient way.</td>
</tr>
<tr>
<td>Project management style</td>
<td>Project management is the discipline of planning, organising, securing, managing, leading, and controlling resources to achieve specific goals.</td>
</tr>
<tr>
<td>Construction</td>
<td>Any activity which is done to construct the project.</td>
</tr>
<tr>
<td>Procurement</td>
<td>Contracting and logistics and the arrangement of resources.</td>
</tr>
<tr>
<td>Network and alliances</td>
<td>The management of relationships, personnel, and stakeholders.</td>
</tr>
<tr>
<td>Financial arrangement</td>
<td>How clients provide money for their project.</td>
</tr>
<tr>
<td>Customer experience (service)</td>
<td>What the customers do for the customer to meet their needs and ensure their satisfaction.</td>
</tr>
<tr>
<td>Process</td>
<td>Any process that is in place associated with planning or delivering projects.</td>
</tr>
<tr>
<td>Product</td>
<td>The project itself or any by-product of the project.</td>
</tr>
</tbody>
</table>
Are the proposed changes achievable? – Market soundings

To test if the proposed solution package is achievable a number of industry experts were asked to provide feedback. The interviewees were drawn from executive management levels with a track record in successful projects. Their recommendations have provided a realistic assessment of the findings.

The industry experts agreed that innovation was not necessarily expensive and that it could contribute to increased value for money in infrastructure projects. They said that it was important to create a management culture that had an innovation seeking approach.

Barriers to innovation included the issues of protecting intellectual property and the legal structure surrounding a project, particularly if the project involved an Act of Parliament. The idea of compensating unsuccessful bidders in a project was thought to be worth further analysis since an unsuccessful bidder may have a valuable idea that could be incorporated into a project. Consideration should be given to paying all or part of the costs of the bid process. With regard to projects involving Acts of Parliament, the legal framework itself can inhibit the application of innovative ideas if they are not in exact alignment with the Act. Government should consider more flexibility in the drafting of legislation to incorporate ideas in later stages of a project that were not originally envisaged. Government is perceived as risk averse and lacking flexibility which is a barrier to innovation. For example, it was hard to apply agile project management in government projects.

In large complex projects with long lead times involving governments something that was considered innovative at the initiation stage of a project may not be innovative at all by the time the project is actually ready to be implemented. This is due to the long time lag between project idea, cabinet approval and commencement of construction. The delay is usually years and technological advances may render the original solution obsolete.

In terms of ICT projects it was considered that advancements beyond the project management of the Telco example could be achieved by detailed critique of the business practices of corporations such as Google and Microsoft. These large multi-national corporations actively seek to identify and purchase innovative ideas for later development within their organisations. Whist beyond the scope of this specific study it raises the concept that ICT projects may gain real innovation by ‘hunting and gathering’. This raises the question of how to develop organisational mechanisms that foster the integration of embryonic innovation into major corporations. Such integration requires a whole of organisation approach which goes well beyond traditional thinking of project and program management as outlined.
In general, the industry experts agreed that there was value in incorporating an innovative approach at all stages of an infrastructure project.
Conclusions and recommendations

Based on the findings of this study the following points can be recommended:

- **Current definitions of innovation are incomplete as they do not consider all the measures for innovation in major projects.** The following considerations need to be taken into account when evaluating innovation:
  
  » Innovation is more than only investing in R&D or high technology. It has a broader meaning. Innovation can occur in different forms including business structuring, management systems, design, project management styles, construction, procurement, networking and alliances, financial arrangements, customer experience, processes, products, services and other alternate approaches.
  
  » Innovation has four main characteristics: newness, capability of making change, possibility of being implemented and creating value.
  
  » Innovation does not need to be radical. Often accumulation of continuous incremental improvement can come to have large positive impacts.
  
  » Innovation is not necessarily expensive. There are some aspects for investment which can lead to improved outcomes by spending little amounts of money or time, such as early project governance, managing network and alliances effectively and having a vision for change as well as an attitude of accepting mistakes.

- **Contracts and procurement strategies have great impacts on innovation promotion.** Those strategies which have reasonable mechanisms for sharing risk such as Public Private Partnership (PPP) or Project Alliancing can act as innovation stimulants in infrastructure projects.

- **The way project management is structured can have a significant impact on innovation drivers.** Project structuring can include project governance, managing people within the organisation, providing a space for learning and having a vision for welcoming changes and accepting mistakes.

- **Current Australian practice in infrastructure proponent selection does not include innovation.** Changes are required to be implemented to improve the current situation:
  
  » A clear definition of innovation should be provided appropriately in the context of infrastructure projects.
  
  » Innovation needs to be selected as one of the criteria in proposal evaluation.
A mechanism needs to be developed to protect the proponent’s intellectual property associated with their submitted innovations.

The risk of innovative ideas must be considered when evaluating the impacts of innovation.

Some approaches of the agile project management methodology seem to be applicable in the context of infrastructure projects. Applicable examples of agile strategies are: individual interactions, customer collaboration, transparency in communication and other people related issues. Further research in this field is required.

The thinking stimulated by agile project management appears to spark creative ideas yet the discipline required by major corporations, and by major infrastructure development necessitates that such creative thinking be integrated into the overall organisation in a manner that can be both controlled and that creates an audit trail necessary for sound governance.

Industry experts selected networks and alliances and business structuring as important elements for the introduction of innovative processes in infrastructure projects. It shows softer aspects of innovation are potential areas for investment in order to improve the outcomes.

Successful case study projects showed that teams, governance, vision, learning space, measurement, procurement and environmental drivers were the most successful practical areas for innovation.

Additional work

Future research is planned to include the development of a framework to evaluate the benefits of innovation in infrastructure projects. Another future study area is the identification of the characteristics required for a creative, collaborative working environment which may lead to enhanced outcomes in infrastructure projects.

The researchers would welcome any comments and feedback because this research is itself the starting point for understanding how innovation may be introduced and evaluated in infrastructure projects. Reader’s comments will be valuable to assist this research. It is part of the investigation for a doctoral thesis in the Department of Infrastructure Engineering at the University of Melbourne.

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soroushm@student.unimelb.edu.au
References


CEID (Centre for Excellence and Innovation in Infrastructure Delivery) (2010). Infrastructure Procurement Options Guide. Government of Western Australia.


Infrastructure Ontario (2009). Alternative Financing and Procurement Project: The Royal Victoria Hospital of Barrie Project. Available from <S:\Communications\AFP Projects\MoH\Royal Victoria (Barrie)\RFP\Royal Victoria Hospital - RFP.DOC>


Appendix 1: Workshop report

Workshop Report
Design Innovation: The State Of Play For Major Australian Projects

Department Of Infrastructure & Engineering
The University Of Melbourne
Wednesday 3rd October 2012

Prepared By:
Colin Duffield
Soroush Maghsoudi
Carolyn Ingvarson
1. **Objectives:**

The workshop provided a safe space to discuss industry experiences on how innovation is produced and captured in Australian major projects and how innovation may arise in design, project management, finance and procurement etc. The workshop tried to:

- Capture views and thoughts of industry experts on how innovation is captured in major Australian infrastructure projects;
- Gain understanding of best practice and areas for improvement from these major projects; and
- Arrive at a consolidated view of current projects’ innovation practices.

2. **Background:**

This research is the first one of this kind in Australia. The workshop is a part of a larger study on benefits of innovation that relate to service outcomes and sustainability through the use of different procurement techniques and a competitive bidding process in Australian projects.

3. **Workshop structure:**

The workshop was structured in following steps;

1. Registration
2. Welcome and introductions to context
3. Review the workshop purpose statement, the agenda, and the ground rules
4. Speeches from guest speakers
5. Three case projects discussion and facilitating the discussion
6. Reporting back findings of each group
7. Consolidation of findings
8. Panel discussion
9. Follow up from here
4. Introducing case studies:

4.1 Project A: A large national telecommunication/ICT project
This case is a major change management project to customize and improve customer experiences with a calling center involving robotic response and the associated ICT networks and distribution routes. It is a private sector company practicing agile project management method with a focus on in-house work using different technical teams.

4.2 Project B: A major rail transport project
This case is a landmark infrastructure project in Victoria which expands the rail network throughout the metropolitan and regional areas. It is a state and federal government funded project aiming at removing major bottlenecks in Victoria’s rail network. It practices a mix of alliance and design and build contracts with a focus on work packaging method.

4.3 Project C: A construction project of a high-tech healthcare building
This case is construction of a very high-tech health facility building with new and innovative equipment, instruments and tools for research purposes. This project is funded by federal and state government with additional funds from debt and equity investors. It has a PPP structure and there are a number of local and international banks involve in financing it. The architectural design team is led by a joint venture of local architectural companies.

4.4 Why these three specific projects are invited for this research
Critical to the success of this study would be the cross pollination of case examples from industry through an open forum, it was decided that those projects being sought would:
- claim to foster innovation, change and sustainable outcomes
- have a variety of ownership structures: government, PPP, private
- seek to deliver enhanced productivity

All these projects met these criteria and are innovative in how they work and manage their businesses.
5. Proceedings:

The workshop proceeded as follows:

Colin Duffield welcomed the participants to the Design Innovation: The State of Play for Major Australian Projects. He thanked the Department of Infrastructure and Transport for their financial support of the research and all participants. He introduced the research project and three case studies and talked through the purpose of the workshop and its structure. Two industry experts played an introductory role to the workshop and tried to frame the day from different points of views;

Firstly, Peter Newman spoke about how innovation is thought about by large government policy makers. He framed what’s happening at the Australian level. He focused the participants’ attention on the importance of dialogues and conversation to provide a creative learning space in order to foster innovative ideas. He said that innovation comes from a team not leadership or individuals.

Then Yvonne von Hartel talked about innovation from a design point of view and raised the importance and benefits of investing early in design over the lifecycle of projects. She emphasized the importance of getting a set of experts together who work as a team to develop a good design. She said that innovative design depends on quality, clarity and purpose of the brief and having a good set of assessment criteria in place to evaluate the design.

6. Workshop method:

The workshop went through a three step process of group discussion, consolidation of findings and plenary report.

6.1 Group discussion

After introductory speeches, all participants were then asked to break into three Project Groups to discuss specifically the innovative practice related to their own projects. Participants were given a list of five questions and were asked to speak freely about current innovative practices they have in their projects. The five questions were as follows:
1. What innovation practices do your projects have at the moment?
2. What was it about them that worked well? Do you have any demonstrable value for them?
3. What did not work well? And why?
4. Where do you see the greatest potential areas for future innovation?
5. How useful would an evaluation tool be for innovative design in infrastructure projects?

After answering questions, all three groups tried to consolidate their findings as well as rank the areas of innovation from 1 to 5 in their projects including; business model, management system, design, construction, procurement, network and alliances, financial arrangement, customer experience, service, product and process.

6.2 Reporting findings to whole group
A representative from each team reported their findings to the audience.

6.3 Plenary discussion
Peter Newman led the discussion on findings from the three groups under several headings while Colin Duffield and Yvonne von Hartel contributed ideas on consolidation as well. All groups discussed the main points rising from the exercise.

7. Results

7.1 Group reports
Each group's responses to the questions have been written up. The leader of each group is being sent their group's write-up for sign off as accurate reporting (the group report is sent separately from this report as an attachment). These documents will inform this section of the paper but will not be directly reported.

The answers to questions 1&2 are combined into ‘innovation practices’ and answers to questions 3&4 are combined into ‘areas for improvement’. Question 5 on possible evaluation tool will be addressed in section 8 (Discussion and Conclusion).

7.2 Consolidated report
Table 1 shows the results of a task in the workshop when different case projects were asked independently to rank to what extent they think they are innovative in the listed areas which represent different forms of innovation. They did this task collectively in each project group but independent of other groups. This ranking was done on a scale of 1 to 5. “1” represents not innovative while “5” was specified for the best innovative area and “N/A” is an option for not applicable.

Table 1: Case projects ranking of innovative areas

<table>
<thead>
<tr>
<th>Areas of innovation</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project A</td>
</tr>
<tr>
<td>Business Model</td>
<td>4</td>
</tr>
<tr>
<td>Management System</td>
<td>2</td>
</tr>
<tr>
<td>Design</td>
<td>4</td>
</tr>
<tr>
<td>Construction</td>
<td>5</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Network and Alliances</td>
<td>5</td>
</tr>
<tr>
<td>Financial Arrangement</td>
<td>2</td>
</tr>
<tr>
<td>Customer Experience</td>
<td>3</td>
</tr>
<tr>
<td>Service</td>
<td>2</td>
</tr>
<tr>
<td>Process</td>
<td>4</td>
</tr>
<tr>
<td>Product</td>
<td>5</td>
</tr>
</tbody>
</table>

5=best, 4=good, 3=to some extent, 2=a little, 1=not innovative, N/A=not applicable

As it is shown Network and Alliances and Business Structuring were two areas that all three projects ranked very high. It appears that these case projects by investing in soft aspects of innovation rather than technical ones have got better results. It implies the fact that it is not necessarily needed to look only at high tech picture or technical side of innovation to improve the performance. There are incremental improvements which may look unimportant but accumulation of those changes over time may come to have a large impact on performance.

One of the interesting results from the discussion around the consolidation of findings is that it is not necessary to implement radical changes to be innovative and improve the performance. Sometimes incremental improvements can lead to remarkable outcomes. The other thing would be the fact that in most cases, managing relationships and alliances makes a big difference.
7.3 Plenary discussion findings

Table 2 illustrates the findings of the discussion on open ended questions in the workshop. Several areas of communality were introduced by one of the industry experts who led the discussion in the workshop. Despite the early notion that these case projects may be very different, as it can be seen in the Table 2 there are many areas of commonalities among these infrastructure projects.

Table 2: Paraphrased summary of findings

<table>
<thead>
<tr>
<th>Innovation areas</th>
<th>Innovative practices</th>
</tr>
</thead>
</table>
| **Teams**        | • A range of skills and experience across public and private, industry and community sectors  
                   • Appropriate skill set  
                   • Required expertise  
                   • Cross functional team to deal with complexity and uncertainty  
                   • Open communication channels  
                   • Engagement of all parties as a team from day one  
                   • Collaborative environment focusing on the best solution |
| **Governance**   | • Early stage governance: evaluate benefits from day one by challenging the business case  
                   • Hold to a clear scope  
                   • Risk sharing between clients and contractors  
                   • Having alternative and competitive decisions in place until late stages of project documentation  
                   • Interactive tendering process: providing assistance for clarification such as workshop, electronic data room or even paying a portion of bidding cost to contractors  
                   • Doing some parts of job in parallel if possible, for example; getting approvals in parallel with procurement  
                   • Regular and continuous planning and control such as weekly meetings  
                   • Provide a research platform to capture all ideas and past experience before and during tendering process |
| **Vision**       | • Flexibility for future changes  
                   • Accepting mistakes  
                   • Welcoming change: Changing scope when required and possible  
                   • Taking advantage of new technology to visualize the outcomes |
| **Learning space** | • Providing a space to learn continuously  
                        • Lessons learned: Considering local and international experience |
As the participants’ views and thoughts were summarized under eight common areas, in the following section a brief explanation of each area with related highlights is presented.

By team, they believed a right group of people with a range of experience and skills is really needed to provide a collaborative environment. They also talked about the role of cross functional teams to deal with complexity and uncertainties. They stated that all project parties should be engaged from very early stages as a team.

With governance they pointed out that the business case should be challenged from the day one to assess its suitability and also to find out if there is any other option available. Having a mechanism for risk sharing, holding to a clear scope and keeping alternative solutions until late stages were other issues in this regard.

With regard to vision, they recommended three important points; flexibility for future changes, accepting mistakes and welcoming changes. For example, changing the scope when it is required was one of those comments put forward by the participants. Taking advantage of technology advances to visualize the outcomes was raised by participants as well.

They discussed the need for a space to learn continually with a focus on local and international lessons learned in order to be more efficient and to prevent repeated mistakes.

They also particularly emphasized the importance of making investment decisions based on real facts rather than promises by having a bottom-up measurement system in place. This is basically the future direction of this research study.
New and alternative procurement methods were discussed as well to get better results. The main concern with new procurement methods were the issues of risk sharing and defining logical and clear boundaries in early stages of projects. Environmental issues were of concern to them as well not only as a project matter but also as an important future issue of the country and the next generations.

8. Discussion and conclusions

Prior works have documented the impacts of investing in R&D practices on innovation (BIS, 2011; OECD, 2005, 2011) and some others have been trying to brought forward the importance of high tech concepts on producing innovation in projects (Flamm, 2010; Hardie & Newell, 2011; Leiringer, 2006; Rose & Manley, 2012). There are also some other works which have focused on establishing the relationship between investing in innovation and the overall economic development at national or macro levels (NESTA, 2009). However all those studies have achieved remarkable outcomes but they have focused on high tech picture of innovation, investing in R&D practices and the overall impacts at macro level. In this study, it has been tried to understand what can be considered as innovation, how it can produced and accomplished in infrastructure projects context by capturing thoughts and views of industry experts and practitioners. It is found that by investing in non technical aspects of innovation such as network and relationships, team work, stakeholders’ management and the way personnel are managed within the organisation we can achieve better outcomes. Early stage governance of projects that is related to business structuring is one of those areas on which most of the experts agreed as a potential area for investment and improvement. Challenging the business case very early, benefits evaluation, risk sharing, holding to a clear scope and so forth are some examples of project governance. Notably, this was the first study of this kind with its methodology approach which sought to collect the real data and information of on-going projects within innovation context.

In fact, these results provide compelling evidence that by looking at incremental improvements in our projects we would be able to enhance our performance over longer period of time. These small improvements usually accumulate over time and would come to have large impacts. Future work is planned to include follow up work to develop a framework to evaluate the benefits of innovation in infrastructure projects. The other area for future work could be to identify the characteristics of the regenerative working environment which may lead to more innovative ideas in infrastructure projects.
Attendees:

Peter Newman
(Presenter, Chair)
Professor, Curtin Sustainability Policy Institute, Curtin University of Technology

Colin Duffield
(Presenter, Facilitator)
Associate Professor, Engineering Project Management Group
Department of Infrastructure Engineering, University of Melbourne

Yvonne von Hartel
(Presenter)
Principal at Peckvonhartel, Architecture & Planning Industry

Telecommunication Project People
- Project Manager
- Senior Technologist
- Program Manager
- Customer Access Technologies
- Project Manager

Health Building Project People
- Project Manager, Design & Construction
- Client Representative
- Associate Director

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