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## **INTEGRATED HOUSING SUPPLY CHAIN MODEL FOR INNOVATION: NARRATIVE ANALYSIS TOWARDS DEVELOPING PATHWAYS METHODOLOGY**

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### **Abstract**

*There are significant problems in the supply of housing in Australia yet very little attention has been paid to the housing construction supply chain. To date the housing supply debate has been largely focussed on housing demand, affordability and land supply. It is contended that one of the key causal factors of poor housing supply is the poor coordination between supply chain actors. The development of integrated supply delivery solutions have not been extensively recognised in the Australian residential sector. Ad hoc examples and applications by some major building companies has seen some limited success, however, this has not been diffused throughout the sector with little real impact on overall sector performance and individual company competitiveness. Whole-scale industry improvement requires a concerted effort to undertake a stepwise change. A key to the solution is to investigate successful examples of integrated supply chains which have resulted in productivity and/or innovation performance improvements. The aim of this research is to undertake a case study analysis of successful implementation of delivering an innovation to the Australian housing construction industry which required an integrated construction supply chain model. The paper describes the theoretical background to the study and the preliminary results of the case study.*

**Keywords:** housing, supply chain innovation, case study

### **INTRODUCTION**

The housing sector has always been seen as an important part of the economy and is considered a key indicator of the health of the Australian economy. The construction industry typically represents between 6-12% of the GDP of an economy. In Australia in 2009 the residential sector accounted for approximately \$70b and from 2000-2009 the average was 47% of the total spend in the construction industry. With anticipated population growth the significance of housing infrastructure provision is expected to increase in the next two decades. The Australian National Housing Supply Council estimates that around 3.2 million additional dwellings will be required in the next 20 years to accommodate a population growth from 2008 to 2028 (ANHSC, 2010). Moreover, it also forecasts that the current demand-supply gap of 178,400 dwellings will increase to approximately 640,000 by 2028. According to the Australian Bureau of Statistics (ABS, 2010), the country currently needs to be building 17,400 homes every month. Housing supply, however, has oscillated between 10,000 to 16,000 dwellings per month since 1990. Based on the average number of approvals over the first three months of 2010, the current supply is around 14,500 dwellings per month. The shortfall means we are faced with a crisis in our capacity to plan, design and construct to meet our nations needs unless we act immediately to improve our capacity for a more efficient, effective and innovative supply system. Discussions on land supply, planning and development approval processes have been ongoing discussion in the housing

affordability debate for decades in Australia (Holmes, London and Sheehan, 2008). The land development and housing supply pipeline is an important future challenge for the federal government of Australia and is being spearheaded through the Council's 2010-2011 agenda. It is contended that very little attention has been paid to the housing construction supply chain and that productivity and performance improvement of this sector has a role to play in improvements to the housing supply problem.

The problems of the housing sector have been described as; low profit margins for builders and subcontractors, high risk, fragmented supply, adversarial relationships between firms, wasted resources (time, cost and materials), low innovation, poor communication flows, low productivity and poor project management skills. The industry is highly resistant to change, participants tend to not have a holistic view of the industry and feel powerless to affect change. There are significant large national companies who are the market leaders in the residential sector who have some capacity to affect change, however in reality it is suspected that this group struggles to do so in a whole-scale concerted manner. The underlying structural and behavioural characteristics create an overwhelming inertia that resists change. The next tier of the housing sector, namely the trade subcontractor level is highly competitive and fragmented and typically involves numerous small to medium sized companies who generally operate in an uncoordinated and uncooperative environment. Then the third tier of the chain typically involves the major multinational materials and product suppliers. The industry participants similar to most sectors of the construction industry tend to be focused on short-term survival rather than overall industry improvements for the medium or long term.

The industry structure involves chains of firms that contribute to many different parts of planning, designing and constructing the final housing development. Because the industry is highly fragmented with numerous firms and many steps along the production chain it is assumed that an integration of the supply chains will lead to innovations. It is assumed that whole scale industry improvement requires a concerted effort to undertake a stepwise change towards integrated supply chain solutions to improve coordination and thus reduce cost, time delays and risk. A key to the solution is to investigate successful examples of integrated supply chain case studies which have resulted in productivity and/or innovation performance improvements. This paper seeks to explore performance improvement efficiency through the creation, development and implementation of innovations in the sector by providing a description of the successful implementation of the waffle footing system innovation in Australia by an "innovator group".

The overarching aim of the study is to undertake a case study analysis of successful implementation of delivering an innovation to the housing sector which required an integrated construction supply chain model. The objectives include:

- Identify the barriers and enablers to creation, development, adaptation and implementation of the innovation
- Examine the characteristics of the process of integration of the construction supply chain towards creation, development and implementation of an innovation by an innovator group
- Develop a methodological process pathway for innovation creation and diffusion for an integrated housing construction supply chain

The overall research question which this study seeks to address is, "What is the pathway for identification, creation, development and implementation of innovation within the innovation group?"

## **THEORETICAL BACKGROUND**

There are two underlying premises to this study. First the assumption that an integrated construction supply chain is necessary to achieve significant productivity and innovation performance improvements in the housing sector. Second that there is a structured methodology which can be developed which describes a pathway for supply chain management that will enable diffusion of innovations, either incremental or monumental, product or process that will improve the performance of the industry. The theory that provides the framework for this study is a combination of diffusion theory and construction supply chain theory.

### **Construction supply chain theory**

A central idea of supply chain theory is that holistic supply chain integration relies upon each firm at each tier in the supply chain knowing and aiming for a common objective (London, 2008). The common objective may be an innovation or it simply may be concerned with efficiency and effectiveness across the whole supply chain. One of the most significant problems is that once a supply chain becomes fragmented at each tier in the chain there is an outcome from a firm and that firm passes their product and/or service to the next firm at the next tier in the chain and a silo effect takes place. Each firm has unique objectives and 'pushes' on to the next tier the outcome they assume the next tier can 'bear'. The outcome is generally the most efficient for the firm but may not necessarily completely satisfy the next tier's objectives [i.e. the customer's objectives]. It is almost certain that the firm would not be considering the objective of the whole chain nor any other levels in the chain at all. This is central to the concept of supply chain management where the concept of 'pull' vs. 'push' explores a different way of thinking about holistic supply chain performance outcomes alongside the individual outcomes at each tier. The final 'customer's objectives and desired outcome effectively 'pulls' through the products and/or services provided by each tier in the chain. Although this fundamental principle is a long standing assumption within the supply chain theorists domain it is suspected that it is still one of the most basic problems in relation to developing integrated supply chains and creating holistic performance goals for supply chains.

The case study that is analysed is an example of an innovation or an outcome being established that is outside the normal practice of the supply chain participants and the usual outcome at each tier. This particular case study was a step wise change in the practices related to residential footing system design and construction in the Australian housing sector. There is theory already established in relation to diffusion of innovations and this theory provides a starting point to interpreting and exploring the particular innovation that shall be studied in this project.

### **Diffusion theory**

Rogers' theory of innovation diffusion (1962; 1995; 2003) provides an initial framework through which examination of the diffusion of an innovation through construction supply chains can be examined. Rogers' defines the diffusion of innovations as the process by which knowledge of an innovation is transmitted through communication channels, over time, among the members of a social system. The theory of innovation diffusion has been used in many different sectors including health, information technology and construction. In particular London et al (2007) and Walker et al (2005) explored e-business and information technology adoption in the Australian construction sector using concepts from this theory. The four key elements comprising Rogers' diffusion theory are defined as;

- The innovation: an idea, practice or object that is perceived as new;

- Communication channel: can be mass media and/or interpersonal networks and is the means by which messages about the innovation gets from one individual to another;
- Time: comprising a) the innovation-decision process, b) relative time which an innovation is adopted by an individual or group – an innovation's rate of adoption
- The social system; a set of interrelated units that are engaged in joint problem solving to accomplish a goal.

Rogers (2003) also outlined the innovation process as consisting of a sequence of five stages including:

- Agenda-setting: the initiation stage when a broad organisational problem is identified which generates a need for an innovation. Within this stage there are two key processes; firstly an identification and prioritisation of problems and requirements and secondly a search within the organisation to find innovations to resolve or manage the identified problems. It is in this stage that the initial motivation is created which drives the later stages in the innovation process.
- Matching: the stage where the problem from the organisation's agenda is conceptually matched with the innovation to determine how well they align. The feasibility of the innovation in resolving the organisational problem is also considered at this stage. This stage is critical to determining if a new idea is sustained in an organisation over time as key decisions are made which may lead to the termination of the innovation process even before its implementation. If it is perceived that the organisation's agenda fits with the innovation then the match is planned and designed.
- Redefining/restructuring: the stage when the innovation is adapted based upon the organisation's needs and structure or vice versa. It is anticipated that a degree of change occurs in the innovation and the organisation during this stage. The ease within which organisations experience the innovation process is influenced by the origin of the innovation (ie whether the innovation comes from within or external to the organisation) as well as the degree of change the innovation creates (radical vs incremental).
- Clarifying: the stage where the innovation has been spread more widely in an organisation. A high degree of uncertainty surrounds its members as an innovation is implemented in an organisation. As a result, individuals go about seeking answers to reduce uncertainty at this stage and construct their meaning of the innovation over time. Innovation champions can play a critical role in the innovation process during this clarifying stage.
- Routinizing: the stage when an innovation has become synonymous with the regular activities of an organisation, which completes the innovation process.

The identification of the different stages in the innovation process has been particularly useful for understanding how to effectively introduce new ideas in organisations because through this we are able to gain insights into the main sequence of decisions, activities and events in the innovation process. However, one would anticipate that to develop and diffuse an innovation in a fragmented industry such as the housing sector would require a collaborative effort between firms along supply chains. It would also require a champion or group of champions who have enough resources and 'pull' to enable the development of the innovation. Beyond these propositions we do not know any more detail of the characteristics of the innovation process or methodology which would integrate the supply chain and achieve innovation diffusion.

Within this framework diffusion is largely measured through the degree of adoption within a system. Adopters are categorised by Rogers' as innovators, early adopters, early majority or laggards. London et al (2007) eventually challenged this simplistic binary approach to categorisation. However, according to this categorisation London et al (2007) explored late adopters and laggards of technology to develop an e-business technology adoption profile of the majority of the industry players, whilst Walker et al (2005) explored early adopters of technology. The work by London et al (2007) on e-business innovation diffusion in the construction industry was unique in that this piece of work identified pathways of adoption by the later majority adopters and laggards. That study challenged the basic premise to Rogers' work in that adoption was considered as a binary proposition, ie to adopt or not to adopt. This conceptualisation was tested. There were different rates of adoption and these were related to the way in which the players involved underwent transformations in their perceptions about the particular innovations. These patterns can be seen in three identifiable pathways which were termed: Perceptions Pathway, Compatibility Pathway and Communication Pathway.

The present research is more particularly focussed on the creation phase, ie the innovators and towards the development of a pathways conceptualisation and methodology for the innovator group. Therefore it would be worthwhile to explore the relevance of the five stages of the innovation process for describing and explaining the successful implementation of an innovation in the housing construction innovation in Australia by an "innovator group" and after that preliminary analysis to then further examine any unique characteristics in relation to pathways for innovation creation, development and implementation. The participants in the "innovator group" include those players who were actively engaged with the identification, creation, development and implementation of the waffle footing system innovation process. The innovator group is differentiated from the other adopter groups in that participants are actively engaged in the creation and development of the innovation and they are not simply adopting something which has already been designed, tested, evaluated and implemented. Manley and McFallan (2006; 2008) also conducted research on innovators in the construction industry and their particular contribution was an identification of the business strategies used by innovators for effective implementation. In particular through a survey with over 3000 key Australian construction firms Manley and McFallan (2008) identified the relative importance of five key types of business strategies was examined relating to employees, marketing, technology, knowledge and relationships. The strategies which had the greatest impact included investment in research and development, participating in partnering and alliances on projects, ensuring transferral of project learning into business processes, monitoring of international best practice and recruitment of new graduates. This piece of work however did not explicitly map the process pathway for innovation creation, development and adaptation by an innovator group.

## **METHODOLOGY**

The study involves an in depth analysis of the creation and diffusion of an innovation in the housing construction industry in Australia. The innovation case study is the creation, design, development and implementation of the waffle pod footing system. The empirical study is organized in three phases:

- Phase 1 exploratory description of case study: description of the chronological history of the creation and development of the innovation including key players, events, drivers and decisions. This will also map the development and then the transition into more widespread diffusion.

- Phase 2 critique of process: detailed critique of the process including the factors affecting creation, development and implementation. It will involve the identification of the barriers and enablers for development and implementation of the innovation.
- Phase 3: development of integrated supply chain innovation methodology: description of the actual process and then the critique of barriers and enablers will allow the development of a structured methodology of 'best practice' for innovations requiring an integrated supply chain approach. However it is noted that this is only one exemplary case study and so as an exemplary case study it is significant in its own right but further studies would be required for improved validity and reliability for broader generalisation.

The study focuses on the organizational, communication, economic contextual factors as they relate to the technological innovation rather than the technical factors of the innovation. It is apparent that the technical innovation has been reasonably well documented already. The project is ongoing and we are now midway through Phase 1. This paper reports the preliminary results of Phase 1. The study is limited by the reporting of only one example of an innovation.

### **Phase 1**

The first phase involves the conduct of detailed semi-structured face-to-face interviews with key players of the "innovator group" associated with the waffle footing innovation. This data collection and analysis will be supplemented with a document analysis on the documents that have been published or developed during the time of innovation development and initial diffusion. Six interviews with seven participants from five organisations have been conducted to date. It is anticipated that in total there will be eight interviews with ten participants from seven organisations which will be analysed for this study. Table 1 presents details relating to the interview participants. The duration of the interviews is between 60-120 minutes.

The interview participants were asked questions relating to four key areas:

- their role in their organisation at the time and their specific role in relation to the waffle pod footing innovation
- key events or milestones/critical moments in the innovation process
- barriers and enablers which hindered/drove the innovation
- key players in the innovation process

The narrative inquiry approach is employed to uncover stories which highlight the organisational, communication and economic factors impacting on the creation, development and adaptation of the innovation. The key actions and events which influenced decisions made are systematically studied to connect and see the consequences of those events over time mapped against the creation, development and adaptation of the innovation (Riessman, 1993). The specific technique of story analysis is used for data analysis as it offers a way of connecting different stories to understand the phenomenon and in particular changes that take place over time (Bell, 1993). The unit of analysis is the participant and these are now considered as unique cases. There are two key parts to the analysis which are within-case and cross-case analysis. The interviews are recorded, transcribed and subjected to two stages of analysis.

The first part of analysis involves a within-case analysis of the case studies to identify links between stories particular to each case. Stories are identified and coded into the five stages of the innovation process. The following steps are undertaken in this stage of analysis:

- Entire interviews are transcribed into “rough drafts” to develop narrative segments.
- The narrative segments are interpreted to identify the meaning of each individual story. In each story a particular feature is identified to demonstrate a certain element of a particular stage of the innovation process. Based on the participant’s decisions, activities or events described within the stories, each story is then classified into categories according to the primary characteristics of the five stages of the innovation process.
- The next stage involves linking the different stories into chronological order. The stories coded into the five stages of the innovation process are then “pasted together” to form a “metastory” to demonstrate the participant’s experiences related to the waffle pod footing innovation.

The second part of analysis involves a comparison across cases to identify common themes and irregularities.

Table 1: Interview participants

<b>Case study</b>	<b>Organisation type</b>	<b>Position in organisation</b>	<b>Role in relation to waffle footing innovation</b>	<b>Location</b>
C1	Large housing developer, CO1	State Manager (retired)	Supply of experimental/prototype sites Organisation of supply chain to create and implement system	Australia-wide
C2	Footing contractor, CO2	Managing director	Construction of footing system for experimental/prototype sites	South Australia
C3	Building materials supplier, CO3	Sales representative (retired)	Promotion, distribution and selling of the system nationally	Australia-wide
C4	Plastic spacer manufacturer, CO4	Managing director	Manufacturing of key component of system, ie plastic spacer	South Australia
C5	Engineering consultant firm, CO5	Managing director	Engineering design of the system Monitoring and testing of experimental/prototype sites Obtained approval/accreditation for system	South Australia, Victoria
C6	Engineering consultant firm, CO5	Managing director (retired)	Engineering design of the system Monitoring and testing of experimental/prototype sites Obtained approval/accreditation for system	South Australia, Victoria
C7	Polystyrene supplier, CO6	Sales representative	Distribution of the system in Victoria	Victoria
C8	Industry association, CO7	State Manager (retired)	Promotion of the system in Queensland	Queensland



## RESULTS

Each participant was analysed as an independent unit and subjected to the two stages of analysis as outlined previously. Barriers and enablers to the creation, development and adaptation of the waffle footing system innovation were identified and a summary of this is provided in Table 3 (refer to appendix). It is not the intention of this paper to discuss this part of the results, however, the table summary serves to indicate the various key themes identified in relation to the barriers and enablers which participants in the innovator group experienced. Many of the barriers and enablers are consistent with those identified in the literature, however, there are a number of these which are particularly unique to the innovator group (bolded text). For example, one of the key issues discussed by the participants involved complications associated with protection and formalisation of intellectual property. This is perhaps something that is unique to the experiences of the innovator group since other adopter groups would not have issues concerning protection of intellectual property.

A number of similarities between the participants experiences related to the creation and development of the waffle footing system innovation were identified and the five stages of the innovation process can be mapped reasonably well as a result of the interview data analysis. The first stage of the analysis involved categorising the participants' stories into the five stages of the innovation process; namely, agenda-setting, matching, redefining, clarifying and routinising. The findings reported in this paper are a result of the second stage of analysis, which involved a comparison across six cases. Analysis of cases C7 and C8 is ongoing. Specifically, the manner in which participants within the innovator group each experienced the five stages of the innovation process will be discussed with key themes identified across the six cases. Table 2 provides a summary of the key themes arising from the cross-coding of the participants' stories into the five stages of the innovation process. A detailed discussion of the key themes identified within each stage is provided in this section. Before this, a brief summary of the waffle pod footing story is described to provide context for the discussion which follows.

Table 2. Cross-case comparison of key themes arising from the participants' stories coded into the five stages of the innovation process

Stages	C1	C2	C3	C4	C5	C6
<b>Agenda setting</b>	Opportunistic surveillance		Opportunistic surveillance		Opportunistic surveillance	
	Performance gap				Performance gap	Performance gap
<b>Matching</b>	Establish fit between problem and innovation	Establish fit between problem and innovation	Establish fit between problem and innovation	Establish fit between problem and innovation		
<b>Redefining/restructuring</b>	Changes to organisation/innovation	Changes to organisation/innovation	Changes to organisation/innovation	Changes to organisation/innovation	Changes to organisation/innovation	Changes to organisation/innovation
		Collaborative efforts between participants	Collaborative efforts between participants	Collaborative efforts between participants	Collaborative efforts between participants	Collaborative efforts between participants

<b>Clarifying</b>	Role of champions	Role of champions	Role of champions		Role of champions	
	Reducing uncertainty	Reducing uncertainty	Reducing uncertainty		Reducing uncertainty	
<b>Routinizing</b>	Widespread diffusion	Widespread diffusion			Widespread diffusion	Widespread diffusion
		Reinventions	Reinventions	Reinventions	Reinventions	Reinventions

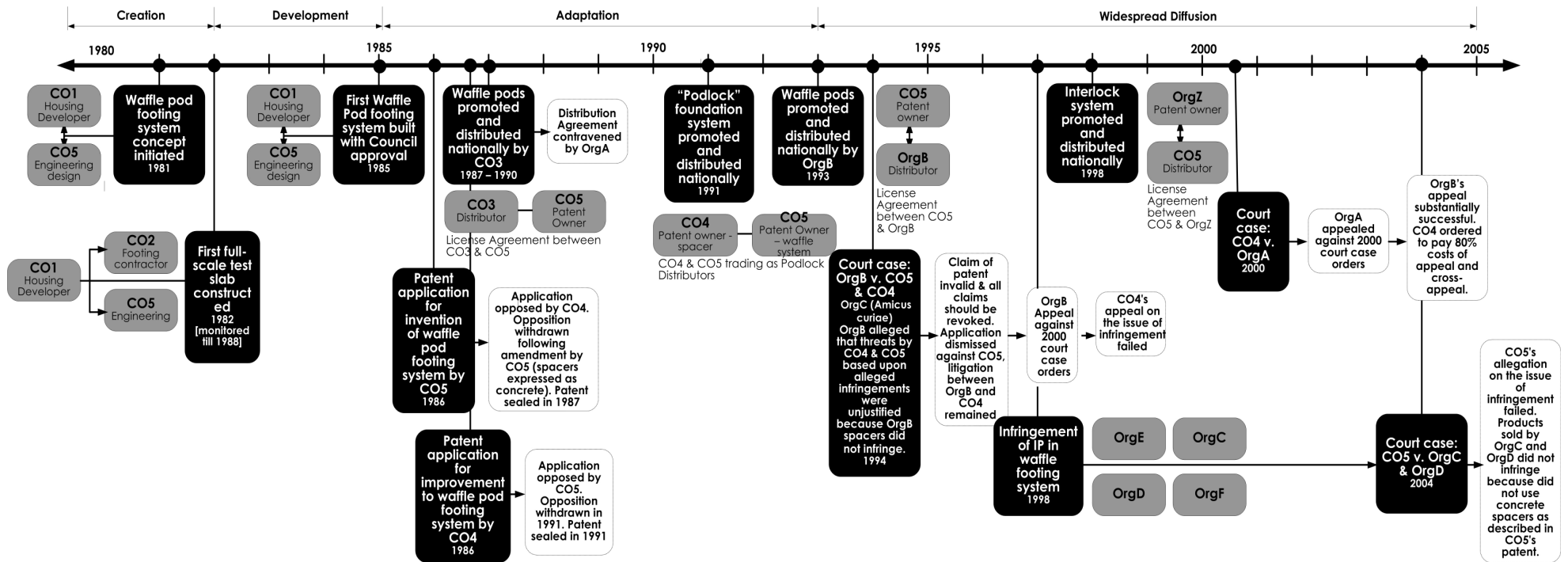


Figure 1. Summary of the chronology of events surrounding the waffle footing system innovation 1980-2005

A summary of the chronology of some of the key events and developments surrounding the waffle footing system is presented in Figure 1. The waffle pod footing system story begins in the early 1980s in Adelaide, South Australia. The state management of a large national housing developer (CO1) was looking for more efficient ways to increase revenues and the waffle footing system was seen as a strategy which offered an opportunity to achieve this. The initiative to create, develop and implement the waffle footing system innovation was championed by C1, who was the state manager of CO1 at the time. During that time, CO1 was trading with an engineering consulting firm, CO5, which had just embarked on a program of research and development in the footings area. The late 1970s and early 1980s saw major developments in Australian building codes in terms of how footings were specified and the waffle footing system was a part of the different streams of research CO5 were engaged with during that time, which was championed by C5. A number of other key players contributed to the creation, development and implementation of the waffle footing system (refer to Table 1).

The footing system although originated in South Australia some 18 months after the first installation had spread to the other states of Queensland, New South Wales and Victoria. There were interesting developments from 1986 onwards when CO5 sought protection to own the exclusive right to commercially exploit the waffle footing system by applying for a patent in 1986. The patent was entitled “Building Foundation Form Work Arrangement” which involved “levelling the ground on which the foundation is to be located, positioning a plurality of box-like hollow members in rows on the levelled ground, separating the hollow members by spacers, positioning lower reinforcing rods on the spacers and between the hollow members, positioning a reinforcing mesh over the hollow members and pouring concrete into channels between the hollow members and over the hollow members so as to envelope said reinforcing rods, mesh and hollow members and thereby form the foundation with a plurality of intersecting reinforced beams and an overlaying reinforced floor slab” (APO Patent Application 198667009, 2011). Not long after in 1987, CO4, sought to apply for a patent entitled “Improvements relating to building foundation form work”. The invention CO4 was seeking to protect involved an improvement on the use of concrete blocks, which was proposed by CO5 as spacers. CO4’s spacer is “in essence, a framework which holds in place pairs of vertical plates set at right angles to each other.” (FCA-FCD, 2011). The plate fits over the corners of the hollow boxes and holds them in place relative to each other.

Both CO4 and CO5 opposed each other’s patent applications. CO4’s opposition to CO5’s application was withdrawn following an application for amendment was made by CO5. The amendment involved specifying the specific use of spacers made out of concrete, which was different from CO4’s plastic spacers. CO5’s opposition to CO4’s patent application was then withdrawn and both patents proceeded to sealing. Over the following years, the waffle footing system gained increasing popularity and there were various business ventures with alliances developed as ‘spin offs’ from the business in Adelaide. From the mid-1990s onwards CO4 and CO5 experienced a number of infringements on their patents which eventuated in a series of litigations and court cases (refer to Figure 1).

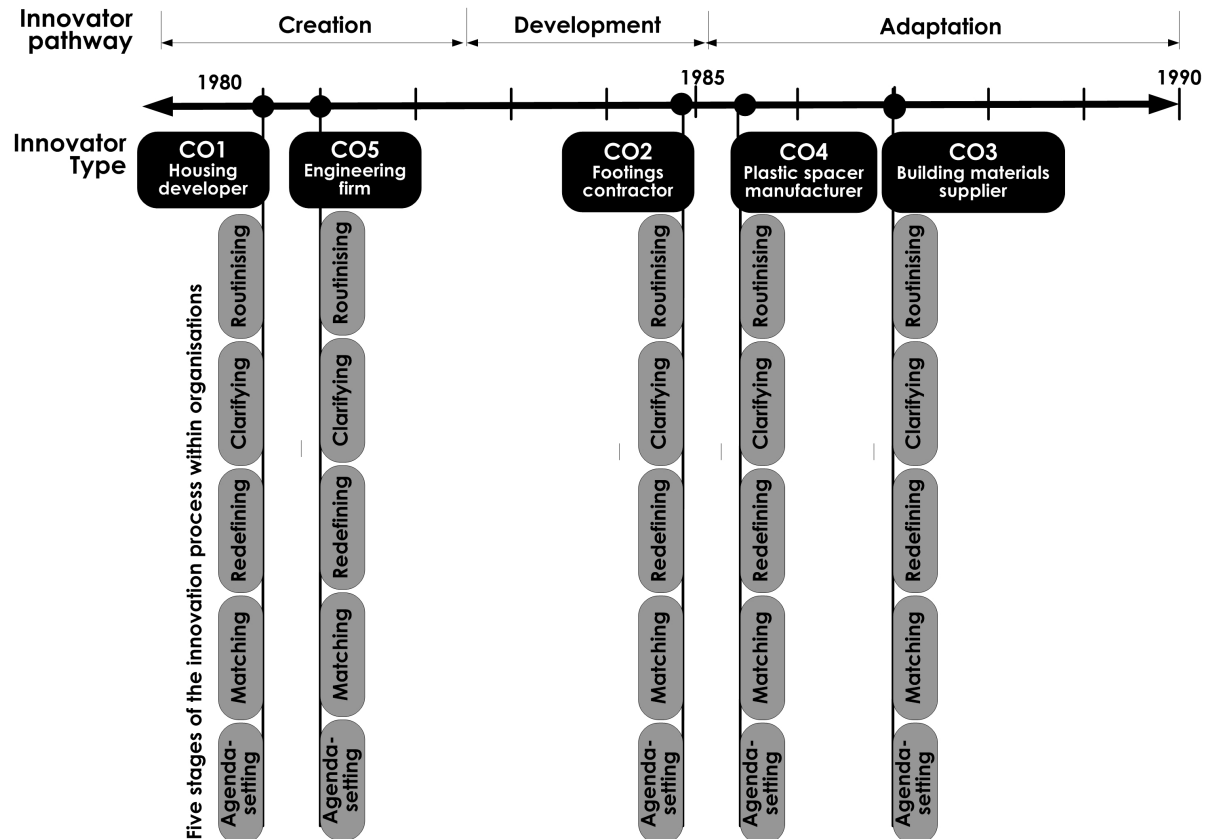


Figure 2. Innovator types and Pathway towards creation, development, adaptation and implementation of innovation

One of the key findings of this research to date is a more complex categorisation of participants within the innovator group. Whilst past research examined the innovation process within organisations (Rogers, 2003), this research explores the innovation process across organisations, ie, within an “innovator group” comprising a number of organisations located at different tiers of the supply chain. Given that the innovator group is made up of various organisations there was more than one clear “cycle” of the innovation process occurring whereby there were individual cycles within each organisation taking place concurrently alongside the overall innovator group pathway. The previously accepted broad classification of “innovators” does not capture the specific characteristics of those case study organisations observed in this research. The preliminary findings demonstrate that participants within the innovator had various roles to play at different stages of the innovation process in the successful implementation of the waffle footing system. Furthermore the analysis highlighted that there are different types of innovators which are:

- Innovator-creator: those who are responsible for initiating and creating the innovation
- Innovator-developer: those who contribute towards the design, planning and development of the innovation
- Innovator-adapter: those who enter at latter phases and contribute to the innovation by modifying/adapting the innovation

### Agenda-setting

In diffusion theory (Rogers, 2003) the agenda-setting stage initiates the innovation process and is where an organisational problem is identified thus generating the need for an innovation. Analysis of the interviews with key players (C1, C5, C6) involved with the waffle

footing system innovation revealed that the agenda-setting stage was significant in that for many of the organisations it was during this stage that the initial motivation to resolve an identified problem was created which helped to drive the later stages of innovation. A total of eleven stories identified from the interviews were coded into the agenda-setting stage. Two main themes were identified as part of this stage including; performance gap and opportunistic surveillance.

The first theme of performance gap is about inconsistencies between how individuals within an organisation perceived its performance and how they expected to perform. C1, C5 and C6 indicated that a perceived performance gap was a trigger to search for an innovation.

*“the traditional was a brick build-up...and what that meant was you had unknown rock excavation on the strip footings...when you hit rock, you called the customers up and said you’re going to have to pay us some more money so straight away you’re off-side... So my drivers were...so that we could actually fix the customer’s price and charge no extras for them... I wanted to be able to control the actual costs... the other thing that hit me was in multi-storey car parks I’d seen where these waffle pods had been used...I just said, cant we do that same stuff here?” (C1)*

*“the idea was to get a footing system that was as near as possible to a factory-produced...and above-ground...cause once you start digging you lose control of what you’re building, you get over runs, your trenches collapse” (C5)*

*“because we were involved with footing designs and having problems with movement. As a structural engineer I had designed waffle slabs for first floors...So I figured we got nowhere for support in soils or footings in soil and maybe a waffle will be a good concept”(C6)*

For these participants the need for an innovation was borne out of the inefficient manner in which traditional in-ground strip footing systems performed which involved excavated trenches with foundation walls built up to the required floor level from the footing. This method was considered labour intensive and not particularly cost-efficient. The problem also with the traditional footing system was unknown required footing depths due to differentials and variability in in-ground movement and consequently the difficulty of trying to accurately control the amount of concrete used. Both C1 and C5 highlighted the key disadvantage of the traditional system as its inability to control quantities and costs. The desire to develop an above the ground footing system which was *“as near as possible to a factory-produced product”* was thus seen as a way to achieve fixed or accurate cost predictions. The experiential problem solving method was employed in the creation of the innovation whereby the innovator-creators drew upon prior experiences in the attempt to create a more efficient product. For C6, the idea of the waffle footing innovation came from his earlier experiences of having designed waffle slabs for first floors as an engineer whereas C1 relied upon broader experiences gained from working overseas:

*“...the margins in housing are quite low, they’re terrible because of the inefficient way we did things but it reminded me of the landscapes around Durban where I’d been working over there. So in one of my thinking modes ... I thought why cant we cut and fill and slab as we did over there. So I started exploring that”*

The second theme revolved around the participants being engaged in opportunistic surveillance (Rogers, 2003) by continuously being on the look out for new ideas which might be beneficial to the organisation. Past work into the innovation process has highlighted that organisations are often driven more by solutions as compared to problems (March, 1981). Given the high number of problems typically faced by organisations, the chances of identifying an appropriate innovation to deal with a specific problem is relatively low. The

possibility of matching an innovation to a problem faced by an organisation can, however, be higher if organisations begin with a wanted solution or innovation. As a result a large number of organisations tend to be involved in opportunistic surveillance to identify promising innovations which may be relevant for dealing with existing problems in the organisation. Indeed this was the case for three of the participants interviewed who each indicated that they were actively scanning the environment for new ideas and “thinking about things”:

*“So what we did was set up some internal R&D projects...so we had different streams to what we were doing” (C5)*

*“had a break when I realised one day sitting in the office...I’m paid to think about things” (C1)*

*“James Hardie is basically a building materials supplier...they were actually looking to diversify and try something else and have another product that they could promote Australia-wide” (C3)*

In the case of C4 in particular, knowledge of an innovation launched the innovation process in the organisation. The organisation took on an opportunistic approach whereby knowledge of the waffle footing system created a need for the innovation process. Prior to the organisation discovering the product there was no specific plans for its use except that the organisation was looking to diversify its product-line. Therefore even though the innovation process is often initiated by a perceived need to address a particular problem it can also be triggered by knowledge of an innovation, as in the case of this innovator-adapter (C03).

### **Matching**

A total of thirteen stories were coded into the matching stage. A common theme that the participants experienced during the matching stage related to establishing the fit between problem and innovation. At this stage, participants determined how well the innovation aligned with the identified organisational problem:

*“so in discussion with my marketing people that time, I said, “What do you really want, like if you could really put the price on the market fixed, no extras would that be a value proposition?” They went “oh boy, would that be!” They said, “go for it!”” (C1)*

*“the first one I actually witnessed...it was an eye opener for me... Straight away I went into gear and said right, this is the easiest way to do it...if you dig a foundation right in the ground you really cant form it up...that’ll cost money and time whereas just the simple process, form up the perimeter of your house foundation...lay some pods in there” (C2)*

*“So we used to supply and fix. So he started the ball rolling on that and I would never have worked any other way because that’s the way I liked to work so I was a good candidate” (C2)*

*“cos basically everybody no matter what industry you’re in especially in the building industry you’re forever looking to save costs wherever you can. And this was a cost saving exercise” (C3)*

*“I was a foundation contractor and when I heard about it I didn’t like the way it was put together ... and because I knew about patents ... So I just wanted to improve it by making a better spacer to hold it together. So I came out with this” (C4)*

As highlighted by these quotes the matching stage was a particularly critical stage in the innovation process for these participants as it marked the decision to proceed with the design, development or implementation of the waffle footing system innovation within their

organisations. The specific benefits of the waffle footing system were anticipated in the form of fixed pricing (C1), ease of construction (C2), appropriate work method of supply-and-fix (C2) and cost savings (C3) and matched against organisational needs. The waffle footing innovation “found a home” in the respective organisations due to the high degree of fit between the innovation and organisational needs or problems. The matching stage can also be influenced by organisational capacity or specific expertise/experiences related to the innovation process as demonstrated by C4. For C4 the decision to adapt the waffle footing system innovation was largely a result of having prior understanding of dealing with an innovation in a different industry and in particular with patents. The waffle footing system innovation was established as one which fit with the organisation’s specific expertise and capacity and thus a decision was made to be involved with the adaptation of the innovation.

### **Redefining/restructuring**

Nine stories were coded into the stage of redefining/restructuring. The first theme of the redefining stage involves changes which occurred to the organisations or innovation during the redefining stage.

*“We invested in a couple of staple guns and stapled them together. So it was so simple...and I self taught myself” (C2)*

*“The only thing that I did was waffle pods...I was employed to drive that...They had people that were already promoting CO3 products and this was an add on for them to promote...And that’s the other thing its changing the whole spectrum ...they could then turn around and use it as an advertising thing and say CO3 can build a house for you” (C3)*

As highlighted above, the innovation process resulted in a degree of change for the participants in terms of work practices and organisational structure. For C2, the waffle footing system can be classified as an incremental innovation as it did not require a high degree of technical expertise to implement and therefore was implemented relatively easily as C2 indicated, “it was so simple...I self taught myself”. For CO3 however, the innovation was a little more radical. Not only did the innovation lead to the creation of C3’s role, which was specifically to promote the waffle footing system, it also affected the “whole spectrum” of the organisation’s marketable products in that the organisation was then able to expand its market share by the ability to supply products for the construction of an entire house. According to Rogers (2003) the redefining/restructuring stage is when the innovation imported from outside an organisation loses its foreign character, that is, the innovation is adapted to suit the organisation’s needs or structure and vice versa. Even though the innovation process did result in changes, there was a slight difference in the way the redefining stage was experienced by the innovator group analysed on this project in that given they were largely the ones creating and developing the innovation, they were provided the opportunity to shape the innovation to suit their organisational needs, rather than change the innovation to suit the organisation at a later stage, as highlighted by C1:

*“I can remember...trying to find plastic tubs or bails or hay or something – but it didn’t matter what we stuck in there and I was cost controlling” (C1)*

For C1, a primary objective of their organisation centred on an ability to control costs and therefore during this stage was found to be developing the waffle footing system to achieve that. Being involved at the start of the innovation process as an innovator-creator, the organisation was able to create the an innovation which was particularly aligned to the objectives of the organisation.



The second theme was the collaborative efforts between participants in the innovator group in the implementation of the waffle footing system innovation whereby various forms of agreements or arrangements were developed in order to successfully achieve diffusion of the innovation.

*“I remember when we did the test slabs...I got all the materials and things from suppliers...I was communicating with our direct suppliers and I said you’re going to be a part of this” (C1)*

*““it was all up and down and I wasn’t really enthused by them...So I suggested that we form it up with higher formwork. So out came my formwork cos I was a concreter over in Lincoln and I also had a concrete pump so I suggested we pump it in...to work in with the waffle system I think CO5 thought of it, CO1 took it, I produced it and it was just a happy meeting and we were all happy to work with each other. And CO1 always paid me on time so no major dramas” (C2)*

*“CO1 gave us this block of land and that footings was built for free. All the suppliers and contractors contributed to it so people were happy to put in as an industry but to give us access to that block of land for that period of time was just something that they did. So there was quite a bit of visionary in doing that. A long commitment type of thing...we did that work very thoroughly very diligently and that provided base information that I think nobody had ever had to give credibility to the design methods we were using” (C5)*

*“We did spend quite a bit of time so we did some researching...So once we got all that testing stuff we were doing engineering stuff for CO1 and they were quite keen to see the outcome of this because they could save money.... So they supported...they gave us a piece of land” (C6)*

*“So CO3 were keen to be behind us and have the rights and we had some sort of a contract with them” (C6)*

Even after the decision was made to create the innovation, a considerable amount of time was spent in the design and development of the waffle footing system. This was particularly important because not only were the participants simply importing an innovation to be implemented within their organisations, they were also implementing an innovation in which required designing and planning. This is an added layer of complexity which the innovator group has to undergo, which many organisations adopting prior developed innovations do not have to encounter. Therefore the participants were committing themselves to a high degree of uncertainty in the decision to create, develop and/or adapt the innovation and as raised by C3, perhaps a “highly revolutionary” move. The quotes above clearly demonstrate the different roles each participant within the innovator group played in the successful implementation of the waffle footing system.

### **Clarifying**

The clarifying stage occurs when an innovation has been implemented in a more widespread manner in an organisation (Rogers, 2003). Within the context of the waffle footing system innovation the clarifying stage involved the innovator group spreading and promoting the innovation to different tiers of players in the construction supply chain. Twenty-four stories were coded into the clarifying stage. Two key themes were identified in this clarifying stage of the innovation process including reducing uncertainty and the role of champions.

Given the newness of the waffle footing system, its implementation was surrounded by a high degree of uncertainty. The first theme revolved around the participants undertaking various activities and strategies aimed at reducing uncertainty of different players in the supply chain.

C5 highlighted a number of strategies which were used to diffuse the waffle footing system and reduce uncertainty amongst potential adopters including publishing and presenting at conferences to develop credibility and provide confidence to those who are considering adopting the innovation.

*“I presented at a 1987 MBA conference in Queensland and out of that came a whole string of contacts. Then I presented...at a local government conference in Perth and out of that building surveyors who check and approve building applications all came to learn about it... The key thing was doing it at different levels” (C5)*

Despite this, the analysis is consistent with past work into the innovation process which has highlighted that the management of the clarifying stage is often challenging and complex because misunderstandings and side-effects may occur. Within the context of the waffle footing system innovation, professional jealousy and overcoming mindsets and perceptions were highlighted by participants as key problems in the promotion of the innovation.

*“so the civil engineer wanted a raft footing system. So I said that’s ridiculous why not we turn around and use a waffle pod system? The engineer wouldn’t have it” (C2)*

*“So it was professional jealousy ... they [engineers] wouldn’t use it for a long time” (C3)*

*“The product might be terrific but sometimes it’s very, very hard to change mindsets no matter what industry, no matter what you’re doing. Because people are so used to their own practices, systems and whatever and it works” (C3)*

C3 in particular explained that he experienced a high degree of resistance and “head banging” in his efforts to promote the waffle footing system to engineers and footings/foundation contractors. According to him the resistance to adopt the waffle footing system was not related to technical issues but rather to do with “human nature”. For the engineers, adopting the waffle footing system was seen to be something that would benefit another engineering company whom they were in competition with and therefore these engineers saw nothing to be gained out of being in favour of the innovation. On the other hand, the foundation contractors perceived that the newness of the waffle footing innovation would equate to a degree of difficulty in having to change their existing practices and systems. For these contractors, the waffle footing system was out of their comfort zone and seen as simply “too hard” adopt.

The second theme is about the role of champions in the innovation process during the clarifying stage. An innovation champion may be viewed as “a charismatic individual who throws his or her weight behind an innovation, thus overcoming indifference or resistance that the new idea may provoke an organisation” (Rogers, 2003, p. 414). The management of the clarifying stage during the innovation stage was characterised by a high level of uncertainty. C1 took on a central role in explaining to those players meant to construct the waffle footing system to reduce uncertainty by running seminars and providing demonstrations:

*“I took the concrete gangs to COS’s offices ... and ran seminars on how to put a box together...cos I was determined and you have to champion that so you’ve got to just push that through like most things in innovation” (C1)*

In the case of the waffle footing system innovation, uncertainty existed not only in the minds of those outside the innovator group but also within the innovator group. As highlighted previously, the collaborative efforts between participants in the innovator group was key to the successful implementation of the waffle footing innovation. This collaboration, however,

was enabled through the efforts of C1, who played a central role in “negotiating my [his] supply chain”:

*“Well I was negotiating my supply chain to move from timber decks on bearers to concrete which means that they were getting 13 metres of concrete of job ....So wouldn't you make sure that you looked after us... And they did believe in this as well...because I think we had a good... ethical trading. We always try to fulfil our part to pay you on time... I mean you've got to look after these people” (C1)*

As indicated, there seemed to be mutual understanding and respect between players in the innovator group in the effort to implement the waffle footing system. The champion in this case, C1, ensured that the anticipated benefits for the group were clearly spelt out so that they would be more willing and committed to participate and contribute to the creation and implementation of the innovation. The credibility and “ethical trading” practice of the organisation was also seen to help in creating a degree of assurance in the group within an uncertain environment. Furthermore, C1 took great care in “looking after” the players in the group by paying appropriately, which C2 indicated was seen as particularly important for his organisation.

### **Routinising**

Twenty-six stories were identified from the interviews which were coded into the routinising stage. Two key themes were identified in this stage including drivers to widespread diffusion and re-inventions.

A number of key drivers led to the widespread adoption of the waffle footing system innovation. One of the primary drivers which C1 described as a “breakthrough” was approval gained from the relevant authority which deemed the waffle footing system as one which complied with the required codes and guidelines related to footing systems in Australia.

*“So that was the actual first system built... so the significance of it was that it was approved by the authority that had to approve footing systems and it was a breakthrough...So from that point it became accepted and we were pricing our land and house packages with it or when people came to us we could definitely give a fixed price... and then it started to be picked up by other builders” (C1)*

Obtaining approval was significant in that it demonstrated to the industry and more importantly it provided the assurance for others to be confident in their use of the waffle footing system. Following this, it was the adoption by a group of early adopters consisting large builders which drove the innovation and “went like wild fire”.

*“...all the competitors were using it. They saw CO1 were doing it, got the ball rolling and they thought why not. I think it took a few years [for that wave to happen] before they were gutsy enough to come into it” (C2)*

*“a couple of major builders thought it was a good idea and once they got on board it just went like wild fire” (C5)*

Sustainability is another concept closely related to routinising which has received considerable attention in recent years. It is defined as the degree to which the innovation continues to be used after initial adoption has occurred (Rogers, 2003). A number of factors have led to the sustainability of the waffle footing system innovation. C5 explained that specific events or characteristics of the industry at different times have helped to ensure the sustainability of the innovation. One example he provided is the ability of the polystyrene

component of the waffle footing system contribute towards achieving the current requirements for house energy ratings by the Building Code of Australia whereby:

*“waffle pod footing system, because of polystyrene in it, it’s worth 1-star out of six extra...So that at the moment is another thing that’s pushing the system” (C5)*

The second theme is concerned with re-inventions which were done on the waffle footing system. Consistent with the literature related to the innovation process which indicates that innovations tend to undergo adaptations and are continuously re-invented to suit changing organisational and environmental needs, the waffle footing system experienced a number of iterations. Of significance was the introduction of polystyrene boxes for a component of the waffle footing system to replace an earlier cardboard box. As with many developments, the use of polystyrene was seen as beneficial in a number of instances when compared to the cardboard boxes however was also disadvantaged due to its bulky nature and the difficulties associated with transporting the product.

A key issue which was raised by all participants in relation to re-inventions concerned the protection of intellectual property. As the system began to gain acceptance, the engineering firm, CO5, which developed the idea of the waffle footing system sought to protect their intellectual property by developing a patent on the system. The process which they eventually experienced was one fraught with difficulty and “a major stuff up” which was characterised by litigations and court cases. As C3 explained, a key player within the innovator group, CO4, which initially patented a plastic spacer which was a central component of the waffle footing system later attempted to patent the “improved waffle footing system” and claimed it as his own.

*“And once the system started to move then all this other junk started to develop...the people that had the spacers were saying that the royalties should come to them from the waffle pods. And the people who had to waffle pods were saying that the royalties should come to them...it was a major stuff up” (C3)*

At the same time, as the waffle footing system was gaining increased widespread uptake in the industry, more and more companies started to re-invent the innovation to market as their own product. C4 and C5 explained how these companies were infringing on their patents which led to a series of litigations and court cases between various parties:

*“well in Australia you can’t defend a patent...without being very rich because you’ve got to be able to go through with the legal stuff to defend it against the people who’re breaching it in small ways or even large ways” (C5)*

*“we were having court cases and this is people infringing on our patent...everybody tried to get around our spacer” (C4)*

While the court cases and litigations did not hinder the successful implementation of the waffle footing system innovation it does raise another important issue in relation to the protection of intellectual property for those who were central to its creation as highlighted by C6:

*“If anything Australia needs to do is change the system of patents because its not fair to someone like me who’s started off something that’s so popular that gets nothing out of it because of some crook” (C6)*

The lack of protection of intellectual property offered by the existing system of patents in Australia does not appear to be a conducive environment for innovative behaviour. There does not seem to be any incentive which rewards innovative behaviour. This is perhaps quite

a significant issue which needs to be considered particularly in an industry where the pace of innovation is low.

## CONCLUDING REMARKS AND FURTHER RESEARCH

This paper presented the preliminary findings of a case study of successful implementation of delivering an innovation to the Australian housing construction industry. It specifically explored the relevance of Rogers’ five stages of the innovation process for describing and explaining the successful implementation of an innovation in the housing construction innovation in Australia by an “innovator group”. Analysis revealed that the experiences of each participant within the innovator group resembled the conditions of the five stages of the innovation process, namely; agenda-setting, matching, redefining, clarifying and routinising. However the findings also demonstrated that the previously accepted broad classification of “innovators” does not capture the specific characteristics of those case study participants in the innovator group observed in this research. Furthermore not only was the success of the implementation of the waffle footing system reliant upon one champion from one organisation, it was also driven by the collaborative efforts of various participants or champions from a number of organisations within the innovator group, each contributing at different stages of the creation, development and adaptation of the innovation. One of the most significant findings of this research has been an identification of different types of innovators which include; innovator-creator, innovator-developer and innovator-adapter. The next stage of the analysis will involve a detailed identification of the unique characteristics of the pathways for the innovator group for innovation creation, development and implementation.

## APPENDIX

Table 3: Barriers and enablers to creation, development and adaptation of the waffle footing system innovation

	C1	C2	C3	C4	C5	C6
<b>Barriers</b>	Lack of organisation support					
		<b>Professional jealousy</b>	<b>Professional jealousy</b>			
		Mindsets/perceptions	Mindsets/perceptions			
			<b>Litigations</b>	<b>Infringements &amp; difficulties in protection of intellectual property</b>	<b>Infringements &amp; difficulties in protection of intellectual property</b>	<b>Infringements &amp; difficulties in protection of intellectual property</b>
		Misuse of system doesn't result in benefits	Misuse of system doesn't result in benefits			
					Absence of specific supply chain player: manufacturer	

<b>Enablers</b>	Role of champions	Role of champions			Role of champions	Role of champions
	Firm organisational culture & support for innovation				Firm organisational culture & support for innovation	Firm organisational culture & support for innovation
	<b>Supply chain integration</b>	<b>Supply chain integration</b>	<b>Supply chain integration</b>		<b>Supply chain integration</b>	<b>Supply chain integration</b>
		Clear demonstration of benefits associated with system			Clear demonstration of benefits associated with system	
					Suitability of innovation to specific conditions of the industry	

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