Innovative Products ARC Research Project

REPORT 1: BACKGROUND STUDY

Conceptual Literature Review and Industry Stakeholder Issues

Dr Tim Rose (Ph: 07 3138 7667)
Dr Karen Manley (Ph: 07 3138 1762)

School of Urban Development
Facility of Built Environment and Engineering
EXECUTIVE SUMMARY

Australian transport, energy, water, communication and social infrastructure is in crisis after 20 yrs of underinvestment. In response, Australian governments have launched the most ambitious infrastructure investment plans developed in our history, particularly in those states impacted by spiralling resource exports, Queensland and Western Australia. The ability to deliver on these plans is severely constrained by rising construction costs and pressing industry resource shortages, predominantly in project delivery expertise. Innovation in the delivery and operation of infrastructure projects promises to alleviate such constraints.

The Australian Research Council (ARC) Innovative Products Project aims to facilitate project innovation by exploring means to improve the diffusion of innovative products to road and bridge projects. It adopts a highly novel approach to achieve this end, developing three different ways of viewing the problem: (1) as a relational governance issue, (2) as an absorptive capacity issue and (3) as a knowledge intermediation issue.

This report presents the results of the first phase of a three phase fieldwork program. As such, it provides direction for the next stages of the Innovative Products ARC Research Project, which comprises the major survey in 2011, followed by the focus group study in 2012. This report is split into two parts. Part 1 presents a literature review relating to the three different ways of viewing the problem of inadequate adoption of innovative products. These three ‘problem lenses’ will be used to guide and interpret the fieldwork. Part 2 discusses the issues raised by interviews with Queensland project stakeholders concerning the adoption of innovative products on road and bridge projects.

PART 1 ‘Problem lenses’ for guiding and interpreting fieldwork

AIM

The aim of the literature review was to identify indicators of performance associated with the three ways of viewing the problem. The indicators helped guide interpretation of the issues identified from the Industry stakeholder interviews and will be used to refine our approach to upcoming fieldwork.

METHOD

In establishing a starting point for this research, literature was reviewed from the general management and innovation management areas. Key articles were then uncovered from a large body of empirical and theoretical literature - primarily from seminal management journals. Cross referencing was also conducted from construction management literature.

FINDINGS

The literature review broadly identified the system dynamics relating to the three ways of viewing the problem, where 18 indicators of performance were revealed. These indicators allow us to empirically assess the nature and roles of various stakeholders in the process of new product adoption on road and bridge projects. In the survey and focus group program, we will frame questions around each of the indicators in order to get a full understanding of the problem. The indicators are listed below under each of the three problem lenses.
<table>
<thead>
<tr>
<th>Relational Governance indicators</th>
<th>Absorptive Capacity indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Managing team boundaries</td>
<td>8. <strong>Exploratory learning</strong>: the ability to recognise and understand potentially valuable new external knowledge outside the firm;</td>
</tr>
<tr>
<td>2. Macroculture development</td>
<td>9. <strong>Transformative learning</strong>: the ability to assimilate valuable external knowledge; and</td>
</tr>
<tr>
<td>3. Incentives and collective sanctions</td>
<td>10. <strong>Exploitative learning</strong>: the ability to apply assimilated external knowledge to create new knowledge and commercial outputs.</td>
</tr>
<tr>
<td>4. Reputation of participants</td>
<td></td>
</tr>
<tr>
<td>5. Trustworthiness: Ability</td>
<td></td>
</tr>
<tr>
<td>6. Trustworthiness: Integrity</td>
<td></td>
</tr>
<tr>
<td>7. Trustworthiness: Benevolence</td>
<td></td>
</tr>
</tbody>
</table>

### PART 2 Industry stakeholder issues

**AIM**

The aim of the project stakeholder interviews was to gain an in-depth understanding of industry stakeholder issues relating to new product adoption on road and bridge projects, as a key input to shaping the scope of the next stages of our research project.

**METHOD**

Between January and May 2010, the project investigators undertook 10 in-depth interviews with Queensland project representatives, selected to represent views from both client and the head contractor stakeholders. The stakeholder interviewees comprised 10 senior managers; six from Queensland Government client agencies and four from head contractor organisations. All interviews were in-person, ranged from 60 to 90 minutes in duration, and were based on structured and unstructured questioning. The issues raised by the interviewees were identified and organised using content analysis of interview data. Problems were found to be associated with two broad construction contexts: (1) the project delivery environment and the (2) on-going business environment. The literature on these two areas is reviewed in this report as background to a discussion of how the interviewees felt associated problems manifested in the Queensland context. Following this, the problems identified by the interviewees are interpreted through the three problem lenses: (1) relational governance, (2) absorptive capacity and (3) knowledge intermediation.

**FINDINGS**

Nine problem areas were identified from the interview data, five relating to the project delivery environment and four relating to the on-going business environment. They are as follows:

**Project delivery environment**

1. **Goal alignment and incentives** - Project goals need to be incentivised to promote client and contractor motivation to propose (and approve) innovative products. In particular, the contractor may need to be offered a share of cost savings achieved through innovation - as usually happens in a project alliance environment. However, incentives should be offered for performance in other areas outside project cost savings to encourage a well-rounded approach to innovation uptake, for example, incentives for exceeding long term operational performance benchmarks.

2. **Contractor tender assessment** - The clients' program pressure and lack of resources negatively impacts on their ability to assess and approve alternative tenders. Hence, the contractor is less inclined to propose alternative tender options if it is believed the client cannot fairly assess them.

3. **Contractual relations** - Under an alliance contract, the client has a good understanding of the project and may therefore be motivated to relax specifications for project benefit and share success (improving innovative product uptake opportunities). A key problem is that the benefits for the road network as a whole may be compromised in the process. Under Public Private Partnerships, the contractor is provided with greater flexibility in specifying products and is not likely to compromise on quality due to contractor responsibility for the long term asset performance. A key problem is that, compared to alliances, PPPs often lack the drivers for cooperation and innovation. Traditional contracts suffer much more than alliances or PPPs, as they contain no relationship or responsibility drivers at all.
4. **Problem solving and idea assessment during design & construction** - Client responsiveness to new ideas proposed during design and construction is constrained, so the contractors’ motivation to propose innovative product options from subcontractors/suppliers is reduced. These constraints include inconsistencies in how ideas are presented to the client and the large number of unsuitable ideas causing backlogs in the clients’ assessment process, resulting in slower response times.

5. **Contractor involvement in design stages** - Contractors need more influence over design to provide more opportunity for proposing the use of alternative products before construction commences. Contractors need more input on constructability and value engineering when budget is tight.

**On-going business environment**

6. **Product development** - A lack of client product trialling is reducing the number of alternative products clients can approve during the tender process, particularly due to the long lead time required for efficient product trialling. Complexities and risks associated with undertaking product trials and a lack of agreed protocols for assessment of performance are also impeding the adoption of new products. Although contractors source new product knowledge externally, there is minimal contractor internal development or trialling. Clients and contractors have different ideas about where the balance lies between them in terms of the responsibility for trialling.

7. **Prequalification** - There is a need for widespread adoption of prequalification of contractors based on their prior history of project performance, including time, cost, quality and innovation.

8. **Agency specifications** - Stakeholders acknowledge that performance-based specifications are better for innovative product adoption than prescriptive specifications, but a ‘dual’ approach may be required as a pure performance-based system may not be ideal for some products/materials. There is concern over lack of agreed methodology and client resources to effectively assess if a product meets the performance intention.

9. **Product liability and warranties** - Clients can be more conservative in their assessment of product liability risk than non-client stakeholders, creating friction between the two groups. At the same time, clients believe suppliers and contractors undertake an insufficient amount of product testing and verification prior to presentation of innovations to the client. More testing by non-clients may encourage clients to become more open to new product ideas. Client conservatism is further impacted by difficulties in encouraging suppliers to accept extended warranties.

**REPORT CONCLUSION**

The results of the first phase of a three-phase fieldwork program revealed unique challenges to innovative product uptake in the road and bridge sector. A key challenge to adoption was found to be related to the client’s absorptive capacity, particularly their ability and willingness to assess and approve alternative products. Although the contractor was identified as being in a strong position to propose innovative product options, key features of the delivery system were found to influence contractor motivation to propose innovative product options. These features included the strength of contractual relations, the use of incentives and the tender approach. It was also discovered that client agency specifications and product liability issues have a significant impact on client and contractors’ motivation to propose and approve innovative products for use. Challenges include the complexity and risk of undertaking product trials and a current lack of agreed protocols for assessing if products meet their performance intentions under performance-based specifications. We will be exploring in further detail the nature of these challenges in the research activities to follow, namely the major survey and focus group study.
Overview

This report is divided into two parts. Part 1 provides the conceptual background to the Innovative Products ARC research project. Part 2 provides the results of 10 background interviews conducted in Queensland with industry stakeholders associated with the research project. Part 2 also analyses those results through the problem lenses described in Part 1.

PART 1 - ‘PROBLEM LENSES’ FOR GUIDING AND INTERPRETING FIELDWORK

INTRODUCTION

Part 1 of this report presents a review of literature relating to three different ways of reviewing the problem of inadequate adoption of product innovation, namely: (1) as a relational governance issue, (2) as an absorptive capacity issue and (3) as a knowledge intermediation issue. These three problem lenses have been shown to contain the key determinants of innovation outcomes under open innovation systems (ARC 2009). The literature review was undertaken to identify indicators of performance associated with each of the problem lenses. The indicators helped guide interpretation of the issues discovered from the key stakeholder interviews and will be used to frame our approach to upcoming fieldwork, namely the major survey and focus group study. In establishing a starting point for this research, literature was sourced from the general management and innovation management areas. Key articles were then uncovered from a large body of empirical and theoretical literature - primarily from seminal management journals such as The Academy of Management Review, Organization Studies, Strategic Management Journal, and Research Policy. Cross referencing was also conducted from construction management literature such as Construction Innovation, International Journal of Project Management, Building Research and Information and Journal of Construction Engineering and Management. These latter sources provide background on the research context – the construction innovation system. The key articles from the general and construction management fields offer valuable insights into the conditions for effective knowledge flow across and within project-based organisations. They also describe the optimal roles played by key actors in the system, such as the role of knowledge intermediaries.

We present ideas from this body of knowledge that ‘unpack’ the three problem lenses and provide indicators of innovation performance to investigate the research problem, ‘How can we improve adoption of innovative products on road and bridge projects?’. In doing so, we reveal gaps in the flow of knowledge across the innovation system that currently impede uptake of innovative products. Table 1 shows the innovation indicators discovered through the literature review to follow, organised by the three problem lenses.
## Table 1: Innovation Indicators

<table>
<thead>
<tr>
<th>Relational Governance indicators:</th>
<th>Absorptive Capacity indicators:</th>
<th>Knowledge Intermediation Indicators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Managing team boundaries</td>
<td>8. Exploratory learning: the</td>
<td>Knowledge intermediary roles</td>
</tr>
<tr>
<td>2. Macroculture development</td>
<td>ability to recognise and</td>
<td>11. the consultant</td>
</tr>
<tr>
<td>3. Incentives and collective</td>
<td>understand potentially valuable</td>
<td>12. the broker</td>
</tr>
<tr>
<td>4. Reputation of participants</td>
<td>new external knowledge</td>
<td>13. the mediator</td>
</tr>
<tr>
<td>5. Trustworthiness: Ability</td>
<td>outside the firm;</td>
<td>14. the resource provider</td>
</tr>
<tr>
<td>6. Trustworthiness: Integrity</td>
<td>9. Transformative learning: the</td>
<td>Knowledge intermediary activities</td>
</tr>
<tr>
<td>7. Trustworthiness: Benevolence</td>
<td>ability to assimilate valuable</td>
<td>15. Access</td>
</tr>
<tr>
<td></td>
<td>external knowledge; and</td>
<td>16. Learning</td>
</tr>
<tr>
<td></td>
<td>10. Exploitative learning: the</td>
<td>17. Linking</td>
</tr>
<tr>
<td></td>
<td>ability to apply assimilated</td>
<td>18. Implementation</td>
</tr>
<tr>
<td></td>
<td>external knowledge to create</td>
<td></td>
</tr>
<tr>
<td></td>
<td>new knowledge and commercial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>outputs.</td>
<td></td>
</tr>
</tbody>
</table>

These indicators are discussed in depth below. The first way of understanding the problem is to interpret it as a relational governance issue, as shown below.

## Relational Governance

Governance can be defined as a set of principles concerning the governing of organisations and how these principles are disclosed or communicated externally (Parum 2005). Similarly, Daily, Dalton and Cannella (2003) broadly define governance as ‘the determination of the broad uses to which organisational resources will be deployed and the resolution of conflicts between the myriad of participants in organisations’ (p.371). The principal agent framework plays a central role in guiding such resource allocations to avoid conflict. Agency theory shows how governance systems can provide incentives for organisational performance. These governance systems are intended to address two key problems in the relationship between a principal and their agent: (1) conflict between the goals and desires of the principal and agent, particularly concerning the different attitudes towards risk; and (2) difficulty for the principal in verifying the motivation and action of the agent (Eisenhardt 1989). Corporate governance literature specifies a range of governance measures that can be used to address the agency problem such as profit sharing mechanisms, direct monitoring, employee competitions, contracts within an organisation, ownership structure and inter-firm cooperative arrangements.

As a key conceptualisation of the influence of corporate governance arrangements on the motivation to innovate in construction organisations, Miozzo and Dewick (2002) propose a three factor influence model. This model proposes that the development of innovation and operational capabilities at the corporate governance level in construction is influenced by: 1) the management and structure of ownership of the contractor; 2) the creation of inter-firm institutions to facilitate innovation diffusion across different divisions within the organisation; and 3) long term relationships and collaboration between organisations and external knowledge sources.

Generally, the corporate governance literature focuses on the unit of analysis of the individual firm, yet new challenges arise in promoting innovation within the multi-company project-based mode of production.
typical in the construction industry. Such challenges revolve around the temporary nature of a construction project organisation, which constrains: (1) how firms are able to integrate knowledge and experience in a coherent fashion into the business models of the project-based organisation; (2) the technical resources available to support the delivery of the project; (3) the ability to capture knowledge across project boundaries, and (4) how knowledge is able to be captured from outside the project-based firms who form the project organisation (Gann and Salter 2000).

Thus, similar to Miozzo and Dewick’s (2002) findings, a firm’s ability to develop innovation capability is influenced by the effectiveness of knowledge transfer across organisational relationships. This argument is also supported by Graham Winch’s model of construction innovation process (Winch 1998), where innovation in construction is partly driven by the firm’s decision to adopt a new idea based on a perceived performance gap in relation to their competition and, unlike many industries, requires a collaborative engagement across the firms within the project coalition, in the process of addressing the agency problem. Winch’s construction innovation processes model is presented in Figure 1. According to Winch, this collaborative engagement across the innovation superstructure (clients, regulators and professional groups), innovation infrastructure (trade contractors, specialist consultants and component suppliers) and system integrators (principal contractor and consultants) mediates the uptake of innovation. Winch extends this argument further by proposing that a significant source of new ideas come directly from the problem solving and learning processes during the project that feed back to the firm’s innovation knowledge bank. Thus, the effectiveness of construction project relationships will mediate the ability of project firms (as a part of the project coalition) to effectively problem solve and learn during the project, while safeguarding against opportunistic and self-interested behaviour.

Figure 1 A model of Construction Innovation Processes (Winch 1998)

Following this argument, how project-based organisations combine into a coherent ‘project organisation’ can be informed by an emerging area in governance literature – relational governance (or informal relationships). Informal relationships, as opposed to market-based relationships, have been recognised as an important form of inter-organisational relationship, with effective coordination leading to efficiency in resource use, competitiveness, enhanced learning abilities, and capacity to solve complex problems (Provan and Kenis 2007). Similarly, Lipparini and Sobrero (1994) argue ‘competitiveness emerges as a network-embedded capacity and the coordination among firms, maximizing firm-specific competencies, represents a strategic leverage in accomplishing and maintaining a sustainable competitive advantage’ (p.127). Indeed, close trans-organisational relationships have been identified as more conducive to the exchange of
knowledge and new ideas across partner organisations than market mechanisms (Lipparini and Sobrero 1994).

According to Jones, Hesterly, and Borgatti (1997), scholars have offered many definitions of team governance, but focus around two key concepts, that is, (1) the patterns of interaction in exchange and relationships and (2) flows of resources between independent units characterised by organic and informal social systems, as opposed to bureaucratic control measures. An authoritative general management contribution by Jones, Hesterly, and Borgatti (1997) assesses the perquisites of effective informal relationships by combining transaction cost economics and social network theory to propose a range of mechanisms that can be used to promote social development across organisations. Jones, Hesterly, and Borgatti (1997) provides further definition in support of the construction innovation literature (Gann and Salter 2000; Miozzo and Dewick 2002; Winch 1998) that effective knowledge transfer across networked organisations can promote improved performance, including the promotion of innovation capability. They specify four actions that enhance social development and hence facilitate, adapt and safeguard exchanges against unwanted behaviour and support improved knowledge flow. The four actions are:

1. **Manage team boundaries:** By maintaining clear borders around a team, the intensity of exchanges can be maximised. Intense interaction between experienced partners, who have proven track record and ability to work together without problems, will improve innovation capability. Having clear borders’ safeguards the cohesion of partners, thus minimising variance in members’ expectations, skills and goals, streamlining communication processes; decreasing the amount of performance monitoring required; and enhancing parties’ interaction. Jones, Hesterly, and Borgatti (1997) emphasise that maintaining tight boundaries is an important element to coordinating effective workflow, however, they stress the need for some permeability across boundaries for innovation and new knowledge uptake. Without this permeability, partners can become ignorant of innovation opportunities. Thus, they argue that ‘too little restriction reduces performance because it impedes coordination of complex tasks, whereas too much restriction reduces performance because it provides inadequate incentives for quality and innovation’ (p.928). Ideally, an intermediate level of restriction is optimal, unless the team is large with high levels of variance in the quality of potential members, in which case greater restriction is warranted. As large construction projects comprise individuals with highly diverse skill sets, relatively tight controls over organisational access would appear to be optimal.

2. **Develop a macroculture:** Development of a strong macroculture within the project organisation will lead to more effective coordination of interdependent activities between independent parties to complete complex tasks. The more parties are connected (or ‘structurally embedded’) and the higher the frequency of their interaction, the more they will share role understandings, values and assumptions. According to Jones, Hesterly, and Borgatti (1997) macrocultures are diffused and sustained through a) socialisation across professions, b) training and education, and c) project and industry events/journals that set standards within a group/sector. Thus, macrocultures develop from repeated interactions, but are sustained through institutional infrastructure. Effective macrocultures enhance coordination through a convergence of expectations, the development of idiosyncratic communication to summarise routines and practices, and specify broadly understood rules to deal with unexpected events. Similarly, the establishment of social processes and structures allows ‘ground rules’ between parties to be established that result in efficiencies for future interactions. Thus, promoting the ‘blur of boundaries’ between project-based firms
enhances the effectiveness of the project organisation. This macroculture will be impacted by external institutional sources and the broader national culture.

3. **Implement incentives and collective sanctions**: Positive social incentives such as acknowledgement of high performance and feedback can promote best efforts within the team. On the other hand, it is necessary to establish consequences for violation of group norms and values. These established consequences can be social in nature such as ostracism and exclusion in group decisions and safeguard exchanges by defining and reinforcing the parameters of acceptable behaviour. Incentives and sanctions reduce behavioural uncertainty by increasing the benefits of good performance and increasing the costs of opportunism (Jones, Hesterly, and Borgatti 1997).

4. **Select partners who value their reputations**: It is important to select partners with a strong reputation and a strong desire to uphold the reputation of the group. The estimation of character, skills and reliability in partner selection is important to safeguarding exchanges as it serves to deter deceptive behaviour, enhancing cooperation. A strong and positive reputation is particularly relevant in conditions of high environmental uncertainty, where parties depend heavily on promoting and assessing their own and others’ reputations. This is relevant in the research under study as construction projects are synonymous with high levels of environmental uncertainty. In the context of construction, this refers to the ability of stakeholders (particularly clients) to capture and use information about other stakeholders’ behaviour, particularly relating to past project performance.

The likelihood of effective governance emerging and thriving will be enhanced if related parties undertake the above actions (Jones, Hesterly, and Borgatti 1997). Such actions are particularly important, but difficult to implement, when there is a need to undertake customised complex tasks in rapidly changing markets under conditions of uncertainty. These conditions abound in the construction industry context under study, making the formation of effective relationships (with high social development) particularly difficult. Yet such social development is essential to facilitate, adapt and safeguard exchanges across the project organisation. Thus project participants need to be able to rise to the challenge of the above conditions and achieve high social development, to enable less reliance on contractual control. Under such conditions, project participants are better able to adapt to new ideas and harness the support of the supply chain without fear of unfair dealings. We will use the four ideal actions listed above to assess the effectiveness of relational governance in our fieldwork.

We have seen that Jones, Hesterly, and Borgatti (1997) use the idea of social development as a measure of relational effectiveness. An important element of social development not emphasised by these authors is the role of trust. Trustworthiness is also an indicator of social development in inter-organisational exchanges. The establishment of trust in inter-organisational exchanges combined with coercion and incentives (directed through contracts and performance monitoring) are relevant and important dimensions to successful governance systems (Nootenboom, Berger, and Noorderhaven 1997). Murakami and Rohlen (1992 -cited in; Nootenboom, Berger, and Noorderhaven 1997) argue that even in pure economic exchanges, some trust is required and over time, economic exchanges will take on greater social complexity increasing trust requirements. Similarly, in the context of inter-organisational alliances, Gulati (1995) argues inter-firm trust is an important variable in the choice of alliance governance structures and repeat exchanges can strengthen this variable. Thus, the development of trust-based behaviour over time is
cited as a critical factor in enhancing innovation adoption through inter-firm collaboration (Häusler, Hohn, and Lütz 1994).

Although trust itself has been argued to be a characteristic of an emerging relationship and not specifically a mechanism (Grandori and Giuseppe 1995), trust can be assessed as an indicator of effective relational governance which is crucial to enhancing innovation (Häusler, Hohn, and Lütz 1994). Although trust is a precondition and outcome of relationship development, the dominant method to measure trust is as an input variable in predicting cooperative behaviour across multiple constructs (Johnston et al. 2004). Although there are many definitions and measures of trust, most definitions reflect the importance of 1) reliability and dependability in partner exchanges and 2) trust that each partner will act in the best interest of one another even if there aren’t measures in place to police partner behaviour. (Zaheer, McEvily, and Perrone 1998). Although the majority of studies have investigated trust at the interpersonal level, some have introduced the role of inter-organisational trust (Gulati 1995; Zaheer, McEvily, and Perrone 1998). Inter-organisational trust investigates both inter-personal relations between key boundary managers as representatives of a partner firm and the collectively held ‘trust orientation’ toward partner firms (Zaheer, McEvily, and Perrone 1998). Although inter-personal and inter-organisational trust can be split, a general approach is just to use key informants’ assessments to represent their organisations’ trust in the dealings with other parties (Johnston et al. 2004). In measuring inter-organisational trust as an indicator of the effectiveness of inter-firm collaboration, we apply the highly influential 3 factor trustworthiness model of (Mayer, Davis, and Schoorman 1995). This approach provides the greatest instruction in operationalising the concept of trust for measurement in the research under study. It is a robust approach and has been generalised across a broad range of contexts since its original publication (Schoorman, Mayer, and Davis 2007). According to Mayer, Davis and Schoorman (1995), the three antecedents of trust are:

1) **Ability** – perceived ability (skills, knowledge, competencies and characteristics) of the partner organisation to have influence in a specific area. This factor also relates to contextual competence in decision-making and judgement within the inter-organisational boundaries.

2) **Benevolence** – perceived intentions and motives of the partner and trust that they would not take advantage of an opportunity to gain at a partner’s expense.

3) **Integrity** – Perceived adherence to the set of principles that the partners find acceptable. This antecedent is similar to dependability and reliability (Zaheer, McEvily, and Perrone 1998), but suggests greater emphasis on partner ‘goodwill’ where a partner can be trusted to be consistent in their actions, and can be trusted to provide creditable communications and maintain a strong sense of justice.

Thus far we have emphasised four ideal social development actions and three antecedents of trust that impact relational effectiveness. These seven indicators will be used to review findings and frame our approach to upcoming fieldwork.

**Relational Governance Indicators:**

1. Manage team access
2. Macroculture development
3. Incentives and collective sanctions
4. Reputation of participants
5. Trustworthiness: Ability
6. Trustworthiness: Integrity
7. Trustworthiness: Benevolence

The following section provides a review of key literature relating to the individual stakeholder’s capability to recognise, assimilate and apply innovative ideas within the project organisation – referred to as the stakeholder absorptive capacity. This is the second way to interpret the problem of inadequate adoption of innovative products.

**Stakeholder Absorptive Capacity**

Absorptive capacity (AC) refers to the fundamental learning process of a firm in its ability to identify, assimilate and exploit knowledge from its environment (Cohan and Levinthal 1998). Absorptive capacity is an essential survival trait for a firm because it allows the firm to complement, reinforce and refocus the firm’s knowledge base (Lane, Koka, and Pathak 2006). AC literature has focused on many themes since the introduction of the concept by Cohan and Levinthal (1998) in their seminal paper: *Innovation and Learning: the two faces of R&D*. Foci have included the relationship between AC and a firm’s organisational structure (Lane, Salk, and Lyles 2001), the role of inter-organisational learning and knowledge acquisition through inter-organisational exchanges (Lane and Lubatkin 1998) and Innovation and AC (Lichtenthaler and Lichtenthaler 2009). In relation to innovation, papers in this area argue that ‘absorptive capacity helps the speed, frequency and magnitude of innovation and that innovation produces knowledge that becomes part of the firm’s absorptive capacity’ (Lane, Koka, and Pathak 2006, p.849). Thus, in a reciprocal relationship, AC positively affects innovation uptake and vice versa, but has been found to be more influential on incremental innovations as opposed to radical ones (Lane, Koka, and Pathak 2006).

The learning environment in which construction project based firms operate is unique, in that, much of the learning occurs throughout a temporary project. Thus, the identification, exploitation and assimilation of knowledge will occur on project specific tasks. Knowledge flows in this environment tend to be discrete and disordered causing difficulty for the firm to capture knowledge and learn from feedback (Gann 2000). The creation of new knowledge in this case is dependent on both the learning ability of the individual organisation and the learning ability of all organisations within the project organisation.

Focusing on the dynamic capability for a construction organisation to create and utilise innovative products within the project, we refer to two seminal AC models from the Academy of Management Review: Zahra and George, (2002) and Lane, Koka, and Pathak (2006).

Zahra and George’s (2002) conceptualisation shows absorptive capacity is influenced by the following four types of learning:

1. **Exploratory Learning:** the firm’s ability to acquire externally generated knowledge. Effort spent in knowledge acquisition processes has three attributes, namely: intensity, speed and direction. Thus the intensity and speed of a firm effort to gather knowledge can determine quality of acquisition capabilities. Also direction of accumulating knowledge influences path of external knowledge acquisition and may require a range of expertise available to capture knowledge. Knowledge
acquisition is also influenced by prior investment and prior knowledge that support the strengthening of the acquisition process.

2. **Assimilative Learning:** the firm’s processes or routines that allow it to analyse, process, interpret and understand new information sourced by external sources.

3. **Transformational Learning:** the firm’s capability to develop and refine their processes and routines to facilitate the uptake of newly acquired and assimilated knowledge in combination with existing knowledge. This is achieved by updating knowledge banks or through the re-interpretation of existing knowledge. The transformation process also facilitates the recognition of new opportunities and allows a firm to gain situational awareness within their competitive environment. To do this, a firm will internalise the information and in reflection, covert into useful knowledge to be applied.

4. **Exploitative Learning:** The firm’s ability to apply knowledge learnt in a useful way. Thus it applies to how a firm can build on their operational capabilities through refining, extending and leveraging existing competencies or expand by incorporating acquired and transformed knowledge. Generally, the use and implementation of the knowledge is achieved through integration into the organisational processes and structures to allow firms to exploit new knowledge over time.

Lane, Koka, and Pathak (2006) have compressed the work of Zahra and George (2002) and provide a three factor model to assess the AC capability of a firm. The key difference between these models is that Zahra and George separate ‘assimilation’ and ‘transformation’ as dimensions, while Lane, Koka, and Pathak (2006) combine these two dimensions under ‘transformative learning’. We prefer the Lane, Koka, and Pathak (2006) approach as it is more straightforward and thus will be easier for fieldwork interviewees to interpret. The Lane, Koka, and Pathak (2006) model comprises (1) exploratory learning, or ability to recognise and understand potentially valuable new external knowledge outside the firm; (2) transformative learning, or ability to assimilate valuable external knowledge; and (3) exploitative learning, or ability to apply assimilated external knowledge to create new knowledge and commercial outputs. In this model, a firm’s AC is influenced by: (a) firm strategies that drive the focus of recognition and understanding of application, (b) characteristics of the firm members mental modes that drives creativity of recognition and application, (c) the characteristics of a firms structures and processes, that drive the efficiency and effectiveness of application; (d) the characteristics of internal and external knowledge, that drives the depth and breadth of understanding; and (e) the characteristics of the learning relationships, that drive the ease of understanding. This model clearly emphasises the importance of environmental conditions (e.g. the firm’s placement within a knowledge flow) that drive motivation to adapt and apply learnt knowledge. This is particularly relevant in the context of innovation product uptake in a construction project setting as decisions to identify, assimilate and exploit knowledge are strongly influenced by external conditions such as the procurement approach and opportunities outside the project to propose new ideas.

**Absorptive Capacity Indicators:**

1. **Exploratory learning:** the ability to recognise and understand potentially valuable new external knowledge outside the firm;

2. **Transformative learning:** the ability to assimilate valuable external knowledge; and
3. **Exploitative learning:** the ability to apply assimilated external knowledge to create new knowledge and commercial outputs.

The following section provides a review of key literature relating to the role and activities of knowledge intermediaries within an innovation system. This is the third way we review the problem of inadequate adoption of innovative products.

**Knowledge Intermediation**

Generally, single organisations do not have the capability and competencies to internally generate the knowledge required for business development. Thus, they must tap into external knowledge sources. Ideally an organisation will collaborate with a trans-organisational network of actors in order to innovate (Millar, Demaid, and Quintas 1997). Key actors in the exchange of information across these innovation systems are knowledge (or innovation) intermediaries. Empirical studies on innovation systems support the view that the quality of inter-connections within the overall system strongly impacts on an organisation’s success in adopting technology, highlighting the importance of intermediaries in the system (Bessant and Rush 1995).

The intermediary acts as the facilitator of the knowledge flow between knowledge producing organisations (the originator of the knowledge) and the knowledge consumer (who applies the knowledge). The knowledge intermediary prepares the explicit knowledge for reuse by ‘eliciting it, indexing it, summarizing it, sanitizing it, packaging it, and performs various roles in dissemination and facilitation’ (Markus 2001, p.59). Similarly, Howells (2006) provides a definition of the knowledge intermediary in the context of the innovation system, as, ‘an organisation or body that acts as an agent or broker in any aspect of the innovation process between two or more parties’ (p.720). This role will include the provision of information to potential collaborators, transaction brokerage or mediation between collaborating organisations and providing advice, support and infrastructure for innovation outcomes across collaborators.

Knowledge intermediation in innovation systems also address the ‘agency problem’ (discussed previously) by resolving knowledge market information asymmetries such as incomplete understanding of the nature, availability and opportunities offered by innovative goods and services in a market. Demand-driven models explain why organisations seek innovation, however these models are unable to fully initiate a demand-driven approach due to a lack of knowledge of innovative possibilities and thus, an intermediary ‘identifies, and expresses a demand in relation to the technological possibilities that are available from discoveries, inventions and capabilities identified in research organisations and innovative businesses’ (Howards 2007, p.8). Howards (2007) identify four distinct intermediary roles in the context of the Australian Innovation System. They comprise: (1) the *consultant* – providing advice and information in the recognition, acquisition and utilisation of knowledge and technological capability; (2) the *broker* – responsible for brokering transactions between parties; (3) the *mediator* – providing independent third party services in assisting the mutually beneficial collaboration between parties; and (4) the *resource provider* – providing material support or securing access to funding for innovation outcomes of collaborative ventures.

Interpretation of the knowledge intermediary role in the uptake of innovative products in construction projects requires an understanding of their key functions and activities. Howards (2007) defines the broad
roles played by knowledge intermediaries, while two influential articles provide further detail (Hargadon 1998; Howells 2006)

Howells (2006) provides a summary of successful innovation intermediary functions from a study across 22 case organisations involved in project collaborations across UK industries. Table 2 presents the types and functions of intermediation in the innovation process from a wide range of industry contexts.

**Table 2** Typology and functions of intermediaries in the innovation process (Howells 2006)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FUNCTIONS</th>
</tr>
</thead>
</table>
| 1. Foresight and diagnostics | a) Technology foresight and forecasting  
| | b) Articulation of needs and requirements | Foresight, forecasting and technology road mapping |
| 2. Scanning and information processing | a) Scanning and technology intelligence  
| | b) Scoping and filtering | Information scanning and technology intelligence - information gathering and identification of potential collaborative partners  
| | | Selection and clearing function - selection of collaborative Partners |
| 3. Knowledge processing and combination/ recombination | a) Combinatorial  
| | b) Generation and recombination | Helping to combine knowledge of two or more partners  
| | | Helping to combine knowledge, but also generating in-house research and technical knowledge to combine with partner knowledge |
| 4. Gate keeping and brokering | a) Matchmaking and brokering  
| | b) Contractual advice | Negotiation and deal making - facilitating contract negotiation once partner(s) selected  
| | | Finalising the contract - may involve specialist IP expertise |
| 5. Testing and validation | a) Testing, diagnostics, analysis and inspection  
| | b) Prototyping and pilot facilities  
| | c) Scale-up  
| | d) Validation  
| | e) Training | Validation of analytic methods  
| | | Joint training in use of new technologies |
| 6. Accreditation and standards | Specification setter or providing standards advice - includes developing reference designs  
| | | Formal standards setting and verification  
| | | Voluntary and de facto standards setter |
| 7. Validation and regulation | a) Regulation | Formal regulation |
| | b) Self-regulation  
| | c) Informal regulation and arbitration | Quasi-formal regulation  
| | | Informal arbiter between different groups, for example between the user and producer |
| 8. Protecting the results | a) Intellectual property (IP) rights advice | Protecting the outcomes of collaboration - help clients assess their ideas for IP protection and securing IP rights and their management |
| | b) IP management for clients | |
| 9. Commercialisation | a) Marketing, support and planning  
| | b) Sales network and selling | Market research and business planning - identify market opportunities and develop business plans  
| | | Support in the selling and commercialisation process - help establish and run sales channels  
| | c) Finding potential capital funding and organising funding or offerings | Early stage capital - Assessment and filtering capability for funding |
| 10. Evaluation of outcomes | a) Technology assessment  
| | b) Technology evaluation | General assessment of performance and technologies  
| | | Specific evaluation of products and technologies once in use |

Although this study provides rich detail concerning the specific functions undertaken by knowledge intermediaries, for the purposes of empirical work a more straightforward model with clearer boundaries
between categories is preferred. Hence, our further research will review the four intermediary roles proposed by Howards (2007) and discussed earlier, together with four activities presented by Hargadon (1998) and discussed below.

Hargadon (1998) reviews the activities undertaken by knowledge intermediaries, rather than their roles or functions. He presents activities underlying innovation uptake through knowledge intermediation. Although not as detailed as Howells (2006) list, Hargadon (1998) more succinctly incorporates the key activities relevant to the research under study. He provides four activity categories: access, learning, linking and implementation. These knowledge intermediation activities have been distilled from Hargadon’s (1998) empirical study of intermediary organisations that were strategically positioned to consistently create new and innovative products and processes and take new ideas from one sector for application in another. The study emphasises the interactions between the intermediary and different parties and their combinational role. It is expected such activities would be relevant in the present study due to the requirement for knowledge brokerage across multiple industry sectors for innovative construction product uptake i.e. across product manufacturing and construction sectors. The four activities proposed by Hargadon (1998) are presented in Table 3 and these will be used to guide the analysis of knowledge intermediary activities in the current study supported by the definition of roles from Howards (2007).

Table 3 Activities driving innovation by knowledge intermediary across sectors (Hargadon 1998)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>• Exposes organisations to a wide range of sectors and the valuable knowledge residing in each sector.</td>
</tr>
<tr>
<td></td>
<td>• Puts organisations in position to broker valuable knowledge from sectors ‘where it is known’ to ‘where it is not’</td>
</tr>
<tr>
<td>Learning</td>
<td>• Brings knowledge of a sector’s existing problems and solutions into the organisation for use at a later time.</td>
</tr>
<tr>
<td></td>
<td>• Creates an inventory of potentially valuable ideas which is typically broader than any inventory held by firms working within a single sector.</td>
</tr>
<tr>
<td>Linking</td>
<td>• Enables development teams facing a problem in one sector to recognise its similarity to other problems – and their solutions – in different sectors.</td>
</tr>
<tr>
<td></td>
<td>• Combines ideas from within a sector with other ideas from outside to create innovative product and process concepts</td>
</tr>
<tr>
<td>Implementation</td>
<td>• Turns innovative concepts from outside sectors into related products or processes by combining them with existing ideas from within a sector</td>
</tr>
<tr>
<td></td>
<td>• Leads to learning-by-doing that further builds the organisation’s knowledge base for use in later projects.</td>
</tr>
</tbody>
</table>

Knowledge Intermediation Indicators

Knowledge Intermediary Roles
1. the consultant
2. the broker
3. the mediator
4. the resource provider

Knowledge Intermediary Activities
5. Access
6. Learning
7. Linking
8. Implementation
These eight indicators will be used to review findings and frame our approach to upcoming fieldwork.

CONCLUSION

This literature review has examined the indicators that can be used to guide and interpret fieldwork undertaken to investigate the research problem ‘How can we improve adoption of innovative products on road and bridge projects?’ Such indicators will be reviewed in interpreting the findings from the project stakeholder interviews in Part 2 of this report, and in guiding and interpreting the major survey and focus group study. This literature review has broadly identified the system dynamics relating to the three main problem lenses – relational governance (with seven indicators), stakeholder absorptive capacity (with three indicators) and knowledge intermediation (with eight indicators). This review has ‘unpacked’ the different ways the research problem can be understood, so that we can more effectively empirically assess the nature and roles of various stakeholders in the process of new product adoption on road and bridge projects. In Part 2 of this report to follow, the indicators will be used to analyse: (1) the overall effectiveness of the relational governance arrangements to promote the flow of knowledge across the Queensland road industry, (2) the absorptive capacity of individual stakeholders and (3) the linkages supported by knowledge intermediaries.
PART 2 - INDUSTRY STAKEHOLDER ISSUES

INTRODUCTION

Part 2 of this report discusses the issues raised by interviews with Queensland stakeholders of the Innovative Product ARC Research Project. The objective of this background research was to gain a more in-depth understanding of industry stakeholder issues relating to new product adoption on road and bridge projects, as a key input to shaping the scope of the next stages of our research project.

Between January and May 2010, the project investigators undertook 10 in-depth interviews with Queensland client and contractor stakeholder representatives to explore the key concerns they perceived as impacting on the uptake of innovative products in the Queensland road and bridge sector. Interviewees were purposefully selected to represent views from both client and head contractor stakeholders. The stakeholder interviewees comprised 10 senior managers; six from Queensland Government client agencies and four from head contractor organisations. All interviews were in-person, ranged from 60 to 90 minutes in duration, and were based on structured and unstructured questioning. Interview data was captured by note-taking, and digital recordings that were later transcribed to electronic text. Interviewees were sourced from the following organisations:

- Department of Transport and Main Roads (DTMR), Queensland (5 interviewees)
- Department of Public Works (DPW), Queensland (1 interviewee)
- Baulderstone Contractors (2 interviewees)
- Leighton Contractors (2 interviewees)

Content analysis was then used to identify the key issues that were derived from the stakeholder interview transcripts. Care was taken to identify issues that were limited in number and were mutually exclusive. This involved manually aggregating and categorising responses from the interview transcripts organised around the three problem lenses discussed in the previous section, namely the: (1) governance of stakeholder relationships, (2) absorptive capacity of the individual stakeholders and, (3) linkages of the knowledge intermediaries. Identified issues were grouped into two construction contexts to aid discussion: (1) the project delivery environment, that is, the activities that occur during project delivery; and (2) the ongoing business environment, that is, the business activities that occur outside the project period, but influence how projects operate.

Part 2 is presented in two sections. First, the identified issues are presented, derived from the analysis of the interviewee data. Second, the key issues are interpreted according to the two construction contexts and 18 innovation indicators identified earlier. This will reveal gaps to be explored in the flow of knowledge across the innovation system that currently impede uptake of innovative products. Part 2 concludes with the presentation of a summary of findings that will be used to inform the development of the national survey questionnaire and focus group protocol.

INTERPRETATION OF INDUSTRY STAKEHOLDER ISSUES

The table below summarises the industry stakeholder issues that interviewees felt impacted on new product adoption in the road and bridge sector. Each stakeholder issue is presented in light of the construction context and innovation indicators.
<table>
<thead>
<tr>
<th>Issue</th>
<th>Description of Issue</th>
<th>Construction Context</th>
<th>Innovation Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Goal alignment and incentives</strong></td>
<td>Project goals should be incentivised to promote client and contractor motivation to propose (and approve) innovative products. In particular, the contractor can be offered a share of cost savings achieved through innovation - as usually happens in a project alliance environment. However, incentives should be offered for performance in other areas outside project cost savings, particularly for verified quality improvements, to encourage a well-rounded approach to innovation uptake.</td>
<td>Project delivery environment</td>
<td>Relational governance, absorptive capacity</td>
</tr>
<tr>
<td><strong>2. Contractor tender assessment</strong></td>
<td>The clients’ program pressure and lack of resources often negatively impacts on their ability to assess and approve alternative tenders. Hence, the contractor is less inclined to propose alternative tender options if it is believed the client cannot fairly assess them.</td>
<td>Project delivery environment</td>
<td>Absorptive capacity, knowledge intermediation</td>
</tr>
<tr>
<td><strong>3. Contractual relations</strong></td>
<td>Under an alliance contract, the client has a good understanding of the project and may therefore be motivated to relax specifications for project benefit and share success (improving innovative product uptake opportunities). A key problem is that the benefits for the road network as a whole may be compromised in the process. Under Public Private Partnerships, the contractor is provided with greater flexibility in specifying products and is not likely to compromise on quality due to contractor responsibility for the long term asset performance. A key problem is that, compared to alliances, PPPs often lack the drivers for cooperation and innovation. Traditional contracts suffer much more than alliances or PPPs, as they contain no relationship or responsibility drivers at all.</td>
<td>Project delivery environment</td>
<td>Relational governance, absorptive capacity, knowledge intermediation</td>
</tr>
<tr>
<td><strong>4. Problem solving and idea assessment during design &amp; construction</strong></td>
<td>Client responsiveness to new ideas proposed during design and construction is often slow due to inconsistencies in how ideas are presented to the client and the large number of unsuitable ideas required to be assessed. This frustrates clients and results in lower contractor motivation to propose innovative product options from subcontractors/suppliers. Clients claim they would be more responsive if suppliers and contractors undertook more prior testing of proposed new products.</td>
<td>Project delivery environment</td>
<td>Relational governance, absorptive capacity</td>
</tr>
<tr>
<td><strong>5. Contractor involvement in design stages</strong></td>
<td>Contractors claim they need greater influence over design to provide more opportunity for proposing the use of alternative products before construction commences. Contractors need more input on constructability and value engineering when budget is tight.</td>
<td>Project delivery environment</td>
<td>Relational governance, absorptive capacity, knowledge intermediation</td>
</tr>
<tr>
<td><strong>6. Product development</strong></td>
<td>A lack of client product trialling is reducing the number of alternative products clients can approve during the tender process. Complexities and risks associated with undertaking product trials and a lack of agreed protocols for assessment of performance impede adoption of new products. Also, a clear balance of responsibility between the supplier/contractor and client is required in relation to the testing and verification of new innovations. Although contractors source new product knowledge externally, there is minimal contractor internal development or trialling.</td>
<td>On-going business environment</td>
<td>Absorptive capacity, knowledge intermediation</td>
</tr>
<tr>
<td><strong>7. Prequalification</strong></td>
<td>There is a need for widespread adoption of prequalification of contractors based on their prior history of project performance, including time, cost, quality and innovation.</td>
<td>On-going business environment</td>
<td>Absorptive Capacity</td>
</tr>
<tr>
<td><strong>8. Agency specifications</strong></td>
<td>Stakeholders acknowledge that performance-based specifications are better for innovative product adoption than prescriptive specifications, but a ‘dual’ approach may be required as a pure performance-based system may not be ideal for some products/materials. There is concern over lack of agreed methodology and client resources to effectively assess if a product meets the performance intention.</td>
<td>On-going business environment</td>
<td>Relational governance, absorptive capacity</td>
</tr>
</tbody>
</table>
As Table 1 shows, there were 9 key issues raised by Queensland stakeholder interviewees that impact on new product adoption. There were five issues relating to the project delivery environment and four issues relating to the on-going business environment. The 9 issues are now discussed in more detail. Each issue discussion is split into three sub-headings: (a) background on the issue – a brief literature review of the issue, (b) interview findings on the issue – derived from the interviewee data and, (c) conceptual interpretation of the issue – relating the interview findings to our three problem lenses.

Project Delivery Environment

The project delivery environment yielded five issues comprising: (1) goal alignment and incentives, (2) contractor tender assessment, (3) contractual relations, (4) problem solving and idea assessment during design & construction and, (5) contractor involvement in design stages. These issues are now discussed.

(1) Goal alignment and incentives

(a) Background on the issue

Many contractual arrangements between construction clients and contractors are confrontational, reflecting considerable mistrust in one another (Zaghloul and Hartman 2003). The use of contracting options such as incentives can provide a balance between the allocation of risk and reward for performance gains and promote innovative behaviour. The primary aim of an incentive is to align the goals of the principal (client) and their agent (contractor) by offering a financial reward for joint-goal achievement. This can potentially be achieved by having project parties sharing the gains flowing from product innovation.

(b) Interview findings on the issue

The research data revealed four out of 10 interviewees mentioned the importance of motivating the client and contractor to align their commercial interests to improve the adoption of innovative products. Both client and contractor interviewees suggested the ‘share of savings’ incentive offered under an Alliance contract motivated the contractor to propose new products that could lead to savings, while the client was motivated to be flexible in their approval of products as they also had an opportunity to share in the savings achieved.

“If client is receiving savings they are more likely to agree [to changes] under an alliance, because they get a share... there is more drive within the client organisation to say, let’s seriously look at this...”

Similarly, one contractor interviewee mentioned the negative impact of goal misalignment under a lump sum delivery approach, where the client believes that the contractors’ cost saving ideas don’t take quality into account. This perceived opportunistic intention results in client reluctance to approve the use of cost-saving products as they are not directly rewarded under this type of contract, and have concerns over quality. One client interviewee mentioned the importance of incentivising contractors to propose new...
ideas that result in whole-of-life cost savings, without compromising quality. This interview thought there was too much focus on project cost savings.

(c) Conceptual interpretation of the issue

Promoting the alignment of goals through incentivisation is related to the development of an effective relational governance system, particularly the development of a project macroculture that encourages and rewards innovative ideas and discourages excessive conservatism on the part of clients and excessive opportunism on the part of non-client stakeholders. This is also promoted by the selection of stakeholders that value the benefits gained through goal alignment. However, the ability of the client and contractor to best utilise the opportunities offered through incentives depends on their absorptive capacity to recognise and assimilate potentially valuable innovative products to be applied to achieve the incentivised goals. This relates to the contractors’ and clients’ capacity to assess innovative products and clients’ capacity to approve promising products.

(2) Contractor tender assessment

(a) Background on the issue

There are significant opportunities for tenderers to propose innovative solutions that can involve new products during the tender stage. Contractors are strongly motivated to utilise their knowledge of alternative options to establish competitive advantage, while clients should be maximising this opportunity and encouraging contractors to propose properly evaluated and tested innovative options. Although contractor-led innovation should be encouraged, clients need to establish a transparent protocol for assessing alternative options and provide the resources to fairly assess them (Sidwell, Budiawan, and Ma 2001). Probity concerns and clients lack of knowledge to effectively assess alternative options can result in alternative tenders not being appropriately assessed. Further, clients can develop the idea that contractors sometimes propose ill-thought through innovations at tender. The client perception that contractors sometimes propose cost-saving ideas that compromise quality has resulted in client cynicism, which negatively impacts the quality of attention given to new ideas proposed during tender. Also, the submission of unsubstantiated ideas ties up client resources, leaving less time for consideration of robust ideas.

(b) Interview findings on the issue

According to the client and contractor interviewees, the clients’ current difficulty to effectively assess alternative tender options is an inhibitor to innovative product adoption. This difficulty was seen to be the result of: (1) time pressures placed on the client representatives to assess the alternative options, (2) the lack of client resources to effectively assess the implications of adoption, and (3) the risk adversity of the client to consider alternative options during tender stage. The most common issue raised by three of the 10 interviewees was the time constraints preventing the client from effectively assessing alternative tenders.

“particularly of recent times, [client representatives] have been so busy that all they have got time to assess and look at, is the thing that is stock standard, that meets the current standard, that they know, and are confident about and don’t need to go searching to see if the claims are defensible or not. They’ve just got five days [to assess], so go away. To some extent this has been the environment.”

According to two contractor interviewees this issue resulted in their companies being unwilling to put forward non-confirming tenders due to the number of failed attempts in the past. One client interviewee
thought their organisation should be playing a greater role in trialling potentially innovative products prior to the tender stage (in the on-going business environment) to address the problem of time constraints and aid in assessing the alternative options put forward by the contractor during tender stage. Contractor trailing would also address the problem of poorly evaluated ideas being put forward.

Finally, one client interviewee mentioned the clients’ opportunity to promote innovation by setting their expectations as a tender selection criterion. For example, clients can include non-price criterion that focus on proposing innovative design options (that can include new products) to meet specific project goals; whereby tenderers will be expected to respond. Tenderers addressing this criterion will be then judged on their capacity to think laterally about innovative opportunities and ability to deliver value-adding options. This approach can establish the expectation that innovation is a key objective for the project. However, a key problem for clients in this situation is the submission of poorly evaluated ideas.

(c) Conceptual interpretation of the issue

The ability of the client to effectively promote innovative options as a part of the tender process is partly determined by their absorptive capacity i.e. their capacity to recognise, assess and assimilate alternative options proposed by the tenderer in the selection process, while maintaining probity and fairness.

This issue also relates to the contractors’ absorptive capacity to effectively recognise, compile and exploit innovative products from suppliers and subcontractors during the tender stage; and their role as a knowledge intermediary in this process. According to two contractor interviewees, their organisation rarely develops in-house products; instead they generally ‘broker’ innovative product knowledge to be used for their competitive advantage during tender. This contractor capacity to broker the knowledge of suppliers and subcontractors and their absorptive capacity to recognise and exploit such opportunities, including their contribution in the product evaluation process, are key determinants shaping the supply of quality innovative product ideas put to clients.

To promote client and contractor absorptive capacity, the results suggest moving away from price-only tender assessment. This is particularly important when the client has minimal control over quality in complex procurement approaches such as ‘design and construct’. This argument has driven the use of combined non-price/price tender approaches, and led to preferences towards performance-based specifications as a part of the tender package (Palaneeswaran and Kumaraswamy 2000).

(3) Contractual relations

(a) Background on the issue

Construction contracts, from a legalistic interpretation, specify precisely the legal, financial, and technical aspects of a project, while contractual relations comprise the contractual terms within a governing relationship; generally encompassing the risk apportionment, the allocation of responsibilities, the reimbursement mechanisms, and the relationships (Cox and Thompson 1997). As large and complex one-off construction projects are often very risky, due to a high level of technical uncertainty where total costs are influenced by a wide range of unforeseen risks (Olsen and Osmundsen 2005), the client should select the type of contract that will most effectively align contractor motivation to the desired results, through appropriate structuring of the governing relationship (Zaghloul and Hartman 2003).

(b) Interview findings on the issue
According to the interviewees, the impact of contractual relations under various contract types was identified as a key issue in the adoption of innovative products on road and bridge projects. Two client interviewees commented that the contract system and relationships influence how products are integrated into an overall design solution and this process is not ultimately controlled by agency specifications, but by how the design is developed and approved under the project relationships, e.g. how flexible the client representatives are in their interpretation of the contractual specifications.

Both client and contractor interviewees advocated the positive impact of strong contractual relations on innovation under an Alliance contract, indicating that the client’s ‘vested interest’ in the success of the project and better understanding of the joint project goals, increased the chance of innovation uptake. Project team leadership under this governing relationship was also identified as an important driver for innovation uptake. Two contractor interviewees mentioned the involvement of an experienced client leader in an alliance project was a driver of innovation as they were more inclined to relax specification requirements for the overall benefit of the project and its outcome, as they had the technical or organisational competence to make appropriate decisions. Similarly, the expectation for innovation on this type of project was greater and thus, client representatives would be more open-minded to innovation opportunities (and innovative product adoption).

“Under more collaborative delivery systems there is a greater likelihood that a proponent’s innovation will be deemed to meet the specification, because they will have better access to the right people, and because the right people will be more open to a flexible interpretation of the specification”.

Notwithstanding these positive forces, two client interviewees noted that the alliance client representative could become so enmeshed in the alliance culture that they approved innovations that had dubious project merit, and even more dubious network merit. There was seen to be too much focus on cost savings, potentially compromising whole-of-life quality.

In relation to hard dollar contracts, two interviewees mentioned that the client can be reluctant to reinterpret project specifications to encourage innovative product adoption, as the client does not generally benefit directly from the innovation (e.g. does not benefit from cost savings achieved). Interestingly, one client interviewee mentioned that despite the relationship benefits of alliance projects, they can become ‘too insular’ and overlook external ideas, while on the other end of the spectrum; lump sum projects suffer directly from poor contractual relations that restrict the formation of strong project relationships, inhibiting the generation of innovative ideas.

The flexibility of specifications afforded under a Public Private Partnerships (PPP) was also raised by both client and contractor interviewees (five out of the 10 interviewees). According to these interviewees, PPP contracts allowed the contractor (as a part of the PPP consortium) a ‘more flexible interpretation of the agency specifications’ than traditional government projects and thus, a greater level of flexibility to propose alternative products. It was also raised that the contractor was less likely to push for cost savings that compromised quality under a PPP arrangement because the contractor often has some responsibility for the on-going management of the asset for many years after construction.

One interviewee had a less optimistic view of the product innovation potential under PPPs on account of tight cost margins. The argument was that financial organisations drive PPP development, and that such organisations have a very hard dollar approach to contracting. They thus drive profit margins down, and when the job is won, the delivery team is severely pressed on time and cost, with no time for cooperative
behaviours or exploring innovation potential. The interviewee felt that innovation is only considered if its assessment is costless, its risks non-existent, and its bottom line is cost reduction.

(c) Conceptual interpretation of the issue

The nature of contractual relations is determined by the nature of the relational governance regime. The selection of client and contractor leaders needs to be undertaken under a positive contractual relationship, where they are perceived to have a strong track record and ability to work together for the project’s benefit (e.g. open to external ideas yet maintain internal control over the project team deliverables). This can result in greater persuasion towards promoting the adoption of innovative products from across the team. Also, stakeholder incentives that are driven by contractual relations, can improve the push for the use of innovative products.

Trust is supported by strong contractual relations (i.e. trust in each party’s ability, intentions and integrity to meet project expectations). The establishment of trust can promote effective relational governance which is crucial to enhancing trans-organisational innovation (Häusler, Hohn, and Lütz 1994). Thus, the trustworthiness of the contractor to propose innovative products that contribute to overall project performance (and not to the detriment of quality or functionality), and the trustworthiness of the client to fairly and openly assess new product ideas will drive product adoption. The effectiveness of strong contractual relations is also determined by the client and contractors’ absorptive capacity to harness and apply new product ideas i.e. contractor ideas from their supply chain and client ideas from the contractor.

(4) Problem solving and idea assessment during design and construction

(a) Background on the issue

Significant sources of new ideas come directly from problem solving and learning processes during a construction project (Winch 1998). Thus, the effectiveness of the project team to promote the development of new ideas through problem solving and learning during the design and construction stages is critical for innovation.

(b) Interview findings on the issue

Five of the 10 interviewees mentioned the opportunities for innovation (and new product adoption) in response to problems and ideas generated during the design development and construction stages. Generally, such problem solving during these stages will involve the reconfiguration of existing products to improve the overall design solution.

“The specifications are descriptions of the client’s broad expectations, but innovation is driven during design and construction stages, which dictates innovative products to a large extent...”

The interviewees noted that exploiting these opportunities is influenced by the client responsiveness to new ideas proposed. This issue is closely influenced by the contractual relations on a project, whereby under strong relations the client representatives are motivated to be more open-minded to the opportunities of innovation. One client interviewee identified the need to establish a ‘go-to-team’ who can provide the expert advice concerning alternative product options proposed during design and construction, and directly and quickly respond to ‘requests for information’ and approve changes. Also, this interviewee mentioned constraints on the innovative product assessment process during design and construction, including inconsistencies in how ideas are presented to the client and the large number of unsuitable ideas required to be assessed resulting in slower response times.
(c) Conceptual interpretation of the issue

The interview results confirm that the effectiveness of project relationships during design and construction stages influences innovation product uptake. The results suggest the benefits of developing a macroculture that is founded on the client trusting the contractor not to act opportunistically, and trusting that contractors have the ability, intention and integrity to propose suitable solutions to problems in the best interest of the project. This also applies to the ability, intention and integrity of the client and their procedures to fairly assess innovative product options that address problems during the design and construction. Finally, the ability of the contractor to effectively propose problem-solving options will also be influenced by their absorptive capacity to quickly acquire, harness and exploit suitable product knowledge when required.

(5) Contractor involvement in design stage

(a) Background on the issue

Front end integration and coordination of the project team at the early design stages can improve the certainty of construction outcomes (Sidwell and Kennedy 2004). This is achieved by involving key stakeholders (primarily the contractor) in the design decisions that can enhance the integration of design and construction, lowering risk of design changes and improving the responsiveness of the project team in addressing design and constructability issues. Early contractor involvement also provides an opportunity to foster better project relationships as the contractor gains ‘ownership’ over the design, reinforcing team commitment towards good project delivery outcomes.

(b) Interview findings on the issue

Three interviewees mentioned the positive impact of early contractor involvement arrangements on identifying possible opportunities for proposing innovative products for integration into the design. Two contractor interviewees also argued that design innovation was improved when the contractor organisation had control over the design process under a ‘design and construct’ arrangement.

“The best way for new products to enter the market or into acceptance is through your D&C, where the risk of design performance is with the contractor… with construct only the client thinks your judgement is biased because you get all the cost saving benefits without any risk.”

It was argued this provided the contractor with the ability to better control their risk, particularly when the budget was tight and gave them more opportunities to propose innovative products during the design stage. However, under this arrangement clients have minimal control over quality during design and construction, requiring careful alignment of the client’ and contractors’ goals to prevent the contractor focusing on cost savings that may compromise quality.

(c) Conceptual interpretation of the issue

The contractor’s involvement in the design stage is influenced by the effectiveness of relational governance, positively impacting on new product adoption. Accordingly, the contractor’s involvement in design development increases the intensity of interaction between the designers and the contractor and improves decision-making. The effectiveness of the contractor to provide useful input in design development and propose innovative solutions to constructability issues will depend on their absorptive capacity to external (suppliers/subcontractors) and internal (designers) information; as well as their
capacity, as a knowledge intermediary, to identify suitable product applications and broker these products across the supply chain.

**On-going Business Environment**

The on-going business environment yielded four issues comprising: product development; prequalification; agency specifications; and project liability and warranties.

**(6) Product development**

(a) **Background on the issue**

The interviews revealed that Australian government agencies responsible for road and bridge projects are under increasing pressure to develop a uniform approach to the assessment and approval of new products, which have not been proven in the field and do not meet existing specifications. Generally, such products have a very risky and protracted pathway to use, despite their potential for innovation. Australian road authorities are currently moving towards developing a standard assessment and approval system on a national basis called the Materials Innovation Management System (MIMS). Despite the benefits that could be achieved through a nationally-accepted certification process, it remains unrealised. Therefore, government agencies are still faced with this issue of establishing independent methodologies to assess new products that have not been field-tested.

Head contractors often use high levels of subcontracting and external purchasing and act as conduits through which new products are suggested to clients. In spite of this, they essentially play a minimal role in the evaluation of such products for use by their clients. The literature suggests that we would not expect to see contractors undertaking such evaluation themselves, as it is outside their core competency, which is monitoring the overall quality of output, rather than understanding all technical details of supplier and subcontractors activities (González-Díaz, Arruñada, and Fernández 2000). However, in their role as brokers of innovation ideas, contractors may supervise testing undertaken for them by specialists.

(b) **Interview findings on the issue**

According to two client interviewees, client agencies should be internally trialling new products, but they acknowledged that there are significant challenges with assessing if a product or product system meets its performance intention, particularly under performance specifications. Such challenges include the complexity and risk of undertaking field trials and a current lack of agreed client agency protocols for assessment. Another major challenge for client agencies is the extensive lead time required to assess the long-term performance capability of a new product. Despite these challenges, client interviewees acknowledged on-going product trialling may improve their ability to effectively assess tenders in the project delivery environment.

“We [the client] should be trialling new products... but need a clear methodology for evaluating if a product meets the performance intention of the specification.”

Two contractor interviewees expressed an interest in their clients supporting smaller ‘exemplar’ projects to assess new product performance, but they thought such ventures should be supported though industry associations (for example the Queensland Major Contractors Association). One client interviewee noted that their agency was moving in this direction.
In Queensland, DTMR have established processes for managing the use of new technology that involve risk assessment of innovative products before approval for use is given. DTMR’s decision to conduct further research and development into new product opportunities appears to depend in part on how the idea is presented to the department. Product ideas that are presented by major contractors or industry associations have a better chance of being tested than ideas presented by independent inventors. The latter might have an increased opportunity of having their products adopted by approaching major contractors in the first instance. In any event, although processes are in place for DTMR to assess new ideas, their effectiveness in use was questioned by the interviewees. It appeared that policy was not actively implemented and that multiple policies existed in isolation to one another.

In any event, one client interviewee emphasised that a clear balance of responsibility between the supplier and client is required in relation to the testing and verification of new innovations. According to this interviewee, much time and resources are wasted in assessing unsuitable products for use. It was suggested that, if suppliers increase their investment in performance verification before presenting their innovations to clients, the efficiency of the client’s assessment process would be improved.

Client long-term supplier arrangements were also identified as positive towards improving the assessment and approval of new products entering the market. One client interviewee mentioned that their long-term relationships with products suppliers supported innovation uptake. This can include standing offer arrangements for specific products. Such arrangements were seen to increase the intensity of exchanges resulting in transaction efficiencies, affording the client greater flexibility (and trust) in certifying the supplier’s new product for use.

The interviewee results also identified the contractor as an outsourcer of innovative products, with little to no in-house development. Two contractor interviewees mentioned their organisation does not develop in-house products, rather they rely on suppliers and subcontractors to develop proprietary products to be integrated into their knowledge bank for strategic advantage in future tenders. These interviewees also indicated their organisation collaborates with major suppliers to investigate new products to be considered for future projects.

“We [the contractor] don’t do trials... but we have suppliers coming in the door with their new products and we review it and our engineers will look at it to see if it can win us a job”.

However, this process is not straightforward as there is not always a lot of trust between new product suppliers on one hand, and the client/contractors on the other. The latter group can be suspicious of lone new product suppliers – individuals they refer to as ‘snake oil salesman’. This dismissive culture comes from client concerns over the submission of poorly substantiated ideas that tie up client/contractor resources remain, impacting on the quality of attention given to robust ideas.

(c) Conceptual interpretation of the issue

Overall, the effectiveness of new product assessment and approval relates to the absorptive capacity of the client to not only identify innovative products, but their capacity to assimilate these products (though product certification) for use in the project delivery environment, where they can be exploited. It appears there is low absorptive capacity within client agencies to assess and approve innovative products that have not been field-tested. This is inhibiting new product adoption. Findings also suggest the supplier and client need to share the responsibility of testing and verification of new innovations. Slow client response to new product ideas may be driven by the proposal of too many innovations with insufficient evidence of long-term performance capability. Thus, suppliers have a responsibility to provide clients with adequate evidence of a products’ capability to meet long term performance requirements. More and better testing
will improve the absorptive capacity of the system, but where does the balance of responsibility lie between supply chain participants?

The study’s findings also suggest that contractors’ absorptive capacity to recognise, integrate and exploit innovative products from suppliers and subcontractors influences innovation product adoption on projects. Contractors may be knowledge intermediaries in the product innovation system with a preference to outsource product development to suppliers/subcontractors and broker their products for use, allowing them to focus on their core competency of managing overall project delivery.

This finding indicates that the quality of knowledge sharing between suppliers and contractors is an important focal point in the investigation of product adoption in road and bridge projects. It is also expected that suppliers will play an important knowledge intermediary role in the promotion of new products for potential adoption on projects. Similarly, an increase in the frequency of exchange between the client and ‘preferred’ supplier can decrease product adoption risks due to greater assurance in suppliers’ product performance, supported through successful past exchanges. However, government clients are constrained by probity (or procedural integrity) issues associated with entering into standing offer arrangements with suppliers. Procurement policies in each Australian state require agencies to be accountable and transparent in their procurement decisions, which can place constraints on adopting long-term supplier relationships, if competitive pressures are seen to be weakened.

(7) Prequalification

(a) Background on the issue

Generally, prequalification of contractors and consultants aims to minimise client risk and time-wasting during the project tender stage, by establishing, up-front, eligible tenderers that meet minimum capacities for project consideration. The literature shows that best practice clients broadly apply prequalification so that it involves the ‘registration’ of eligible contractors and consultants in the on-going business environment, including the initial assessment of capacity and capacity upgrading over time (Palaneeswaran and Kumaraswamy 2001). A common assessment category for prequalification is contractor financial capacity to undertake certain work values, but there are endless possibilities for prequalification assessment categories.

(b) Interview findings on the issue

A client interviewee suggested that innovation on projects can be driven by the contractor and consultant selection approach including how project delivery risks can be decreased through prequalification, positively influencing the potential for innovation.

“Clients can ask an engineer to be innovative... but innovation has to come from clients and what they expect from a project... supported by their selection processes including prequalification”.

It was suggested this could be achieved by assuring the contractor has the financial capacity to support the delivery of the project and the end product, and ‘warrant’ their performance, e.g. ability to support the rectification of defects that may include integrated products. This may lead to lower client risk adversity and thus greater willingness to relax specifications and approve alternative options.

(c) Conceptual interpretation of the issue
This issue is influenced by the effectiveness of relational governance, supported through client trust and reassurance that the contractor will act in the best interest of the project. The contractor is thus motivated to uphold their reputation within the project organisation and will want to avoid procedural sanctions that can be enforced through the prequalification system for poor performance. Although prequalification may decrease client risks, it may also result in a conservative approach from the contractor, out of reluctance to put forward new products that may negatively affect their reputation.

As past performance can be recorded in prequalification systems, there is also an opportunity for clients’ to maintain contractor performance records to encourage the contractor’s desire to uphold their reputation for commercial advantage in future projects. This opportunity relates to a client’s absorptive capacity to recognise innovative contractor/consultants and assimilate this knowledge into their current prequalification systems, to be exploited in future projects.

(8) Agency specifications (performance-based or prescriptive)

(a) Background on the issue

Over recent years, there has been a move to introduce performance-based specifications to construction projects and to phase out prescriptive measures. Traditionally, under a prescription-based regulatory system, the methods to achieve performance objectives are explicitly described - based on the assumption the client and their representatives know exactly what is to be constructed and how construction should be achieved. The major problem with this is that clients no longer possess the level of skill and expertise in the design and construction of their facilities as in the past, resulting in a greater reliance on engineers and constructors to deliver projects as specified (Ohrn and Schexnayder 1998).

As a result of reduced technical competency within client agencies, they have looked to developing alternative ways to specify their project expectations, while encouraging the contractor to apply their technical knowledge to deliver the highest quality end product. These approaches have involved more emphasis on specifying the clients’ expectations of the end product, as opposed to specifying in detail how the product is delivered. Sketch shelf

One approach that has generally proven successful has been performance-based specifications. A key advantage of performance-based specifications is the clear distinction of roles that allocates the contractor the responsibility to develop and apply the ‘means and methods of construction of their choice provided the end results meet the acceptance of the owner’ (Ohrn and Schexnayder 1998, p.26). This provides the contractor flexibility to be innovative in their design and construction techniques (that can incorporate innovative products), and places emphasis on their technical innovation and experience to deliver the project; rather than their ability to provide labour, materials and plant to construct to a rigid, highly-specified design (Ohrn and Schexnayder 1998). For example, prescriptive concrete specifications will focus on the properties of the ‘raw materials, mixture proportions, the batching mixing and transport of fresh concrete and the full range of construction operations from placing to curing’, while a performance-based approach to concrete will fully describe ‘the required performance characteristics of the end product, leaving materials selection, proportioning and construction means and methods up to the party contractually bound to comply with the specifications’ (Bickley, Hooton, and Hover 2006, p.5).

(b) Interview findings on the issue

Client interviewees noted that design innovation is not always limited by prescriptive specifications, and design solutions (potentially integrating a range of innovative products) can be proposed and approved.
However, individual products and materials are generally controlled by prescriptive specifications (e.g. asphalt and concrete materials). Two contractor interviewees mentioned the conservatism of clients as an inhibitor to new product uptake in the way they rigidly interpreted prescriptive specifications, but felt clients were moving to providing more opportunities to contractors to propose new products that they would consider.

According to two client and three contractor interviewees, a move to performance-based specifications has the potential to improve the adoption of innovative products on road and bridge projects. The general argument was that performance-based specifications can introduce contractor opportunities to propose innovative products that can improve project performance. Despite the benefits that could be gained through the increased application of performance-based specifications, three client interviewees cautioned that not all product systems would suit pure performance-based specifications, and that a ‘dual approach’ (combined prescriptive and performance-based) would be required in some instances.

“There are some areas that we should be looking toward performance-based specifications for…but some are best specified by a recipe type arrangement and others that [a performance-based approach] doesn’t work that well for”

One client interviewee also raised that a major hurdle to the introduction of performance-based specifications is a lack of clarity concerning the performance intention of specific products, due in many cases to the loss of key individuals from agencies.

“We need a higher level interpretations of specs, in the aim to relax requirements for new products [to] be used, but it may go wrong for some if that agency does not have a record of the performance intention behind the specification …we have hundreds of specs, but only a couple with performance-based commentary to guide innovation adoption decisions.”

Interestingly, one client interviewee also mentioned an inhibitor to the adoption of performance-based specifications was the cultural risk adversity of engineers and their concern over the ‘greyness’ of meeting performance intentions, where they may be liable if things go wrong. This interviewee also mentioned engineers generally do not like radical innovation, where they may be placed under scrutiny and attention.

(c) Conceptual interpretation of the issue

These results suggest that the effectiveness of performance-based specifications to promote innovative product uptake is influenced by the trustworthiness (as an indicator of strong relational governance) of the contractor to deliver on the expected performance intentions and their motivation to do so. The introduction of performance-based specifications can be perceived as a major risk to the client as they rely on the expertise and experience of the contractor to deliver an end product, without control over the process or products used. The clients’ trust in the contractor to deliver under this regulatory environment will be influenced by the contractors’ ability and proven track record. Thus, a proven track record can reduce client risk and promote clients’ capacity to assess and approve innovative products proposed by the contractor.

Additionally, client capacity to define the performance intention of specific products will be influenced by their absorptive capacity to acquire, assimilate and use information in the development of performance specifications, and their capacity to assess adherence to performance intentions. Dual specifications will require identification of what product and material combinations are prescribed and identification of the performance intention. The ability to identify these features may depend on the specification writers’ competency to clearly discern the performance characteristics appropriate to the intended use, and
describe these valid performance characteristics in a clear, unambiguous and in most cases, quantitative way, so performance can be assessed (Bickley, Hooton, and Hover 2006). It is expected that the effectiveness of performance-based specifications is also influenced by the contractors’ absorptive capacity to acquire and assimilate new product information to be exploited to meet performance intentions.

(9) Product liability and warranties

(a) Background on the issue

In general, the increasing levels of product liability litigation and a perception that construction product applications can result in high exposure to liability, has had a negative impact on product innovation and promoted conservatism in construction. According to a major US study undertaken by the National Cooperative Highway Research Program (Gittings and Bagby 1996), the highways sector experiences significantly lower levels of innovation in comparison to many other sectors (such as manufacturing) partly due to a perception of product litigation risk exposure to public agencies, private suppliers and contractors. This has resulted in a general apprehension towards experimentation and deployment of new products, processes and equipment, significantly inhibiting innovation. This US study also acknowledged a resistance to change in a well established market of traditional technologies and a slow evolution to establishing criteria for testing and evaluating new products - as potential inhibitors of product innovation. There are many methods that can be used to alleviate perceived construction product liability risks, one being the use of product warranties.

Warranties for construction products are not as well developed or practically applied in comparison to warranties in other markets such as consumer products. Generally, warranties that apply to construction are either implied/ statutory warranties (for the general statute that product fits its purpose for which it is intended) or express warranties (for affirmation of fact or promise made by the manufacturer about the performance of the product). There are acknowledged difficulties in establishing an argument for ‘fitness of purpose’ under an implied warranty arrangement when a government client specifies and certifies a particular product and its performance (Gittings and Bagby 1996). Thus, express warranties that offer variable terms that suit a particular application offer an opportunity for suppliers to gain competitive advantage by offering fuller warranty conditions to their clients concerning the performance of their products.

(b) Interview findings on the issue

Two client interviewees mentioned that client agencies would need to seek warranties for new products under a performance-based specification environment. This could provide the client greater certainty in performance and offset client liability risk for certifying a previously untested innovative product, particularly when specifications are open to interpretation under a performance-based environment.

It was also identified that suppliers are not used to providing warranties, and for them to do so could potentially be expensive. But according to one client interviewee, warranties could lessen the need for internal trialling and thus, clients may be more motivated to approve alternative product options during a project. This interviewee also mentioned that client confidence in products would increase with a sufficient trial warranty period (5 years was proposed) to ‘field-test’ longer-term product performance.

“With the performance specification, you would need a whole lot of testing that is done for the performance of the product – and you’d need a warranty period ...you could probably test less,
Another client interviewee argued that although warranties can be useful in minimising client risks, if the client ‘goes over the top’ on the expectation for product warranties, it may discourage innovation as suppliers will take a more cautious approach to product development and trialling; so they have more confidence in their products and thus less financial risk in providing a warranty. This client interviewee also argued that client agencies should be doing more product training and certification, to decrease warranty requirements. There is a need to establish the appropriate balance of responsibility between the client and supplier in trialling and bearing risk.

(c) Conceptual interpretation of the issue

The interview results suggest that there is a general client apprehension towards the deployment of new products due to product liability issues. These issues are acknowledged by both client and contractor organisations as inhibiting innovative product uptake and relate to the effectiveness of the project organisation to address these concerns, particularly relating to the delegation of project performance responsibility. This includes issues relating to the development of trust and cooperation within the project organisation that encourages project stakeholders to share the responsibility and cost of trialling new products and preventing opportunistic behaviour.

Project stakeholders are faced with the challenge of who accepts risk for product failure and thus, what is determined as an appropriate warranty length. It was indentified that Australian suppliers are reluctant to offer warranties for their products as it can be difficult to define who is responsible for product failure in complex design configurations. The absorptive capacity of suppliers to adopt the new idea of warranties, may be influenced by the willingness of clients and contractors to share the cost and risk for new product trialing, promoting collaboration and trust across supplier and contractor relationships, and encouraging the uptake of new products on projects.

Client agencies can play a significant role in this process, particularly in discouraging conservatism, and providing a supportive environment for suppliers and contractors to propose innovative products. This applies to the ability, intention and integrity of the client and their procedures to fairly assess (and share the risk for) the use of innovative product options. On the other hand, suppliers and contractors need to be willing to share the responsibility of product testing and verification to encourage clients to become more open to new product ideas. Improving client absorptive capacity towards identifying, trialing and certifying new products can decrease product liability risks and lessen the need for extended product warranties.

CONCLUSION

In summary, the analysis of issues raised by project stakeholder interviewees revealed some interesting findings to be further investigated in the upcoming research activities. A broad finding that arose from the project delivery environment was the impact of the selected delivery system on innovative product adoption. In particular, this finding related to how the delivery system (including the tender approach) motivated the contractor to propose innovative product options, influenced by the ability and willingness of client representatives to assess and approve alternative products. Also, the results suggested that the contractor is perceived to be in the strong position to suggest the adoption of new products, but that constraints to the clients’ absorptive capacity create a significant barrier to adoption.
Another broad finding that arose from the on-going business environment was the significant impact of agency specifications and product liability concerns on new product adoption. In particular, prescriptive specifications were identified as a barrier to adoption, with interviewee support for the increased application of performance-based specifications that offer contractor opportunities to propose innovative products. Also, project liability concerns’ resulting in client conservatism was identified as a barrier to adoption, influenced by the challenges faced by project stakeholders in allocating risk for product performance and warranty requirements for un-trialed products. This issue related closely to a need within the industry for shared understanding of the responsibility for product testing and evaluation. The results indicate that clients are unsatisfied with the level of evidence, presented by suppliers and contractors, of long-term product performance capability. This has resulted in slower client response to new product ideas.

Part 2 of this report has provided an in-depth discussion of Queensland industry stakeholder issues relating to new product adoption on road and bridge projects. These issues were identified using content analysis of interview data and coding of issues into two key construction contexts, the project delivery environment and the on-going business environment. The discussion of each issue provided a brief background based on the academic literature of the topic, a description of how the issue manifests in the Queensland context as described by the interviewees, and an interpretation of the issue through three problem lenses. This background work comprises the first phase of a three-phase fieldwork program. As such, it provides focus for the next stage of the Innovative Products ARC research project: the major online survey in 2011, which will be followed by the focus group study in 2012. Figure 2 shows the 18 innovation indicators sourced from the conceptual literature review. It also shows the 9 industry issues that emerged from use of interview questions based on the indicators. These issues for found to impact on product adoption in the road and bridge sector and will provide guidance for upcoming fieldwork.
Figure 2 Innovation Indicators and Industry Issues

**Industry issues by construction context**

**Project Delivery Environment**
1. goal alignment and incentives
2. contractor tender assessment
3. contractual relations
4. problem solving and idea assessment during design & construction
5. contractor involvement in design stages

**On-going Business Environment**
6. product development
7. prequalification
8. agency specifications
9. project liability and warranties

**Innovative Product Adoption on Projects**

**Relational Governance**
1. Managing team boundaries
2. Macroculture development
3. Incentives and collective sanctions
4. Reputation of participants
5. Trustworthiness: Ability
6. Trustworthiness: Integrity
7. Trustworthiness: Benevolence

**Absorptive Capacity**
8. Exploratory learning
9. Transformative learning
10. Exploitative learning

**Knowledge intermediation**
Intermediary Roles
11. the consultant
12. the broker
13. the mediator
14. the resource provider

Knowledge Intermediary Activities
15. Access
16. Learning
17. Linking
18. Implementation

**Innovation indicators by problem lenses**
REFERENCES


