

A Holistic View of Barriers to Innovation in Australian Construction

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Abstract—Innovation in the construction industry has been acknowledged as a challenge. Much of the research has been focused in a particular area of concern such as in the Small and Medium Enterprise (SME) sector or the relationship between the manufacturing supply company and the contractor. This paper describes a holistic approach with the pilot research examining if organisations from across the design and construction business in Australia believe innovation is important for the industry and further explores the forces that hinder innovation. The research findings appear to be consistent with much of the previous research however also reveal the prevailing sources of barriers to innovation adoption. Common themes made salient include the view by participants that rather than offering benefits, innovations were considered sources for potential failure. Construction professionals also see innovation as an expense due to the cost of having an innovation certified for use in Australia and high wages for skilled workers. Such contradictions perpetuate a risk-adverse, conservative approach to construction.

Index Terms—Australian construction and innovation, barriers, holistic analysis.

I. INTRODUCTION

An innovation is defined by Rogers [1] as an “idea, practice or object that is perceived as new by an individual or other unit of adoption.” Additionally, the innovation provides some benefit to that user or unit of adoption. Innovation adoption in the Australian construction industry is well studied with a consistent theme indicating that there is a distinct lack of innovation [2]-[5]. This is despite the identified advantages on offer such as cost savings, competitive advantage, improved quality, increased productivity [6], improved coordination and collaboration between firms participating in the construction project [3] and continued growth and profitability [7].

The lack of innovation has also been found to be a function of a variety of non-technical factors. A key factor identified [2] is associated with “conservative partnering organisations” such as design consultants (engineers and architects) who are described as “gatekeepers” impeding innovation implementation. The construction industry requires specialisation and collaboration between several different participants across the different stages of a project life cycle and innovation implementation often requires cooperation between the many stakeholders.

Another factor found to obstruct innovation is a lack of an adequate technical skill-base to use an innovation [2]. In relation to the limitation of an adequate skill base, other

researchers found that a deterrent to innovation in the construction industry is the financial cost burden associated with the training of workers to develop the skill level required to use an innovation [6].

In the case of the Australian construction industry a key figure commonly acknowledged by researchers that impacts the implementation of an innovation is that of the Client [4]-[8]. The Client is often a developer that has little interest in the finished product other than to meet the minimum requirements (and therefore the lowest production cost) to complete the sale of the unit of production. Loosemore [4] noted “many clients are unwilling and unable to effectively encourage innovation because many see buildings as short-term asset and do not understand the relationship between their buildings and their core business performance... The vast majority of the industry are left to work with clients who procure buildings very rarely, who want the lowest possible price for their investment and who do not see them as a key long-term asset in the success of their core business.”

Yet another influence on innovation adoption in the construction is the project nature of the industry [4], [5]. Teams are formed of specialists (both in the design and the construction fields) to deliver a defined construction project. Blayse and Manley [5] stated, “One of the features of production said to be most difficult is the temporary or one-off nature of construction projects. This is associated with discontinuities in knowledge development and in transfer of knowledge within and between organisations, and restraints on the development of an ‘organisational memory’”.

Researchers in the general field of technology development have also found that despite the benefits offered by an innovation, other factors play a significant role in its adoption. For example, the Technical Adoption Model (TAM) [9], [10] identifies the perceived usefulness of an innovation as well as the perceived ease of use for the user as key elements to adoption.

Diffusion of Innovation [1] posits that the rate of adoption of an innovation, and even success or failure, is dependent on how an innovation is communicated within a community. Socio-technical researchers [11]-[13] consider the technical development of innovations in relation to the end users and the need to account for existing work practices. Researchers in the innovation development and adoption fields commonly highlight the difficulties of introducing change and the need to overcome or at least consider the social impact of innovation and the cultural norms associated with existing work practices.

Innovation development researchers [11]-[13] emphasise the importance of accounting for the work practice of the

worker to improve usability and adoption. The study of work practice develops an understanding of existing Rules and existing Tools that mediate the work activity. It suggests that the introduction of a new way of doing things (using an innovation) creates difficulties in adoption as there is a strong affiliation with the existing Rules and Tools. Encouraging innovation in a community of practice, particularly if it contradicts existing implicit rules (cultural norms), will take time as it requires a change to well-developed work practices associated with ecologically higher level Activity.

The introduction or the development of an innovation needs to account for a holistic view of the existing work environment. Many influences which impact the adoption of an innovation are not immediately identifiable as they do not appear on the surface. Work practices as highlighted by Activity Theory (14,15) are ingrained in work practices. Other groups may impact the success of an innovations adoption which are not directly involved in the work itself and therefore hidden when considering the work being undertaken. For example, Government policy may impact how an innovation is received in the construction industry even when government is not in direct participant in building.

II. RESEARCH METHODOLOGY

Research in the area of the construction industry indicates that the adoption of an innovation is subject to mediating forces that are beyond the scope suggested by well-recognised theories such as DOI and TAM. The research in this paper takes a qualitative research approach to develop a pilot case study that looks to identify the potential influences that affect the ability to adopt an innovation in the Australian construction industry context. A broad holistic view of innovation in the construction industry is adopted to examine both direct and indirect factors impacting innovation adoption.

The qualitative case study approach is an established research methodology [16]. Considered to account for the exploratory nature and ‘real life context’ of the research [17] to gain an insight into the forces that mediate innovation adoption in the Australian construction industry.

The case study was developed using semi-structured interviews that provide an image of the individual’s view of innovation adoption. The collection of data using semi-structured interviews allowed for interviewees to respond freely and facilitated the direction and exploration of new ideas. The interviews were completed as a component of a research project considering innovation in the Australian Construction Industry.

Six (6) construction professionals formed the sample group that constituted the development of the pilot case study (see Table I below). The professionals interviewed were considered to be in a position to introduce an innovation into their construction related organisation. The organisations and positions that the professionals worked in varied to cover several sectors of the industry including those involved in the design / build (mid and large size contractors as well as subcontractor) and post construction sectors. A holistic approach was taken to the data sample by interviewing representatives from design consultants, client’s representative, construction companies and subcontractor.

TABLE I: CONSTRUCTION PROFESSIONAL SAMPLE GROUP

Interviewee	Construction Role
DB	Director of a mid-size building company
CPM	Client-side project manager (working for a developer)
ARCH	Director of an architecture practice
SPM1	Senior project manager for a large building company
SPM2	Senior project manager for a sub-contractor
DEng	Director of a remedial and structural engineering builder

Interviews with the construction professionals were digitally recorded and transcribed with all data collected subject to de-identified to ensure the anonymity of case study subjects and the organizations where they were employed. Coding of the transcriptions was used to develop a thematic analysis of the interviews in which patterns of experience were identified [18].

III. FINDINGS AND DISCUSSION

The participants interviewed for this research all agreed that in general innovation was important in construction. For example, SPM1 noted that “Innovation is important in the industry and company, because you always have to work out better ways to do things...” and CPM “I believe that there is a push for innovation, we certainly look to engage consultants and our wider team for ways to improve construction and developments”.

Although participants believed the construction industry would benefit from the introduction of innovations, it became apparent that what innovation looked like and what benefit was derived from use were conceptualised quite differently. The construction industry is reliant on an adhocracy organisation model. Morgan [19] described the adhocracy organisation involving “project teams that come together to perform a task and disappear when the task is over, with members regrouping in other teams devoted to other projects.” (p. 52). Both the complexity and large capital investment required means that specialised professionals ranging from the consultants involved in the design of a building to the different sub-contractors engaged to physically deliver the build are required. The variations in the roles of participants resulted in differing visions of what innovation was and what the outcome of using an innovation would bring. Innovation was seen to bring improvements to areas such as sustainability, productivity and a reduction in construction times. For example, SPM1 suggested that workers in the construction industry would be interested in innovation if there were savings in the area of time and cost noting “obviously, time and cost are a big thing in our industry. So, if there’s something that could save time and cost it’s always a good outcome.” DB on the other hand was interested in innovations that resulted in interacting with fewer contractor workers. CPM being the Client’s representative believed that innovation is a required attribute of consultants and contractors to “improve speed or the quality of materials and finishes, whatever way shape or form that is...”. Holistically the participants did agree that an innovation is a new or different way of doing things with some resulting benefit.

Another clear theme that became salient from the research

was that despite understanding the variety of potential benefits innovations can bring to their organisation there was also reluctance in implementing innovation. This originated from a variety of sources. Some thoughts with respect to resistance to innovation were individual such as the Construction Project Manager who thought that one of the issues creating a barrier was that the industry had “a mentality that we want immediate gains which could stop investing” (CPM). Another interesting viewpoint offered by the Design engineer centres around education. The Design Engineer proposed that there are too many degree qualified construction professionals who lack the hands-on skills of those with a trade qualification. His belief is that the lack of professionals with the hands-on skills limits the innovation. “You look at education, where’s the push now? we don’t have trades, it’s a dying trade... Problem is all these guys have degrees but no one can work with their hands. Innovative ideas can come through design, whether its cars or dowels but you need to experience things by working with your hands. That’s what I believe starts innovation, you have to have necessity.” (Deng)

Other considerations emerged from the interviews to form consistent themes across the different participants, despite their differing viewpoints. These themes are discussed further below.

A. Innovation Is Viewed as a Point of Potential Failure

The Architect identified the conservative nature of the construction industry resulted in resistance to change that comes with the introduction of an innovations. He noted that “the building industry is very conservative; I think change is harder than other industries”. Past research recognises the impact that cultural norms have as a barrier to innovation. Senior Project manager 2 noted that innovation is “not conventional for our industry, very few companies use the new technology and everyone else is doing it the old way. The reason they don’t use it is because they’re not used to it, it’s not a normal thing to do... I think it comes to the fact that some people are stuck in their ways, for some reason in Australia no one wants to take that step forward and take that chance.” This resistance is further observed in the conservative nature of management resulting in the maintenance of standard work practices. The Construction Project Manager also noted the strong link between construction work activity and existing cultural norms. “I think we are very rooted in our approach to construction, there’s a way that we have done things in the past and it’s hard to escape that method and steps we take for constructing...” (CPM)

The responses to innovation by interviewees indicated that when the construction industry has a well-used and understood method of achieving their goal (activity used to reach the goal of completing the contracted building) and as a result change or innovation can be viewed as a potential for failure rather than something that would potentially bring benefit. CPM elaborated saying there was a “fear of uncertainty or it could fail. I need the proper back up and provide information behind it to achieve use” and “if it’s not broken why fix it’ to some degree”. Senior Project Manager 2 agreed with the risk that an innovation brings to the construction process stating, “If you have a tight project and

times a constraint then there’s no way you’re going to use it, why would you risk it either.”

Senior Project Manager 1 describes a situation in which the organisation he worked for implemented an innovation. This innovation used plastic piping for the supply of water, replacing traditional copper pipes. “We had a bad experience about 5 or 6 years ago, plastic pipes had made it onto site and got rid of copper and used plastic pipes. That was at a time were copper was really expensive, we looked into it and it ticked all of the boxes and used it on a few of our jobs. 3-4 years later they have realised that after time the pipe has begun to move and break. We’ve had to go back and return copper pipes through all the risers.” The failure of the plastic water supply pipes proved to be a costly exercise and reinforced the risk associated with using a new product.

The hesitation in using a new product or innovation can further be attributed to government legislation on warranty of work. For example, the warranty on residential building work in Australia falls upon the contractor and their sub-contracting trades for a period of 6 years. This is a substantial time period for a contracting firm to carry risk and can often mean that only well used products or construction methods are relied on and innovation ignored. The fear of using something unfamiliar with potential risks was shared by interviewees such as the Director of the Building Contractor who noted, “me personally I don’t like using new products and I like to hear that people have been using it for at least 10 years. To see the long-term negative effects of the product then I’ll start using it.” and the Construction Project manager who looked for the reliability of an innovation to “provide peace of mind before using a new product or method.”

As mentioned earlier, construction projects rely on an adhoc organisation with many participants working as a team. The different professions interoperate directly or indirectly with each other creating the need for dependability on consistent, reliable performance. This reliability was considered to be challenged with the introduction of an innovation. The Construction Project Manager explained that the impact of a failure was viewed as broader than just the one participant. A failure from an untrusted innovation had implications and effects on the whole team working on a project. “People are rooted in the way they construct things and it’s hard to bring a new product in because it could affect so many across the board” (CPM).

B. Implementing Innovation Comes at a Cost

As noted above, using an innovation that fails can potentially be a costly exercise however costs are often incurred prior to use. There are substantial formal rules around warranty periods and product use which are used by the Australian Government to ensure the protection of consumers. Senior Project Manager 1 noted, “the Australia market doesn’t like to see change and there’s a lot of red tape down here like standards and OHS stuff”. Before an innovation, particularly new building products, can be used it must first be certified by an accredited engineer. For example, a new wall sheeting product used as a fire barrier must be tested to meet the Fire Resistance Level (FRL) as outlined by the National Construction Code. Deng noted that if an innovation had not been tested and certified then you are not

able to use it. This process creates a barrier to new products due to the expense associated with the certification process. Deng provided an example of the difficulties and high costs involved describing a new dowel that he wanted to use in his construction work:

“For the dowels were trying to introduce it will be about 150 thousand dollars, a testing rig to test the bars will cost 10-15 grand to shear the bars. Testing it at university will cost you over 100 grand alone, I know another product that cost 150 grand in development testing. So, 70 grand to set it all up then we pay for some university personnel and give them all the data then pay them 30-40 grand to write you a report that you can use and it says that it complies with a past standard. And only then can I use the reports along with my new product the dowels and that’s the only way we can break into the market. But you look at the process you can see it’s a huge task and we will get there, is that innovative or just slogging it out!” (Deng).

The Australian Construction Industry is largely comprised of small business with research in 2014 reporting that 98.6% employing less than 20 people and only 5.9% of businesses generating revenue of more than \$2 million [20]. The Director of the Building Contractor pointed out that the average industry participant cannot afford to undertake the costly exercise of getting an innovation through the accreditation process. “Builders in Australia are average size so they can’t spend a big amount of money experimenting.” (DB). Both the Director as well as one of the Senior Project Managers (SPM1) suggested that Product Suppliers should undertake the accreditation. On the surface this appears logical since they are the organisations that will profit from the sale of new products however the Construction Project Manager disagreed. His experience suggested that Australia is viewed as a relatively small market that could not sustain enough demand for products to justify the cost of accreditation by Suppliers. Agreeing with the sentiments of the Construction Project Manager both the Architect and Design Engineer noted that other world markets where much larger and profitable for supply companies (such as Europe with a population of over 300 million people as opposed to Australia with around 25 million). “I think it’s got to do with distances, its costly to ship here. I’ve worked in Holland and England. over there I believe there was a desire to do it [innovate] but it was easier due to location, you’re surrounded by 300 million people that you can supply your stuff.” (Arch). The Design Engineer described an instance in which he wanted to get a product he had seen in another country (USA) however when he asked the same multinational Supplier for that product he was informed that it was not available. He was informed that the particular product was not approved for use in Australia and it was not a priority to introduce the innovation.

C. The Workforce and Innovation

A 2019 report on the Australian construction industry [21] noted that the “availability of skilled construction workers has become an issue at the forefront of people's minds,” and “the pipeline of building and non-heavy industry engineering work within both Australia and New Zealand is continuing to place pressure on both head contractors and subcontractors who are finding it challenging to secure adequate levels of

labour for current and future projects.” The research participants from the construction industry agreed that the lack of innovation was directly related to the shortage of skilled workers. The Design Engineer, Senior Project Manager 1 and the Building Director associated the lack of innovation in the construction industry with the shortages in the skilled workforce. Senior Project manager 1 stated that participants in the construction industry “don’t really look outside the box to do things differently. That has a lot to do with the labour cost in Australia that’s ridiculously high compared to other countries.” (SPM1).

Market forces and the shortage of skilled labour was also identified by Senior Project Manager 1 as a source of increases in cost of skilled workers and this resource could not be wasted trying out new innovations. The Building Director agree with this sentiment noting “if you keep changing products and methods the skill and the quality could be jeopardised. and the new product could require time for people to get good at using it and therefore complicate the industry.” (DB).

An underlying source of the shortages in the skilled workforce was attributed by the Design Engineer to lack of investment in education. Managers in the construction industry were not willing to have their workers trained, rather continue to deliver projects in traditional ways. “I think it comes back to education and investment in educations and I don't think there's enough of it.” (Deng).

D. Why Spend Money on Things That Benefit Someone Else?

The forming of teams to design and deliver a construction project means that consultant, contractor (and sub-contractor) teams change from project to project. The individual project character of the industry [4], [5] combined with the competitive nature between construction contractors (and consultants) results in siloing of any innovation between organisations. Senior Project Manager 2 noted, “At the end of the day no one’s going to spend money for the greater good of someone else and that’s how private companies operate” (SPM2).

Most developers of projects tend to sell off their ownership of the finished building. Innovations aimed at improvements in quality and sustainability (such as reduced costs in the operation of the building into the future) was found to be of little interest and is consistent with previous research [4], [6], [8]. An important theme explored with participants was the introduction of sustainability systems. Sustainable systems provide a long-term gain for the owners of the completed project however they are often disregarded as they provide very little to Clients who sell off their ownership at the completion of the build. The Architect suggested that this is an environmental factor (activity wise) that could change noting “As a designer [innovation is] absolutely important, looking at different ways people live and build. It’s the forefront for architects... however [innovation related to] cost tend to get pushed more than you have the environmental side” (Arch).

E. Initiating Innovation

All of the participants believe the government should be involved in mediating the take up innovations. Design Engineer stated that “the government should have something

set up to incentivise people to do this sort of stuff, like the testing, or tax cuts or anything to help you out and at least provide the testing could you imagine how many other ideas would break the market if they funded testing” (Deng). Support for training was again raised as a source to initiate innovation and could be supported by government training grants.

Senior Project Manager 2 indicated that the government can be a positive influence in mediating innovation noting “I’ve noticed to win particular tenders usually larger ones such as government jobs, they give you points for the way you price and it’s not only based on price. If you can show them you can be innovative I think they’ll give you the job just based on that” (SPM2).

The Architect believed that the government has failed to deliver support for innovation of late noting that Australian government research centres such as CSIRO (Commonwealth Scientific and Industrial Research Organisation) have had their funding cut, reducing their testing and reporting on innovations. As a result Architect believes that attention should be paid to the client and contractor as alternatives to foster innovation. “It depends on the client, some are traditional and some try to push the boundaries and do something different... I think it has to be across the board. The client has to be enthusiastic about pushing forward something new and I do think you have to have a sympathetic builder, enthusiastic and wants to try new things, knows what he’s doing and will take the risks” (Arch).

IV. CONCLUSION

The construction participants interviewed as part of this research came from a variety of backgrounds yet all agreed that despite an interest in innovation there was a distinct lack of implementation. Innovation was found to be complex issue with a variety of factors impeding adoption and significantly, innovation was collectively seen as a point for potential failure as opposed to significant improvement. Those that had tried to introduce an innovation found significant cost related roadblocks such as the expense related to certification of a new product by the Australian Government or the penalty associated with using a new product that failed due to incorrect installation. Other points of resistance to innovation came from the lack of a skilled workforce that can take advantage of innovations and the cost of training a worker only to lose that resource to another organisation.

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