

Innovative Products

Focus Group Report 2012



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Innovative Road Products Focus Group Report

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1. Executive Summary

This report presents the results of Phase 3 of the *Innovative Road Products Project: National Focus Groups*. The groups developed solutions to address the most important obstacles constraining the adoption of innovative products in Australian road construction projects. The research team comprises: Tim Rose, Karen Manley, Deb Messer, Stephen Kajewski, Rachel Parker and Keith Hampson from Queensland University of Technology; Jane Marceau from the University of New South Wales; Jon Oxford from Queensland Department of Transport and Main Roads; and the Board of the Construction Industry Institute Australia. The research project was supported by these organisations and the Australian Research Council. Support was also received from VicRoads, NSW Roads and Maritime Services, Consult Australia, Australian Asphalt Pavement Association and Cement Concrete and Aggregates Australia, who assisted in securing focus group participants.

The Innovative Products Survey, the major Project deliverable in 2011, and the largest innovation survey ever undertaken in the Australian road construction industry, resulted in the identification of key obstacles constraining the adoption of innovative products on road projects. Earlier research (Rose and Manley 2012) identified a range of obstacles that were ranked by survey respondents, with the following being the most important: 1) the restrictive nature of the tender process discouraging product innovation, including a shortage of time and other resources to assess non-conforming products and over-emphasis on direct price; and 2) disagreement across industry stakeholders about how new product risks should be managed, which impacts on the willingness to propose and approve new products for adoption.

Drawing on the survey findings, focus groups were conducted over three weeks in May 2012. The research population was defined as key organisations involved in the Australian road construction industry. These were identified by industry partners on the project. The focus group participants were drawn from four sectors across the road product supply chain: clients (state government road agencies), contractors (comprising head and trade contractors and subcontractors), consultants (primarily engineering consultant firms) and suppliers (comprising manufacturers and distributors). The focus group program involved three workshops, each of three hours duration, conducted in three mainland states – New South Wales (Sydney), Victoria (Melbourne) and Queensland (Brisbane), consistent with the population frame of the original survey. The overall number of focus group participants was 40, spread relatively evenly across the four sectors and three states.

In all cases, focus group participants were operational managers with experience in new product adoption processes. They represented the following influential organisations:

Sector	Organisation
Client	Queensland Department of Transport and Main Roads, VicRoads, New South Wales Roads and Maritime Services.
Contractor	Visionstream, Thiess Contractors, Leighton Contractors, Abigroup, Cut and Fill Contractors, Fulton Hogan.
Consultant	ARUP, Sinclair Knight Merz, Aurecon, Parsons Brinckerhoff, Brown Consulting.
Supplier	SRS Roads, BP Bitumen, Boral Concrete, Hanson, Boral Asphalt, Wagners CFT; Ecoflex.

The focus groups were conducted by an independent facilitator and field researcher, with focus group discussions recorded and transcribed verbatim for analysis. The field researcher also took notes to augment transcriptions. Content analysis of the focus group transcripts and field-notes was undertaken manually to aggregate and categorise the most frequently cited solutions to address key problem areas, across the three focus groups, from a whole of industry viewpoint. The overriding organising principle for the content analysis was the research question driving the study: *'How can the Australian road construction industry go about addressing key innovative product adoption problems and improve new product uptake?'*

Seven key initiatives were identified from the focus group discussions; four initiatives relating to the restrictive nature of tender assessment and three initiatives relating to disagreement over who carries the risk of new product failure. Although the industry is already moving in the direction of the suggested initiatives, focus group participants stressed the need to expand efforts in the target areas. The initiatives identified are as follows:

RESTRICTIVE TENDER ASSESSMENT

- 1. Product certification prior to tender stage.** Focus group participants wanted to see the development of a well resourced product certification process outside the tender stage, so as to alleviate project resource constraints. This process may involve the development of an independent certification body representing government and industry interests, to assess and confirm performance and comparative value of innovative products that may be outside current specifications. To develop a suitable product certification process, focus group participants proposed that the road industry benchmark against successful international product certification schemes such as HAPAS (UK), Charte d'Innovation (France), and Agrément South Africa (South Africa). Greater resourcing was also recommended to (1) further develop the fledgling MIMS system (Ausroads) and (2) integrate successful state road agency certification processes such as TIPES (Queensland Department of Transport and Main Roads).

- 2. Emphasis on the strategic value of innovation during early project stages.** Focus group participants recommended incentives and improved methods for government clients to accurately assess the strategic value of innovative products during early project stages, including the tender stage. Clients were encouraged to take a stronger leading role in promoting an 'innovation culture' across the road industry through their behaviour and project expectations. Improved client knowledge for assessing innovative product options according to 'value for money' may decrease apprehension about new product risks. This in turn may increase decision-maker confidence to make product judgements based on value, reducing the current emphasis on minimising up-front costs.
- 3. Assessment of past innovation performance as a tender selection criterion.** Greater emphasis on contractors' past innovation performance was recommended as a non-price tender selection criterion. This may offer improved incentives for contractors, who normally act as a 'broker' of new product knowledge generated by suppliers. Contracts may then better champion the uptake of innovative products for project benefit.
- 4. Earlier involvement of suppliers and road asset operators in project planning and design.** Earlier involvement of front-end suppliers and back-end road asset operators in project planning and design stages was recommended. This is expected to improve product-design integration from a whole-of-life planning perspective, and better define the value of innovative products under consideration.

DISAGREEMENT OVER WHO CARRIES THE RISK OF NEW PRODUCT FAILURE

- 5. Development of formal knowledge exchange networks.** Development of dedicated, multi-disciplinary knowledge exchange networks was recommended. These would 'broker' new product innovation knowledge across local supply chains and international markets, thus promoting Communities in Practice. This may improve the quality of information available to decision-makers in defining risk and assessing value of innovative products under consideration. Knowledge exchange could be facilitated through regular innovative product workshops/forums. A knowledge exchange web-based portal could also be developed, providing an interactive environment to showcase emerging products and to present product development opportunities.
- 6. Increased uptake of performance-based specifications.** It was recommended that clients and their representatives further increase the uptake of performance-based specifications. This was thought to provide greater flexibility to adopt new products that may have previously been considered to be non-conforming. However, adequate lead time and specialist expertise is required to

clearly specify functional performance assessment criteria and conduct accurate assessments to verify and enforce compliance.

- 7. Increased relationship contracting.** Increased use of relationship contracting delivery models, such as Early Contractor Involvement (ECI) and Alliancing, was recommended. This would encourage greater risk sharing between contracted parties and recognition of mutual benefits in the adoption of innovative products on road projects.

In summary, focus group findings suggest the Australian road industry should be: investing more in the effective transfer of innovative product knowledge to inform decision-making; streamlining road agency regulatory processes to provide greater flexibility; assessing new products on their long term value for money; developing new processes for assessing and certifying product performance; and increasing the use of project governance arrangements that offer a joint approach to risk management.

The focus group results provide a strong base for future research to develop and pilot these recommended initiatives. In the short term, the industry needs to develop a formal innovative product knowledge exchange network and assess the feasibility of an innovative road product certification system benchmarked against successful international certification processes. These initiatives clearly offer benefits to increase innovative product adoption on Australian road projects.

2. Introduction

In 2012, the Innovative Products Research Team based at the Queensland University of Technology (QUT) undertook focus group research to identify shared solutions to the most important obstacles constraining innovative product adoption in the Australian road industry. The research team comprises Tim Rose, Karen Manley, Deb Messer, Stephen Kajewski, Rachel Parker and Keith Hampson from Queensland University of Technology; Jane Marceau from the University of New South Wales; Jon Oxford from Queensland Department of Transport and Main Roads; and the Board of the Construction Industry Institute Australia. The research project was supported by these organisations and the Australian Research Council. Support was also received from VicRoads, NSW Roads and Maritime Services, Consult Australia, Australian Asphalt Pavement Association and Cement Concrete and Aggregates Australia, who assisted in securing focus group participants.

Product innovation is defined by the world authority in this area as ‘the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials’ (OECD/Eurostat 2005). Thus, product innovation covers the introduction of new and significantly improved goods and services with regard to their functionality and user characteristics within the specific market. Innovative products in road construction often comprise new materials, such as high performance concretes and asphalts, geo-synthetics, or fibre-reinforced polymer composites. Other examples include advances in intelligent network technologies, lighting, or damping and energy dissipation devices.

Despite the positive impact of innovation on construction industry performance (see Gambatese and Hallowell 2011; Slaughter 1998), there are challenges to increasing the diffusion of innovation. These challenges differ from those encountered in other industries, such as manufacturing. Broadly, these construction challenges include: (1) the unique and novel characteristics of the constructed product, involving a wide range of specialised professionals embedded within a complex production system; and (2) high risks associated with failure and requirement for long term durability that leads to conservatism towards trial and error approaches (Blayse and Manley 2004; Nam and Tatum 1989). These types of challenges have constrained product innovation at an industry level, exacerbated by the necessity to deliver larger and more complex road infrastructure projects in response to fast-growing demand. In Australia, this growing demand is evident by the total value of engineering investment in the pipeline, which was estimated at A\$96 billion in 2011, representing more than ten times that of ten years prior (Austrade 2011). Significant ingenuity on the part of the road project supply chain is required to deliver such a large program of work, including maximising product innovation opportunities to enhance long-term road infrastructure asset performance.

To address the need for improved understanding of product innovation and how it can be increased in the Australian road industry, the research team conducted a major industry survey in 2011 to rank problems that were seen to constrain innovative product adoption. The list of problems was generated by an interview program conducted in Queensland in 2010 (Rose and Manley 2012). In total, 865 survey questionnaires were distributed to senior managers representing their respective organisations across the road construction supply chain. Overall, 212 usable responses were received, providing a response rate of approximately 25%. This was an important exercise for policy makers and comprised the largest innovation survey of the road industry ever conducted in Australia. In summary, the survey identified two key problems that were ranked as the most important to be addressed by respondents across four key supply chain sectors surveyed, namely product suppliers, consultants, contractors and government road agency clients. The key problem areas identified were:

- (1) *Restrictive Tender Assessment*. This problem relates to the restrictive nature of the tender process discouraging product innovation, including a shortage of time and other resources to approve non-conforming products (as a part of a tender submission) and the over-emphasis on up-front costs.
- (2) *Disagreement over who carries the risk of new product failure*. This problem relates to a general disagreement across industry stakeholders about how new product risks should be managed, which impacts on the willingness to propose and approve innovative products for use.

Drawing on the 2011 survey results, the broad objective of the focus group research was to unite key industry stakeholders involved in the production and adoption of roads products, and to 'brainstorm' key initiatives from a whole of industry viewpoint, to address the two key problem areas.

It is anticipated the focus group findings provided in this report will inform the development of refined strategies and assist public policy targeting improved product adoption rates. Further, the research team will broadly disseminate these industry recommendations, aiming to further develop the solutions derived from the focus groups, leading to change strategies across state and national jurisdictions.

3. Methodology

Focus groups are an effective qualitative data collection tool to elicit unified themes from a group of participants. As groups are 'focussed' through the collective activity of participation, and are inherently informal, participants are encouraged to openly converse, exchange experiences and comment on each others' perspective about the topic. It is the focus group dynamic that generates rich inductive data and offers more

effective exploration of how attitudes and points of view are both constructed and conveyed (Fern 2001). Focus groups typically involve small groups of six to twelve people who participate in open discussion (Flick 2009). Focus groups allow participants to discuss a particular topic under the direction of a facilitator, who promotes interaction and leads the discussion on the topic of interest (Stewart and Shamdasani 1990).

Despite the benefits of focus groups, there are some common criticisms of the approach. The main criticisms are that they do not yield 'hard' data and that group members may not be representative of a larger population due to the small numbers and the idiosyncratic nature of the group discussion (Stewart and Shamdasani 1990). Other criticisms include that: (a) relatively few groups are conducted in a given study; (b) the selection of respondents is not a random process; and (c) the open ended nature of responses can make interpretation of results difficult (Fern 2001). Such concerns are common in qualitative research and can be minimised by clearly defining the research population, carefully selecting focus group participants and expertly managing the focus group process to elicit group perceptions. The focus group facilitator plays a key role in maintaining validity in the process by conscientiously minimising bias and undesirable cue questioning (Stewart and Shamdasani 1990).

The focus group program was conducted over one week in May 2012 and involved three workshops, each of three hours duration, conducted in three mainland states – New South Wales (Sydney), Victoria (Melbourne) and Queensland (Brisbane). The overall number of focus group participants was 40, comprising 11 suppliers, nine consultants, 10 contractors and 10 clients across the three states. To ensure the focus group program remained manageable and aligned with the scope of the survey study, the research was confined to these eastern Australian states.

The focus group study responds to an identified need within the Australian road industry to develop strategies to increase product innovation by addressing key problem areas. The research question driving the focus group discussion was:

How can the Australian road construction industry go about addressing key innovative product adoption problems and improve new product uptake?

The research population (from which the focus group participants were drawn) was defined as key organisations in the delivery of Australian road construction projects across four types of project stakeholders: clients, contractors, consultants and suppliers. These groups are defined below:

- Clients – government managers responsible for project management, risk management and budgetary management – providing the link between governance, regulation and project management decisions.
- Contractors – main contractors responsible for the construction process and

input to the design process, and subcontractors/trade contractors responsible for management of various trade packages on projects.

- Consultants – responsible for specific design areas such as engineering design development and management.
- Suppliers – responsible for the manufacturing and/or distribution of products to projects, procured by the contractor, consultant and/or client.

Key organisations were defined as those actively involved in the delivery of government road projects in the three states; and member organisations of the three selected industry associations. The government road agencies across the three states were also appropriately represented. The three industry associations comprised Cement Concrete and Aggregates Australia (CCAA), Australian Asphalt Pavement Association (AAPA) and Consult Australia. These associations were chosen for inclusion in consultation with the industry partners working with the researchers. They were considered to be important to road project innovation outcomes in Australia. This population frame was consistent with the survey study so as to maintain external validity and allow researchers to compare results across the two studies.

Within the research population frame, effective selection of participants and group composition is critical to the robustness of the focus group approach because it affects compatibility, cohesiveness and group motivation (Fern 2001). Focus group participants were purposefully selected and invited through project partner referrals, industry association and state government road agency contacts across the research population. This included senior managers represented on state government industry boards. Participants were also sourced from an expression of interest process led by two industry associations through their membership newsletters. Approximately 45 suitable candidates were invited to attend the focus groups, with forty accepting the invitation. To maximise research validity, each sector was represented by at least two participants in each focus group session, with at least eight participants in each focus group across the three states. This sample distribution provided enough data variation, while maintaining control over the complexity and volume of data. In all cases, focus group participants were operational managers with experience in new product adoption processes, within the defined industry sectors. They represented the following influential organisations.

Sector	Organisation
Client	Queensland Department of Transport and Main Roads, VicRoads, New South Wales Roads and Maritime Services.
Contractor	Visionstream, Thiess Contractors, Leighton Contractors, Abigroup, Cut and Fill Contractors, Fulton Hogan.
Consultant	ARUP, Sinclair Knight Merz, Aurecon, Parsons Brinckerhoff, Brown Consulting.
Supplier	SRS Roads, BP Bitumen, Boral Concrete, Hanson, Boral Asphalt, Wagners CFT; Ecoflex.

Although it is not possible to control all characteristics of focus group participants (Barbour and Kitzinger 1999), participants were purposefully selected to take part based on their perceived ability to strategically discuss the industry problems, and their willingness to embrace the ethos of the focus group approach. Many focus group participants had previously shared road construction project experiences with other participants. Barbour and Kitzinger (1999) support this approach and argue that 'bringing together people on the basis of some shared experience is often most productive.' (p.9). In many cases, the researchers spoke with potential participants prior to the workshops to gauge their suitability in the context of each groups' composition across the three workshops.

In preparation for the focus groups, a discussion guide was developed that provided direction to how the focus groups were to be conducted, and a general outline of the direction and type of questioning to be undertaken. This included question cues for steering the discussion and probing for further information. The development of the focus group discussion guide (see *Appendix A*) drew on earlier project work and was designed to address the requirements of project partners. Additionally, participants were provided an introductory brief (see *Appendix B*) one week prior, to encourage them to prepare for their focus group and maximise their contribution to the discussions.

An external facilitator was selected and appointed to facilitate the focus groups. The appointed facilitator was Mr Andrew Stevenson (Alchimie). The facilitator had extensive experience in road project design and delivery, and as such, promoted the development of rapport with the focus group participants, and encouraged participants to openly communicate their ideas, views and opinions. The facilitator was also selected on the basis of personality and the ability to generate open discussion. A fieldwork researcher was also involved in all workshops to observe, take notes on emerging themes, record any personal impressions and direct the facilitator in refining the focus group approach.

To maximise validity of the focus group data, the facilitator and fieldwork researcher also actively sought to break down pre-existing hierarchical norms across the focus

group participants, as hierarchies within groups can inhibit the contributions of certain participants. Bias due to pre-existing hierarchical norms cannot be completely discounted in a focus group environment, however such influence was minimised by promoting equal opportunity and confidentiality across participants.

Informed consent and confidentiality are important ethical considerations for focus group research. Under the agreed consent of the participants, focus groups were audio recorded and transcribed verbatim for analysis. Personal information shared during the focus group workshops was treated confidentially by the researchers. Although it is not possible to ensure that other focus group participants will keep shared information confidential, participants were requested to respect each other's privacy and anonymity. The researchers stressed that participants would not be required to reveal commercially sensitive information. A consent procedure (see *Appendix C*) stipulated that any personal information of participants (e.g. their name and their position) remained anonymous and focus group recordings and transcriptions would be securely stored, used only by the research team for analysis purposes, and then destroyed thereafter.

Manual content analysis of results was undertaken; this is a commonly used technique for analysing qualitative data in the social sciences area. It provides rich interpretations through the systematic and objective review of communication (Krippendorff 2004). Manual content analysis of the focus group transcripts and field-notes was conducted to aggregate and categorise the most frequently cited initiatives to address pre-defined problem areas, across the three focus groups. Analysing aggregated data across the three groups was appropriate, as the research study focuses on identifying key initiatives from a 'whole of industry' viewpoint, as opposed to initiatives that may apply in a specific context, e.g. state government jurisdictions. When categorising the data, care was taken to identify initiatives that were: (1) frequently and broadly cited; (2) limited to the most significant and (3) mutually exclusive.

4. Focus Group Solutions

Table 1 summarises the key industry initiatives raised by participants across the three focus groups, to address the two problem areas constraining product innovation adoption in Australian road projects. As shown in Table 1, there were seven solutions most frequently cited across the three focus groups. There were four solutions identified to address the restrictive nature of tender assessment, and three solutions identified to address issues relating to disagreement over who carries the risk of new product failure.

Table 1 Focus Group Solutions

Solution	Description
OBSTACLE 1: RESTRICTIVE TENDER ASSESSMENT	
1. Product certification process prior to tender stage	Development of an innovative product certification process outside the tender stage to alleviate project resource constraints. This process may involve the development of an independent certification body representing government and industry interests, to assess and confirm performance and comparative value of innovative products that may be outside current client road agency specifications.
2. Emphasis on the strategic value of innovation during early project stages	Incentives and improved methods for government clients to accurately assess the strategic value of innovative products during early project stages, including the tender stage. Clients take a stronger leading role in promoting an ‘innovation culture’ across the road industry through their behaviour and project expectations.
3. Assessment of past innovation performance as a tender selection criterion	Greater emphasis placed on contractors’ past innovation performance as a non-price tender selection criterion. This may offer further incentives for contractors, who normally act as ‘brokers’ of new product knowledge, to champion the uptake of innovative products for project benefit.
4. Earlier involvement of suppliers and road asset operators in project planning and design	Earlier involvement of suppliers and road asset operators in project planning and design stages to improve product adoption decision-making and better define the value of new products in comparison to existing products from a whole-of-life perspective.
OBSTACLE 2: DISAGREEMENT OVER WHO CARRIES THE RISK OF NEW PRODUCT FAILURE	
5. Development of formal knowledge exchange networks	Development of dedicated, multi-disciplinary knowledge exchange networks to promote awareness of promising new products, benchmark potential benefits and promote Communities in Practice. This will improve the quality of information available to decision-makers in defining risk and assessing the value of innovative products under consideration.
6. Increased uptake of performance-based specifications	Increase the uptake of performance-based specifications, argued to provide greater flexibility to adopt new products that previously have been non-conforming. Product suppliers should be encouraged to offer longer expressed warranty periods for new products to increase client confidence in product performance and offset liability, particularly under performance-based specification conditions.
7. Increased relationship contracting	Increased use of relationship contracting delivery models, such as Alliancing, to encourage greater risk sharing between contracted parties and recognition of mutual benefits in the adoption of innovative products on road projects.

The seven solutions are now discussed in detail, with respect to the obstacles to be addressed. Each of the following sections also includes example quotes from the focus group discussions to provide further contextual depth. The first problem area to be discussed is the restrictive nature of tender assessment on innovative product adoption.

4.1 Restrictive Tender Assessment

According to the 2011 survey results, the restrictive nature of tender assessment was seen as the most significant problem constraining the adoption of innovative products on Australian road projects. This key problem area relates to two main issues regarding the restrictive nature of tender selection. The first issue relates to inadequate time and other resources available to road agency clients to adequately assess non-conforming tenders that may include innovative product options during the tender stage. Additionally, clients can receive proposals that lack supporting evidence of long-term performance, contributing to apprehension to approve new products for use on projects. Such pressures lead to unwillingness for client representatives to approve products outside prescriptive specifications because they are unable to effectively verify performance implications within the time constraints of the tender assessment process. This can lead to approving officers resorting to standard approaches that are less risky. Focus group discussion reinforced this as a key problem.

'Even if you've got enough information [on product performance], at a review period of a week you are not going to be able to dig deep enough to give you that level of confidence you require.' (Client)

Contractors also face significant time pressure during the preparation of tender submissions and it seems this pressure also restricts their ability to consider new products from within their organisations and from consultants, subcontractors and suppliers. This leads to conservative product selection, particularly when risks are not easily quantifiable. Such inhibitors, combined with lower expectations that new products will be accepted due to likelihood of non-conformance, results in the industry becoming less willing to invest in new product options that may have significant value to a project, but are currently non-conforming.

'It's a waste of time putting up new products in a tender process. It doesn't matter how many resources you throw at it, given the checks & balances that have got to be ticked... you're never going to achieve it. Let's be realistic about it. If we put [the new product] up as an alternative, it is struck out immediately. Non conforming, end of story ...If it's a big innovation that costs of a lot of money to price up then we all agree it's just not worth [it], it will just cost us too much money, so you just don't do it.' (Contractor)

The focus on price criteria in the tender selection process is also an obstacle to new product uptake. This enduring obstacle arises from (1) the difficulty for clients to effectively assess alternative tender options when focused on selecting a contractor

based on price and (2) the unwillingness of the contractor (and their suppliers) to propose alternative product options during a potentially adversarial price-focused tender process, particularly in project priority areas that sit outside cost-savings. According to focus group discussions, this remains a common problem:

'There's new products and technology coming along that we're not taking advantage of, and we can't because the tender doesn't let us or the specification doesn't let us, and as we've discussed, the tender periods are so short, you just go in, give them the bones, the cheapest price, because that's all it is, the cheapest option... You will look at how you can be smarter and use new products that might give you an advantage over your competitor in terms of price, but that's about all you can do in the tender period.' (Contractor)

'The team are pushed by driving down the time and cost. So even internally, having price-only [selection] without someone independently assessing the full value of what is being offered often creates tension.' (Consultant)

Ideally, the tender process should encourage contractors, consultants and suppliers to utilise their innovation knowledge and leverage competitive advantage, while encouraging client agencies to maximise this opportunity and reap the benefits of innovation. Four solutions to the obstacles that prevent this happening were suggested: (1) the establishment of a product certification process prior to tender stage to alleviate resource pressures during tender assessment, (2) greater emphasis to be placed on the strategic long-term value on innovation during the early project stages, 3) assessment of contractors' 'past innovation performance' as a non-price selection criteria; and 4) early involvement of suppliers and road asset operators in project planning and design, so as to inform the assessment of innovative product opportunities from a whole-of-life perspective. Each solution is now discussed in detail.

4.1.1 Product certification process prior to tender stage

The literature encourages construction clients to establish a transparent process for assessing alternative product and design options, and provide the resources to fairly assess them (Sidwell et al. 2001). Probity concerns and clients' lack of resources to effectively assess new product 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 submission of unsubstantiated ideas ties up client resources, leaving less time for consideration of robust ideas. According to focus group participants, new product approval processes are currently slow because client agencies are required to accurately validate the performance of a product before full scale adoption. This tends not to suit the short-term constraints of a project tender process.

'...you have to take baby steps. We have been working on getting porous concrete for pavements up [at the state government level]. We started in 2004 or 2005, and it's now almost there. Over the next 6-12 months it will be assessed and if it stands up, it is a viable alternative to asphalt in some areas. That has been a slow process, lab trials, small field trials,

big field trials, main field trials to now we are at the stage where it is done, being assessed, and if the assessment stands up, there is a viable product ...it's a long process' (Contractor)

Overwhelmingly, focus group participants agreed that a potential way forward for the industry to alleviate the project pressures constraining the acceptance of new products during tender is to establish a product certification process outside the project tender process.

'The first thing is that you don't look at implementing an approval process as part of the tender - step it outside of the project and that way you don't have the time and weight of the project bearing down to try and assess it because, if you have got that pressure, and there is any doubt or confusion about the product logically, it is not going to be considered. If you are not in a constrained environment - you are probably going to get a better hearing' (Client)

'Put in place a [certification] process offline from any project at all, offline, together as an industry, it might be suppliers, it might be contractors, it might be government, all involved to get these things assessed and approved - such that when we go to the next job if it's a different type of pile we want to use which is 50% of the price of the approved one but better performance, all the work has been done to measure risk and has been taken out of the heat of the moment.' (Contractor)

'We agreed that we [the industry] need a product certification process where an independent body certifies the product through a panel of experts, so when you file the certification, it has already been done, so that avoids the strain on resources, time during tender ...It is done internationally, why not here?' (Consultant)

'We pretty much all came to the conclusion that trying to introduce innovative products during a project is very, very difficult... particularly if you are approaching a non conforming area; because of the resource constraints and risk and all that sort of stuff... so the general idea is we need a certification and trialling process outside the project tender... try and set that up so you avoid throwing away potentially valuable innovation that's non-conforming.' (Supplier)

Product supplier participants also raised the importance for product developers to be able to retain control over Intellectual Property (IP) associated with an innovation, so as to encourage ongoing product development. Thus, the product certification process would require a robust commercial management model to retain commercial advantage for proposed developers during independent assessment.

'The trouble with a product certification process is that if you are the one trying to deliver the innovation, that is your competitive advantage, and once it is open to the market and 'standardised', your competitive edge is gone. You need to build in protection measures so we have confidence that rights are retained' (Supplier)

Within this context, Australian road agencies have made advances in establishing product certification processes outside project stages over the last ten years. This has included the early development of the Materials Innovation Management System (MIMS), developed by Ausroads, and tailored state government road agency systems

including Queensland Department of Transport and Main Roads (TMR) Transport Infrastructure Product Evaluation Scheme (TIPES) and NSW Roads and Maritime Services (RMS) Management of Innovation Technologies System. These initiatives have aimed to accelerate the acceptance and implementation of new products. However, despite the heralded benefits that could be achieved through nationally-accepted certification processes, there is currently no inter-jurisdictional consensus. Thus, government agencies are still independently establishing methodologies to assess new products that may not meet current specifications.

Internationally, there are a number of successful road product certification systems that could be benchmarked to further develop an integrated Australian system. Of note, are international product certification schemes such as the Highway Agency Product Accreditation Scheme, or HAPAS (UK); Charte d'Innovation (France); and Agrément South Africa (ASA) (South Africa). Future research is recommended to benchmark against these systems to advise how the Australian road industry could successfully implement an integrated road product certification system. EAPA (2003) provides a summary of the commonalities across existing European certification systems, which could be considered when determining an appropriate system for Australia:

- The innovation product development is done by the industry. The road authority may describe [its] wishes in terms of performance (Charte d'Innovation) or may accept novel products which the producer has proven to have equal performance quality compared to conventional products (HAPAS).
- The proof of the performance quality is based on known technology: functional test methods, accepted construction [and] design models.
- The verification of the performance quality is done by independent bodies. These bodies are formed through mutual cooperation between road authorities and industry.
- When a product is accepted, the field of application, the performance characteristics and practical experiences are published. (EAPA 2003 p. 4)

Thus, a key feature of a product certification system is establishing an independent assessment body that has the broad range of expertise and support to accurately assess product performance. This body could also monitor the quality of testing, manage what types of applications should be considered for a specific product, and maintain a database of long term performance during broader product implementation.

4.1.2 Emphasis on the strategic value of innovation during early project stages

Although, focus group participants acknowledged the importance for government clients, contractors, consultants and suppliers to efficiently and accurately verify the long term performance of innovative products at early project stages, it was felt there

was a general lack of incentive or encouragement for parties to develop and facilitate new products for use at the early project stage.

Broadly, governments have an obligation to seek value for money in the delivery of infrastructure projects, such as road projects. The UK's HM Treasury provides a practical definition of 'value for money' as, "securing the best mix of quality and effectiveness for the least outlay over the period of use of the goods or services bought. It is not about minimising upfront prices...[and] value for money will involve an appropriate allocation of risk" (HMTreasury 2008 p. 35). However, emphasising value for money rather than direct costs seems to remain a challenging task for client road agencies, particularly in assessing the relative value of innovative products. According to the focus group participants, this issue relates back to an over-emphasis on upfront cost objectives rather than value for money objectives. This is driven by budget constraints and difficulties in assessing the long-term value of innovative products. Budget constraints require political amendment, while assessment difficulties can restrict the client's ability to approve new products as benefits cannot be easily verified.

A solution to this obstacle, raised by focus group participants, was for clients to take a leading role in promoting a 'culture of innovation', by placing greater emphasis on the strategic value of innovation in emerging areas outside immediate cost benefit outcomes, for example, increased emphasis on sustainability objectives. This could lead to greater willingness to accept and jointly manage innovative product risk. Focus group discussions also suggested government clients can drive this type of industry culture through their project expectations, facilitated in the early project feasibility and the tender stages. However, clients need to be able to trust in the information they are being provided by industry, and need the expertise to interpret this information to effectively assess strategic value in early stages of a project.

'So if you compare different innovative products and one might only have a small financial benefit, but the social and economic benefit could be major. We don't know how you put a financial figure to that type of benefit. ...it is about recognising that there is value in a whole lot of different things and we need to be able to justify value in areas other than cost if we want to encourage innovation.' (Client)

'Price is what you pay, value is what you get. If what you pay is the same, and what you get is the same, then that is appropriate. But it is when the value is different for the same prices - then you are missing something. ...while maybe price is a major criterion, there needs to be a better way to quantify value, or score it so you have confidence in that score. ...it's only when the market starts to see [the client] accepting this type of innovation that we are going to want to invest more [in new products]. If you constantly see a client rejecting valid alternatives, what is the incentive?' (Contractor)

'Price may be the driver of some product innovations, but assessment must be broader to take into account products that offer broader benefits... [clients] need to be encouraging the market to develop [product] innovation in a wide range of areas, not just cost [reduction] ...' (Supplier)

Additionally, focus groups participants suggested government and industry should be to be investing more into coordinated product assessment processes with the flexibility to deal with changes in how new products should be assessed:

'We discussed the complexities of the scenario where you are dealing with technology that is changing pace, where you should go through a totally different engagement process, not the stock standard approach, because you're really assessing something that is going to give you a better result ...because you want product innovation; as opposed to a process where you are accepting the lowest common denominator ...you need a flexible [assessment] system that can intelligently deal with changes' (Contractor)

Client focus group participants acknowledged the difficulty they face in assessing new product options at early project stages and suggested greater clarity in product assessment methods is required to more effectively assess value.

'I think as a client we could better support verification if we've got a clear process of how you take [a new product] from concept to implementation and say this is the required response, these are the test methods we will use. You can then have that dialogue and set the process, and by then we know what it is you need to give us to support your claims.' (Client)

'We need a clear process for transition from development of a new product to adoption ...we have to clearly understand the process to go through - who has to do what and at what stage. I think it's really variable at the moment. So without a clear process and clear criteria - how do you assess whether it's even a good thing or a bad thing.' (Client)

Additionally, focus group participants indentified opportunities to target and develop specific product innovations at the initial project feasibility stage, long before the tender stage. This approach may take the form of an 'exemplar' trial to showcase emerging new products with the purpose of utilising the long lead time of project feasibility. This may also assist in developing tailored products to suit the specific project objectives.

'...we felt it would be good to take advantage of the long lead time prior to tender to consider product innovation ...say a highway widening that is years and years in the planning, and the actual tender period might only be a couple of months; obviously you don't have a lot of time there to put ideas forward, so if the [client], or [the designer] or whoever is putting the tender together, they have all this time look at innovation, talk to the right people about innovation, then that is a way in.' (Consultant)

Clients could be taking a stronger leading role in promoting product innovation through their behaviour and project expectations, focusing on the strategic value of adopting new products. To achieve this, clients need to both improve their knowledge base for accurately assessing innovative products according to value for money, and utilise opportunities to showcase new products on projects for long-term benefits.

4.1.3 Assessment of past innovation performance as a tender selection criterion

Clients have the opportunity to set their expectations for contracted parties through early stages of a project, particularly through the tender selection process. For example, clients can set expectations through selection criteria that focus on proposing innovative options to meet specific project goals. The benefit of innovation-focused selection criteria is that tenderers will be judged on their capacity to think laterally about innovative opportunities and the ability to deliver value-adding options, establishing the expectation that innovation is a key objective for a project (Rose and Manley 2012).

Although greater investment in verifying product benefits may lead to improved adoption, according to earlier research findings, there seems to be inconsistency and confusion about appropriate tender criteria for encouraging product innovation. In response to the question of how the road project tender selection process can be improved to encourage innovative product adoption, focus group participants agreed there was opportunity to further emphasise non-price selection criteria, particularly past innovation performance in areas such as contractor experience in championing new products that have benefited project outcomes. Given that a contractor generally acts as a project innovation knowledge intermediary between suppliers, clients and consultants (Rose and Manley 2012), this may incentivise contractors to champion the uptake of innovative products with proven value to a project, for competitive advantage on future project bids.

'[Selection] should be about contractors' knowledge and [ability to] actually bring new product ideas from other parts of the country and the world - so it is that component of their proven track record - prior organisational competency that looks to their experience with product innovation ...So what you are measuring is their overall level of service in supporting innovation throughout the project and beyond the project, above tendered price'. (Client)

'Assessment could be based on the innovation track record... you'll have people come in trying to do the cheapest job possible, and others will come in and try and save money, but they won't compromise on the quality or performance but past innovation performance is critical and relates to the skills of the people on the team. ...I think it gives a client a level of comfort to know they've engaged someone who has past experience in this area'. (Contractor)

Despite recent moves towards tender selection criteria based on previous experience and performance in the road industry, focus group discussion suggests greater emphasis on non-price selection criteria, particularly past innovation performance, is required to further promote new product adoption. A barrier to change is the continued emphasis on direct project costs as the key driver in contractor selection. Clients can drive innovation by placing greater emphasis on the strategic value of incentivising contractors to champion new products, thus establishing the expectation that product innovation is a key project objective.

4.1.4 Early involvement of suppliers and road asset operators in project planning and design

There are significant benefits for proactively integrating key suppliers in early concept and design stages, including leveraging suppliers' specialised technical knowledge to aid in effectively integrating various supplier components, while retaining the flexibility to adjust product design to meet changing objectives (Bozdogan et al. 1998). As the key knowledge base for innovative products resides with manufacturers or distributors of those products, design innovation (involving integration of innovative products with existing systems) can be restricted if suppliers are not effectively integrated into the development of design. Similarly, the integration of the extended supply chain, including subcontractors, suppliers and end-users, in early project stages, can facilitate improved value engineering and promote the sharing of innovative ideas (Khalfan and McDermott 2006), while focusing attention towards the collective objectives of a project (Dulaimi et al. 2003).

According to focus group participants, the *embeddedness* of product suppliers and client road operators/maintainers in the project planning and design stages was seen to improve the project team's ability to judge the relative value of innovative products to be incorporated into a design. It was also seen to increase the quality of information available to the project client to inform innovative product value decisions at early project stages, including the tender stage.

'To elevate some of these [tender] constraints we are all talking about is getting the suppliers involved earlier [in a project] to show us how we can benefit from using their [innovative] product.... this could give us a more accurate picture in judging if they are worthwhile.' (Client)

'...the maintenance guys wear the issues [of innovative product adoption] down the track, get them involved in establishing the trials and judging value for money over the long term as the experts in long term performance.' (Consultant)

Early involvement of the extended supply chain in design stages may be difficult as there is a risk that design consultants may look upon such involvement as interference rather than assistance (Eriksson et al. 2007). Interestingly, a consultant focus group participant acknowledged that such consultants tend to be sceptical of supplier motivation where suppliers have a vested interest in pushing their innovation to succeed. To overcome this issue, clients should endorse new products to be integrated into design to lessen consultant scepticism.

'We often think that there is a major risk if you start getting a supplier directly involved in design because there is always a level of scepticism from the consultants, because if someone is selling you a product, you naturally assume it might be a risky product. So it may not be a conflict of interest, but you tend to think they've got a vested interest in the products they offer.....But it can be done through a client that says well these are the new products that are

available and we need you to work with them [suppliers integrated in the design process].'
(Consultant)

Early involvement of front-end suppliers and back-end road asset operators in project planning and design stages can increase the quality of information available to the project team on the relative value of new products to be integrated into a road design. Such information can inform adoption decisions with greater accuracy, thus, increasing the opportunities for new products that offer improved value for money.

4.1.5 Summary

Focus group results indicate the decision to adopt an innovative product can be constrained by a lack of resources and time available to effectively assess product performance. Also constraining the decision to adopt new products was a misalignment of client project expectations and innovation opportunities, and a lack of accurate information to inform value judgements. Such constraints are encountered early in a project, particularly at tender stage, when alternative product options are proposed.

To support new product adoption at tender stage and improve the ability for decision-makers to accurately validate the performance of a product before full scale adoption, focus group participants proposed: (1) the implementation of an innovative product certification process outside the tender stage to alleviate project resource constraints, (2) improved methods for government clients to accurately assess the strategic value of innovative products, (3) assessment of contractors' past innovation performance as a tender selection criterion; and 4) early involvement of the extended supply chain in project planning and design stages, to inform the relative value of new products over existing options from a whole-of-life perspective.

The following section discusses the second broad problem area and the three recommended solutions to address this problem, which is disagreement between industry participants over who carries the risk of new product failure.

4.2 Disagreement over who carries the risk of new product failure

According to the 2011 survey results, disagreement between industry participants over who carries the risk of new product failure was the second highest ranked obstacle constraining innovative product adoption on road projects. Construction projects are synonymous with high risk associated with failure and heavy requirements for durability, which leads to conservatism towards trial and error (Blayse and Manley 2004, Nam and Tatum 1989). Therefore, new product adoption is obstructed when experimentation is difficult due to the high consequences of failure. Previous research results found this obstacle generally arises from the risk aversion of both the client and the party proposing the new product, and concern about liability should the product fail. This has resulted in a perception that new product applications can result in high

exposure to liability. This perception has had a negative impact on innovation and has promoted conservatism in road construction (Gittings and Bagby 1996).

Previous research results (Rose and Manley 2010) identified conflicting views on which party in the project supply chain is best suited to manage risks associated with new product adoption. For example, clients may often think contractors, consultants and suppliers need to more effectively confirm and warrant the long-term performance of proposed products to meet client expectations. On the other hand, contractors and suppliers may think clients should be more flexible in their expectations and share the risk of approving new products for use.

According to the focus group discussion, road industry stakeholders should be more willing to share the risk of new product adoption for strategic industry benefit that may include improvements in productivity. However, to do so requires improvement in how the benefits of new products are quantified. Thus, if risks and benefits of new products can be more accurately assessed, it may lead to more informed adoption decisions.

'I like the concept about allocating the risk based on benefit, and then another dimension to that is to allocate the risk based on the ability to control risk causing events... resolving the risk issue is about defining and understanding the risk, not necessarily monetary value related to that risk'. (Contractor)

'The main thing we are talking about is that risks should be allocated based on a ratio of reward, and how benefit is being received by a certain party apportioned to the levels of risk that they should take ...to allocate risk, you need to be able to accurately assess risk, by doing detailed risk assessments against benefitsSo we are talking about coming up with an agreed assessment of risk, and then an agreed allocation of risk, based on benefits received'. (Supplier)

To improve project stakeholders' ability to define product risk and value and to develop strategies to allocate risk appropriately, three key initiatives were discussed in the focus groups to resolve existing disagreements over risk allocation. Solutions to this problem area comprised: 1) industry development of formal knowledge exchange networks to encourage product knowledge sharing and improve the quality of information available to decision-makers to make informed risk and value judgements, 2) increased uptake of performance-based specifications providing greater flexibility to adopt new products that previously may have been non-conforming, and 3) increased use of relationship contracting delivery models to encourage greater risk sharing between contracted parties. Each of these key initiatives is now discussed in detail.

4.2.1 Development of formal knowledge exchange networks

To encourage a group of organisations to successfully develop and implement innovation, they must have the capacity to share accumulated knowledge and resources (Oliver and Ebers 1998). Similarly, drawing from literature on the concept of 'open innovation', effective sharing of innovative ideas and knowledge across inter-

organisational boundaries is driven by the openness of a network (Tether and Tajar 2008). This requires significant coordinated effort on the part of networked organisations to bring together their disparate functions and systems and facilitate knowledge sharing. The concept of Communities of Practice focuses on situated learning and acknowledges that knowledge acquisition is a social process where 'communities' are linked through their involvement on certain shared activities, and it is this mutual engagement that binds the social entity together (Wenger 2000).

Simply, the shared activity of identifying and exchanging new product innovation knowledge across a multi-disciplinary construction supply chain builds the community. According to organisational management literature, there are four common drivers of effective Communities of Practice information and knowledge exchange. They comprise: 1) *Awareness*: assisting knowledge 'seekers' and 'sourcers' to become aware of one another; 2) *Access*: providing the time and space for knowledge 'seekers' and 'sourcers' to connect; 3) *Application*: ensuring the knowledge 'seekers' and 'sourcers' have a common content and understanding necessary to share their insights; and 4) *Perception*: creating an atmosphere where knowledge sharing behaviours between 'seekers' and 'sourcers' are respected and valued (Lesser and Fontaine 2004).

Broadly, the need for effective inter-organisational networking and sharing of innovative ideas has been justified by recognition that innovation has become less about the output of an isolated individual organisation (e.g. through internal research and development activities) and more about joint outputs across organisations that lead to adoption (Bahemia and Squire 2010; Manley and McFallan 2006; Drejer and Jørgensen 2005). Within a construction project environment, there is a need for key organisations to 'broker' the transfer of information and knowledge across communities of practice to institutionalise construction project learning capacity, particularly for tasks with high levels of interdependency (Hargadon 1998). Certainly, this is the case in a road project environment, where high levels of interdependency and cooperation are required to facilitate the adoption of innovative products.

According to the focus group discussion, a key initiative in addressing disagreements over innovative product risk allocation is to improve the quality of information available to industry stakeholders in order to better define (and allocate) new product risk and value. This initiative also relates to building confidence throughout the industry on the benefits that can be achieved through innovative road product investment.

We [the client] need the confidence to open ourselves up to the level of risk exposure that is common when accepting innovation ...and the way to do this is by providing us with all the information so we can make an informed decision...' (Client)

In order to improve the quality of information available about promising new product opportunities, focus group participants suggested formal knowledge sharing opportunities should be further encouraged in the road industry.

'What we would like to see in say, 5 years time, if you have a new product, you could access an assigned group represented by the industry and government... and you go there and you get access to everybody you need, the maintenance guys, the structural engineers, the installers, and everyone sits down together, and go OK, this looks like a good idea, what are the risks, what are the problems, what are the benefits and you get everybody's input.' (Client)

'It is amazing how little we share information about [new] products... I think the simple lack of awareness of the possibilities is restricting innovation opportunities ...if only we could capture more of this information.' (Consultant)

According to supplier and consultant participants, future product needs could be defined by clients and contractors and disseminated throughout supplier groups. Thus, clients or contractors would present the product supply market with 'emerging needs' and encourage product suppliers to come up with optimal solutions in response to these needs.

'Well, I think the recommendation the group made before is a good one [an open forum]. We'll only innovate what we think needs innovating. We're not capturing all the opportunities, so there's scope probably to work in that space, to work with the likes of the client, what do you need? What you do you want in the future? We're just doing what we think is needed, but if we could see where the emerging markets may lie for specific products then we could invest more in that area.' (Supplier)

'...if we [designers] were brought in upfront with areas where improvements were needed, and we then individually or collectively approach a group of suppliers, maybe it's a specific supplier instead, and say 'we always have a problem with barriers. This is the problem we're having. We move them twice and they fall apart. We need them to last for longer - is there a new barrier [product] that we could bring in... They can then go away and work on it.' (Consultant)

Consultant participants also highlighted there may be opportunities for new product information to be integrated into their design modelling systems, to assist project teams in planning construction and decreasing product implementation risks.

'In terms of new products, and looking at it from our space; there are opportunities for better integration of product information into the design process. ...at the moment there is a whole lot of different tools we use, and in a lot of ways it is still a relatively manual process to integrate those with new products, so some sort of more integrated tool that can be passed on to the construction teams for a better planned and organised construction process.' (Consultant)

A formal knowledge exchange could provide practitioners and decision-makers across the road construction supply chain with *awareness* of available information, *access* to one another, a common *application* to share compatible knowledge, and the *perception*

that the sharing of such knowledge would be of value to them and to the industry as a whole. This could take the form of a dedicated 'best-practice' exchange network managed by a central organisation to provide interactive opportunities to share information and ideas, showcase emerging products and provide links to other knowledge resources, collaboration, research and support. The objective of such a system, in response to the needs identified in the focus groups, would be to encourage the development of a Community of Practice. The community would broker robust information on innovative products to promote improved decision-making. This formal system could comprise:

- Forums showcasing successful products from Australia and abroad, focusing on value offered in comparison to existing products ('innovative road products best practice program'). These forums would encourage open discussion of potential risks and opportunities relating to innovative products, capturing the expertise from a wide range of industry perspectives.
- The establishment of regular innovative product knowledge exchange workshops, involving key supply chain organisations sharing their knowledge in an open risk-free environment.
- The development of an innovative road product knowledge exchange web-based portal, providing an interactive environment to share experiences and knowledge about new products, present best practice case studies for learning, industry and research blogs, social media tools and research network portals.

Finally the focus group participants suggested the road industry should be benchmarking the performance of new products against an extensive international knowledge base – to better define product risk and value. According to focus group discussions, Australia is a relatively small market for road products and thus, new products in this market may have a proven history in larger markets overseas. Focus group participants acknowledged the importance of understanding local conditions when assessing the suitability of a new product, but agreed that the road industry should be seeking international product performance data to minimise local duplication, if clear value to the local market can be identified.

'We need to draw a lot more on overseas experience ...the fact that overseas they use this [product] and it's been used for the last 5 years with great success and you then try and get it over here –it's impossible. To me that's just crazy ... We need some sort of system where you can say, well yes it ticks that box and we can all sit down and benchmark the criteria from there to here. No doubt you've got to create some performance criteria around it – there is performance in use and performance in maintenance and so on ...but if there is data available we should be taking advantage of that.' (Contractor)

To improve the quality of information available to industry stakeholders and to better define and allocate new product risk and value, the road industry should invest more in formal knowledge sharing, such as a dedicated 'best-practice' knowledge exchange

network. Also, to improve the definition of new product risk and value, increased benchmarking of product performance against an extensive international knowledge base should also be supported.

4.2.2 Increase uptake of performance-based specifications

Project specifications provide the means of defining client construction requirements to a contractor, by assigning separate and joint responsibilities for compliance. A specification forms the basis of the construction contract and should have clear, measurable and achievable requirements (Lobo et al. 2005). Generally, specifications play an important role by defining the quality of the delivered product and preventing disputes (Barlow 1999). However, it is argued that 'over-regulation' in construction can negatively impact on innovation (Hartmann 2006; Dubois and Gadde 2002). For example, heavily detailed prescriptive specifications are argued to limit the opportunity for project organisations to propose alternative innovative solutions, due to a lack of flexibility to experiment and deviate from prescribed methods (Aktan et al. 2007). Such experimentation can lead to more effective or efficient delivery approaches (Gann et al. 1998).

On the other hand, detailed prescriptive specifications can prevent ambiguity and provide an economical solution for repetitive outputs that share 'common, time-tested geometry, shape, form and materials' (Aktan et al. 2007). Prescriptive specifications are also acknowledged to be easier to implement from a design and performance measurement standpoint. Despite the intention of detailed specifications to control output, there are acknowledged challenges in achieving intended performance requirements under prescriptive specification provisions. For example, prescriptive parameters on the composition of concrete mixtures, such as maximum water-cementitious materials (w/cm) ratio or cement contents, can potentially contradict intended or implied performance requirements due to variations in the materials employed from region to region (Lobo et al. 2005).

Rapid changes in materials, products and construction techniques have led to a loss of rationale in prescriptive provisions (Aktan et al. 2007). This has resulted in recent moves to introduce alternative ways to specify project expectations, while affording contractors the flexibility to apply their technical knowledge to deliver the highest quality end product. Performance-based specifications are argued to place greater emphasis on the technical and innovation experience of contractors and their suppliers, rather than focussing on their ability to provide labour, materials and plant to construct to a rigid, highly-specified design (Ohrn and Schexnayder 1998).

A key advantage of performance-based specifications is the clear distinction of roles - affording the contractor 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). 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 et al. 2006 p. 5).

According to focus group participants, increased uptake of performance-based specifications across government road projects may encourage the road industry to take greater responsibility for functional performance outcomes and provide the flexibility required to develop and implement new products that previously may have been non-conforming under a prescriptive regime.

'...when you have got a prescriptive spec, new products are very hard to get up because you have basically got to redo the spec... If it is a performance-based spec, new products can be integrated more seamlessly.' (Client)

'The big one is performance specs; you can only cover innovation if you have got the scope for it, simple as that. [Clients] still have this notion that if it's non-conforming you are not delivering the best product. ...performance specs needs to be looked at if we want to encourage [product] innovation.' (Contractor)

'We live and die by our reputation and in a competitive market system that controls quality. If we can deliver a project more competitively with the flexibility offered by performance-based specs then I think you will see the more innovative companies rise to the top.' (Contractor)

One contractor participant felt prescriptive specifications indirectly acted as a protectionist mechanism to industry, stifling a competitive and innovative product supply market.

'Obviously in that retail type area where your whole success depends on products, you don't exist unless you are bringing new products to market... but we are protected by prescriptive specs, so as long as you can meet the client's specs, and as long as you can do it cheaply, you will stay in business ...the specifications are almost making it a protective industry.' (Contractor)

It was also raised by contractor participants that concerns over IP and confidentiality in the product approval process could be alleviated if performance-based specifications were implemented more broadly. Thus, if there wasn't the requirement to provide the 'recipe' for an innovative product to be included in prescriptive specifications, it could potentially improve developers' ability to control their IP and ownership rights through a certification process.

'In the past we've come up with a new product and we go out and promote it, and invariably what comes with that is, give us the recipe because we need that for our own records, so we will hand that over, and next thing, bang, everyone's got it and its in the specification. We got

to start to moving towards performance-based... where we say, well, don't worry about what's in it, it does what it does, and we're not going to share the recipe.” (Contractor).

Performance-based specifications should clearly specify functional criteria and compliance test methods to be used to assess performance (Lobo et al. 2005). Despite the agreed benefits of performance-based specifications, consultant participants (who would be generally responsible for setting performance criteria) cautioned that performance-based specifications require client representative skill and adequate lead time to clearly specify functional criteria, and to conduct accurate assessment to verify and enforce compliance. Accurately specifying and testing functional requirements may encourage contractors to explore product innovations in areas outside scope minimisation and cost reduction, thus minimising opportunistic behaviour.

‘Performance specs are good, they are what we want, but they take more time to analyse. You have got to do your own calculations; you have to see if the recommendations fit into this performance criteria, you have got to double check it. You can't rely on the contractor saying, based on our calculations we can meet this performance spec. You have got to check otherwise you are buying into something that is risky and that is not on with tax payers' money.’ (Consultant)

Finally, both client and contractor participants raised the idea that if product suppliers were offering longer expressed warranty periods for new products, it could increase client confidence to ‘field-test’ longer-term product performance and offset client and contractor liability risk. Such warranties could provide the client greater certainty in performance, particularly when specifications are open to interpretation under a performance-based environment.

‘I agree there are two ways where you have some sort of process to deal with the risk issue. One is you get [the product] prequalified and then it is all OK at tender time - or the alternative is, to provide us a big warranty, say, you are going to warrant it for 5 years proving they have confidence in the product...’ (Client)

‘If a supplier is putting an innovative product forward, only they really know how long it is going to last, and whether or not the application you are looking at is fit for purpose... because if it is [a] new [product], generally the client is not going to know - so you have really got to lock down the supplier, and for them to warrant the product for say 3 or 5 years. You might pay a premium for that, but it is still a case of the supplier warranting the product... I think good suppliers would agree to warrant their product if [the client] was willing to use them.’ (Contractor)

Finally, client participants raised the argument that extended warranties would also be required to support a product certification system, to further encourage clients to approve new products for use.

‘The HAPAS system in Europe, for example, when you read the contracts that those products are used on - they have a 5 year warranty - notwithstanding trials with highly extensive testing - it includes a very onerous warranty associated with it - so I don't think it is enough

just to say there needs to be a [certified] list [of new products], it also needs extended warranties... If there is a warranty associated with the certified list I think that the two could work in conjunction with each other.' (Client)

Prescriptive specifications can constrain opportunities for contract parties to adopt innovative products. A performance-based approach, involving the specification of functional performance requirements, is seen to provide contract parties the flexibility to experiment with new product options that may be non-conforming under existing prescriptive specifications.

4.2.3 Increased relational contracting

The diffusion of construction innovation requires close collaboration across a complex cluster of project organisations (Dubois and Gadde 2002). Innovation diffusion in construction is argued to be mediated by the effectiveness of relationships across the 'innovation superstructure', such as clients and regulators; 'innovation infrastructure', such as trade contractors, specialist consultants and component suppliers; and 'system integrators', such as principal contractors (Winch 1998). According to Miozzo and Dewick (2002), the strength of such relationships and capacity to advance project innovation 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 organisational divisions, while maximising firm-specific competencies; and 3) established relationships and collaboration between organisations and external knowledge sources. Thus, the effectiveness of innovation diffusion is argued to be governed partly by the nature of the project procurement approach and more specifically, by how the procurement approach may encourage or discourage the formation of a coherent and coordinated 'project organisation'.

As a part of a procurement approach, conditions of contract allocate the responsibilities and liabilities of each contracting party, and define contractual risk and reward. Although the clear definition of responsibilities in the conditions of contract encourage efficient management of risks during construction, the attitudes and motivations of contracted parties towards risk, facilitated through strong relationships and co-operative teamwork, are important for innovation and high project performance (Rahman and Kumaraswamy 2002). Such conditions also influence how effective product innovation risks are allocated and managed across contracted parties under specific contractual conditions.

Focus group participants (particularly contractor participants) advocated the positive impact of relationship contracting delivery models, such as Alliancing, on addressing disagreements over new product risk allocation. According to participants, greater risk sharing and recognition of mutual benefits, promoted under relational contracting, can increase innovative product uptake. Improved uptake is driven by increased expectation for innovation in this type of project, and thus, clients are encouraged to

endorse innovative product options and are more willing to jointly manage the associated risk.

[Traditional procurement] just drives everybody down to reduce cost – forces us to do it cheaper and cheaper... and that clearly drives out new [product] innovation that may cost more, but has long term benefits... In Alliancing it is different, because all of a sudden, everyone says, well ‘price is at the end’, we’ve got the budget, we’ll keep it in that budget, but we want to drive quality and we want to drive innovation.’ (Contractor)

‘That’s where all the product innovation happens; it happen after the tender is awarded. In a D&C you have to go back in and negotiate [the innovation], and you get there, and whoever the client is, they say “well, what’s in it for me, give me some money for the benefit”. That was why Alliances work well, because there is no “give me some money” from the client. ...you all work on the innovation together.’ (Contractor)

Increased use of relationship contracting delivery models, such as Alliancing and ECI, can encourage greater risk sharing between parties, thus addressing disagreement over new product risk allocation.

4.2.4 Summary

Focus group results show industry disagreement over new product risk allocation is influenced by the: quality of information available to industry stakeholders in order to define and allocate risk and value; flexibility of the regulatory environment to allow experimentation; and, nature of the delivery model to facilitate innovation. To address this broad problem, focus group participants recommended: (1) industry investment in a dedicated, multi-disciplinary knowledge exchange network to encourage improved sharing of product innovation information; (2) increased use of performance-based specifications to provide flexibility to trial and adopt new products, which have previously been non-conforming; and (3) increased use of relationship contracting delivery models, such as Alliancing, to encourage greater risk sharing and joint risk management.

5. Conclusion and Recommendations

The Australian road construction industry needs to develop new processes for accelerating the acceptance and implementation of innovative products, compatible across jurisdictions, with a particular focus on encouraging the uptake of non-conforming products in relation to current road agency regulations. An important outcome from the focus group workshops was the identification of seven key solutions, suggested to address key obstacles and improve new product uptake on road projects.

Focus group findings suggest that the Australian road industry (including government road agencies) should be: investing more in the effective transfer of innovative product knowledge to inform decision-making; streamlining road agency regulatory processes

to provide greater flexibility; assessing new products on their long term value for money; developing new processes for assessing and certifying product performance; and increasing the use of complementary project governance arrangements that both offer a joint approach to risk management, and reward organisations willing to invest in product innovation.

The following is a list of industry recommendations derived from the focus groups to address the two key problem areas constraining innovative product adoption in the Australian road industry. The recommendations are mainly for client-led change:

- Develop an innovative product certification process outside the tender stage to alleviate project resource constraints.
 - Develop an independent certification body representing government and industry interests, to assess performance and comparative value of innovative products relating to agreed performance criteria, outside current client specifications.
 - Benchmark against successful international product certification schemes such as HAPAS (UK), Charte d’Innovation (France), and Agrément South Africa (South Africa).
 - Develop the proposed MIMS system (Ausroads) and integrate successful state road agency certification processes such as TIPES (Queensland Department of Transport and Main Roads).
- Increase incentives and improve methods for government clients to accurately assess the strategic value of innovative products during early project stages, including the tender stage.
 - Clients to take a stronger leading role in promoting an ‘innovation culture’ across the road industry through their behaviour and project expectations.
 - Clients to improve their knowledge base for assessing innovative product options according to ‘value for money’.
- Greater client emphasis on the strategic value of incentivising contractors to champion new products, thus, establishing the expectation that product innovation is a key objective for a project.
 - Assessment of contractors’ past innovation performance as a non-price tender selection criterion.
- Increase the quality of information available to the project team on the relative value of new products to be integrated into a road design.

- Achieve earlier involvement of front-end suppliers and back-end road asset operators in project planning and design stages.
- Develop a dedicated, multi-disciplinary knowledge exchange network to encourage the sharing of product innovation information across local supply chains and international markets.
 - Establish regular innovative product workshops/forums
 - Develop a knowledge exchange web-based portal, providing an interactive environment to showcase information on emerging products and product development opportunities leading to sponsorship or trials.
 - Provide links to other knowledge resources, research and support.
- Increase the uptake of performance-based specifications to provide greater flexibility to implement new products that previously have been non-conforming.
 - Establish an adequate lead time and specialist expertise to clearly specify functional performance.
 - Suppliers to offer longer expressed warranty periods for new products to increase client confidence.
- Encourage joint risk management between contract parties, driven by recognition of mutual innovative product uptake benefits.
 - Increase use of relationship contracting delivery models to encourage greater risk sharing and increased expectations for innovation in this type of project.

The focus group results provide a strong base for future research to develop and pilot these recommended initiatives. In the short term, the industry needs to develop a formal innovative product knowledge exchange network and assess the feasibility of an innovative road product certification system that is benchmarked against successful international certification processes. These initiatives will increase innovative product adoption in Australian road projects.

6. Appendices

6.1 Appendix A: Focus Group Discussion Guide

The purpose of the focus group is to discuss potential solutions to address inadequate uptake of innovative products in Australian road projects. The focus group will run for 3 hours, followed by drinks and canapés.

Before the group begins, the facilitator will remind all participants that they have provided us with signed Consent Forms and we have provided them with a copy of the Information Sheet for their reference – extra sheets are available from the facilitator. The electronic Consent Form process will have been completed prior to the session. The following comprises instructions and text for the facilitator.

Introduction (15 m)

- Welcome participants and introduce yourself.
- Show the location of amenities and ask participants to help themselves to the complimentary beverages – and mention food will be available at the end of the session.
- Note the purpose and process of focus groups.
- Explain the presence and purpose of recording equipment and introduce observers.
- Address the issue of confidentiality. Reinforce that information discussed is going to be analysed as a whole and that participants' names and affiliations will remain confidential and transcriptions will not be shared outside the researcher group.
- Outline general ground rules and discussion guidelines such as the importance of everyone being provided an opportunity to speak, talking one at a time, and being prepared for the facilitator to interrupt to assure that all the topics can be covered.
- Use the Introduction Guideline below to present objectives of the session and why participants were chosen.
- Ask participants to introduce themselves.

The Innovative Products Research Project aims to improve outcomes on road projects by increasing the adoption of innovative products. The research project is being run over three years and has national funding. The project is led by Queensland University of Technology.

Innovative products are defined as 'the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials'. Innovative products in road construction often comprise new materials, such as new types of asphalt, concrete, or fibre composites. Other examples include advances in road marking, lighting, or steel structures.

*Last year the researchers undertook a major survey of the Australian road industry with an aim to identify key problems faced by the industry in promoting the uptake of innovative products. This survey of over 200 industry participants identified **two** key problem areas that are seen to constrain product innovation in the road industry. I will discuss these two problems with you in a moment.*

The objective of today's session is to brainstorm possible solutions to these problems from an industry viewpoint, and to discuss the role your organisation might play in addressing them. This focus group contains four types of industry participants comprising clients, contractors, consultants and suppliers. The diversity of perspectives represented should help build shared solutions.

Perhaps if we could move around the tables introducing ourselves, noting our organisations.

I would like the discussion to be as informal as possible, so there's no need to wait for me to call on you to respond. If you don't understand a question, please let me know. I will ask questions, listen to your responses carefully, and make sure everyone has a chance to share.

If we seem to be stuck on a topic, I may interrupt you; on the other hand, if I see someone that is not saying much, I may call on you directly, so beware! This is my way of making sure your opinion is included.

We will all keep each other's identities, participation and remarks private. I hope you'll feel free to speak openly and honestly.

We will be audio recording the discussion because we don't want to miss any of your comments. Only the researchers will have access to these recordings, which will be securely stored until they are transcribed and then destroyed.

Background (15 minutes)

Today we will be focusing on two main problem areas which were highlighted in the national innovation survey of the road industry last year. We acknowledge these two problem areas are not the only ones currently facing the industry, but our survey found they were the most important, so given resource constraints; we will focus on these two.

- Facilitator to explain each of the key problem areas impeding new product adoption identified from the industry survey.

Our challenge today is to assess how we can work together to craft clever solutions.

Brainstorming Solutions (120 minutes)

- Facilitator will now prompt participants to discuss the two problems and provide the opportunity for all participants to contribute. We have 60 minutes per problem. Problems to be listed on the whiteboard for easy reference. The actual process may vary according to each group's progress and the experience of previous groups. This process is not intended to be pre-scripted - but interactive in its nature. The goal is for the participants' experience to lead the way and if there is confusion during the discussion please request clarifying comments from the participant. If the discussion gets bogged down or off topic - please quickly move the conversation on. The idea is not to point the finger at other stakeholders in the supply chain, but for us to seek 'best for industry' solutions!
- The first 5 minutes of the session may involve splitting the group into three groups of four industry participants covering the four sectors, each generating potential solutions – to be fed back to the facilitator and placed on butcher's paper for discussion.

The Focus Group Question is: *How can the Australian road construction industry go about addressing key innovative product adoption problems and improve new product uptake?*

Closing (30 minutes)

- Highlight the most important findings of the focus group.
- Ask each participant what they will do when they get back to work to help solve the problems raised.
- Closing remarks.
- Thank participants for attending.

- Emphasise that the project seeks change in how the industry promotes product innovation and their ideas count towards this change.
- Mention that results will be made available them.
- Finally, ask them to join us for a drink and canapés, where the issues might be further discussed.

Drinks and Canapés

- Participants invited to stay for drinks and further discussion.

6.2 Appendix B: Focus Group Introductory Brief

Focus Group Objectives

The objective of the focus group discussion is to: brainstorm possible shared solutions to address key problems seen to be impacting the adoption of innovative products on Australian road projects from a whole of industry viewpoint;

Thus, the key focus group question is: *How can the Australian road construction industry go about addressing key innovative product adoption problems and improve new product uptake?*

As focus groups are ‘focussed’ through the collective activity of participation, and are inherently informal, participants are encouraged to openly converse, exchange experiences and comment on each others’ perspective about the topic.

To allow you to start thinking about the topics to be discussed during the workshop, below are some example questions to consider:

1. *What might we do about the shortage of client resources to assess the full implications of new product implementation in the time required to approve non-conforming tenders?*
2. *What types of non-price selection criteria encourage the generation of innovative ideas?*
3. *How do we resolve disagreements over how risk of new product failure is allocated?*
4. *Can contractors, consultants and suppliers increase adoption rates through greater investment in verification of benefits before presenting innovations to clients?*
5. *How can we measure product innovation benefits and encourage this information to be shared?*

Focus Group Outcome

The key outcome from the workshop will be an agreed list of recommendations on how the adoption of innovative products on road projects can be improved to benefit the road industry.

A summary of results from the focus group workshops will be made available to you as a key contributor towards improving product innovation in road construction. Further information on the project can be found at: <http://www.qut.edu.au/research/research-projects/innovative-road-products>

Please note all comments and responses from the workshops will be treated confidentially and will be anonymous in published reports. You are not required to reveal commercially sensitive information. The workshops will be audio recorded, with that recording being securely stored, used only by the research team for transcription and analysis purposes, and then destroyed. Please complete the information sheet and consent form prior to the workshop.

6.3 Appendix C: Focus Group Consent Forms

	INFORMATION SHEET FOR QUT RESEARCH PROJECT
Innovation Adoption on Road Projects	
QUT Ethics Approval Number 0900000816	

DESCRIPTION

We are conducting research into product innovation on road projects. The project is funded by the Australian Research Council, Queensland Department of Transport and Main Roads and the Construction Industry Institute Australia. The funding bodies will not have access to focus group transcripts. Your responses will be anonymous in any published reports. The purpose of this project is to improve the performance of infrastructure projects.

PARTICIPATION

Your participation in this project is voluntary. If you agree to participate, you can withdraw at any time during data collection without comment or penalty. Your decision to participate will not impact on your current or future relationship with QUT or any of the funding bodies. Your participation will comprise focus group involvement for a duration of 2 ½ hours.

RISKS AND EXPECTED BENEFITS

There are no risks associated with your participation in this research project. It is expected that this project will benefit you indirectly by improving the performance of infrastructure projects.

PRIVACY AND CONFIDENTIALITY

All comments and responses will be treated confidentially and will be anonymous in published reports. You are not required to reveal commercially sensitive information. The focus group recordings and transcripts will be held on QUT's computers for verification by the researchers, and not be used for any other purpose.

CONSENT TO PARTICIPATE

We need you to complete the attached Consent Form if you agree to participate in a Focus Group and if you agree with the statement of consent.

QUESTIONS

Please contact Dr. Tim Rose, Project Manager if you require further information about the project.

PROBLEMS

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.



Innovation Adoption on Road Projects

QUT Ethics Approval Number 0900000816

STATEMENT OF CONSENT

By signing below, you are indicating that you:

- Agree to participate in the project.
- Understand that the session will be recorded using an audio device.
- Have read and understood the Information Sheet.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw at any time during data collection, without comment or penalty.
- Understand that you can contact the Research Ethics Unit on 07 3138 5123 or email ethicscontact@qut.edu.au if you have concerns about the ethical conduct of the project.

Name

Signature

Date

7. Bibliography

- Aktan, A. E., Ellingwood, B. R., and Kehoe, B. (2007). "Performance-based Engineering of constructed systems." *ASCE Journal of Structural Engineering*, 133(3), 311-480.
- Austrade. (2011). "Australia: A wealth of opportunities: Benchmark Report 2011 (September)." Australian Trade Commission, Canberra.
- Bahemia, H., and Squire, B. (2010). "A contingent perspective of open innovation in new product development projects." *International Journal of Innovation Management*, 14(4), 603-627.
- Barbour, R. S., and Kitzinger, J., eds. (1999). *Developing Focus Group Research: Politics, Theory and Practice*, Sage Publications Inc., Thousand Oaks, California.
- Barlow, J. (1999). "From craft production to mass customisation: innovation requirements for the UK housebuilding industry." *Housing Studies*, 14(1), 23-42.
- Bickley, J., Hooton, R. D., and Hover, K. C. (2006). "Preparation of a performance-based specification for Cast-in-Place concrete." RMC Research Foundation, National Ready Mixed Concrete Association (NRMCA), Silver Spring, MD.
- Blayse, A. M., and Manley, K. (2004). "Key influences on construction innovation." *Construction Innovation*, 4(3), 143-154.
- Bozdogan, K., Deyst, J., Hoult, D., and Lucas, M. (1998). "Architectural innovation in product development through early supplier integration." *R&D Management*, 28(3), 163-173.
- Drejer, I., and Jørgensen, B. H. (2005). "The dynamic creation of knowledge: analysing public-private collaborations." *Technovation*, 25, 83-94.
- Dubois, A., and Gadde, L. (2002). "The construction industry as a loosely coupled system: implications for productivity and innovation." *Construction Management and Economics*, 20, 621-631.
- Dulaimi, M. F., Ling, F. Y. Y., and Bajracharya, A. (2003). "Organizational motivation and inter-organizational interaction in construction innovation in Singapore." *Construction Management and Economics*, 21(3), 307-319.
- EAPA. (2003). "Innovation implementation in road contracts." European Asphalt Pavement Association, Breukelen, The Netherlands.
- Eriksson, P. E., Dickinson, M., and Khalfan, M. M. A. (2007). "The influence of partnering and procurement on subcontractor involvement and innovation." *Facilities*, 25(5), 203-214.
- Fern, E. F. (2001). *Advanced Focus Group Research*, Sage Publications, Inc., Thousand Oaks, California.

- Flick, U. (2009). *An Introduction to Qualitative Research*, 4th ed. Ed., Sage Publications, Ltd., London UK.
- Gambatese, J. A., and Hallowell, M. (2011). "Enabling and measuring innovation in the construction industry." *Construction Management and Economics*, 29(6), 553-567.
- Gann, D. M., Wang, Y., and Hawkins, R. (1998). "Do regulations encourage innovation? - the case of energy efficiency in housing." *Building Research & Information*, 26(5), 280-296.
- Gittings, G. L., and Bagby, J. W. (1996). "Managing product liability to achieve highway innovations." National Cooperative Highway Research Program, Washington D.C.
- Hargadon, A. (1998). "Firms as knowledge brokers: Lessons in pursuing continuous innovation." *California Management Review*, 40, 209-227.
- Hartmann, A. (2006). "The context of innovation management in construction firms." *Construction Management & Economics*, 24(6), 567-578.
- HMTreasury. (2008). "Infrastructure Procurement: Delivering Long-Term Value." Office of Public Sector Information, London.
- Khalfan, M. M. A., and McDermott, P. (2006). "Innovating for supply chain integration within construction." *Construction Innovation*, 6(3), 143-157.
- Krippendorff, K. (2004). *Content Analysis: An Introduction to its Methodology*, Sage, London.
- Lesser, E. L., and Fontaine, M. A. (2004). "Overcoming knowledge barriers with communities of practice: Lessons learned through practical experience." *Knowledge networks: Innovation through communities of practice* P. Hildreth and C. Kimble, eds., Idea Group Publishing, York, UK, 14-23.
- Lobo, C., Lemay, L., and Obla, K. (2005). "Performance-Based Specifications for Concrete " *The Indian Concrete Journal*, 79(12), 13-17.
- Manley, K., and McFallan, S. (2006). "Exploring the drivers of firm-level innovation in the construction industry " *Construction Management & Economics*, 24(9), 911-920.
- Miozzo, M., and Dewick, P. (2002). "Building competitive advantage: innovation and corporate governance in European construction." *Research Policy*, 31(6), 989-1008.
- Nam, C. H., and Tatum, C. B. (1989). "Toward understanding of product innovation process in construction." *Journal of Construction Engineering & Management*, 115(4), 517-534.
- OECD/Eurostat. (2005). "Guidelines for Collecting and Interpreting Innovation Data - Oslo Manual ", Organisation for Economic Cooperation and Development Paris.

- Ohrn, G., and Schexnayder, C. (1998). "Performance-related specifications for highway construction." *Journal of Construction Engineering and Management*, 124(1), 25-30.
- Oliver, A. L., and Ebers, M. (1998). "Networking network studies: An analysis of conceptual configurations in the study of inter-organizational relationships." *Organization Studies*, 19(4), 549-583.
- Rahman, M. M., and Kumaraswamy, M. (2002). "Joint risk management through transactionally efficient relational contracting " *Construction Management & Economics*, 20(1), 45-54.
- Rose, T. M., and Manley, K. (2010). "Innovative products research project: Background study 2010." Queensland University of Technology, Brisbane.
- Rose, T. M., and Manley, K. (2012). "Adoption of innovative products on Australian road infrastructure projects." *Construction Management & Economics*, 30(4), 277-298.
- Sidwell, A. C., Budiawan, D., and Ma, T. (2001). "The significance of the tendering contract on the opportunities for clients to encourage contractor-led innovation." *Construction Innovation*, 1(2), 107-116.
- Slaughter, E. S. (1998). "Models of construction innovation." *Journal of Construction Engineering and Management*, 124(3), 226-231.
- Stewart, D. W., and Shamdasani, P. N. (1990). "Focus Groups Theory and Practice." *Applied Social Research Methods Series*, L. a. R. Bickman, D. J., ed., Sage Publications Inc., Newbury Park, California.
- Tether, B. S., and Tajar, A. (2008). "Beyond industry university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base." *Research Policy*, 37(6-7), 1079-1095.
- Wenger, E. (2000). "Communities of Practice and Social Learning Systems." *Organisation*, 7(2), 225-246.
- Winch, G. (1998). "Zephyrs of creative destruction: understanding the management of innovation in construction." *Building Research and Information*, 26(5), 268-279.