

Procuring radical waste-reducing innovations in entrepreneurial New Zealand construction SMEs.

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Abstract Traditionally the construction industry in New Zealand and in other countries has seen a low productivity and a low track record for successful sustainable innovations. This has a negative impact on private and government spending, on quality and on health and environmental aspects. This research proposal posits that the construction industry needs disruptive (discontinuous, radical) technology innovations to be able to make drastic improvements. Such innovations often come from entrepreneurial small firms from outside the industry or at the beginning of supply chains and must be procured and adopted into such chains. This PhD proposal focuses on procurement activities of such firms in the New Zealand construction industry when they conduct disruptive waste-reducing innovations. These procurement activities must be aligned with (internal and external) innovation activities for an optimal firm performance. This performance is moderated by four clusters of internal and external variables.

This PhD research proposal is structured as follows. It starts with an introduction and a conceptual framework. Paragraph 2 gives the rationale and significance of this research. Next, paragraph 3 discusses the theoretical perspective and the related unit of analysis. This proposal uses the Resource-Based View (RBV) and the Resource-Dependency Theory (RDT) perspective; it hence has the small firm and its (external and internal) procurement activities as unit of analysis. Paragraph 4 discusses the key concepts that emerged from a first literature review. Paragraph 5 gives working hypotheses, the current research design and methodology. Paragraph 6 gives activities and results to date. Paragraph 7 give conclusions and the way forward. Several appendices give background information.

The heart of the empirical research will consist of two rounds of case studies with four Delphi-type studies. The PhD proposal will be finalised and submitted in May 2014. Articles are planned for refereed journals. The PhD thesis will be submitted in August 2016.

Key words: Procurement; disruptive (radical, discontinuous) technology innovations; entrepreneurs; waste-reduction; small firms / SMEs; construction industry; New Zealand.

1. Introduction to the research subject and the conceptual framework

The New Zealand building & construction industry (*in short*: construction industry) designs, builds and maintains houses and other types of buildings, and accounts for approx. 4% of the New Zealand GDP. Its 178,000 employees account for approx. 10% of the nations' workforce (Page 2013a). The economic activity related to GDP is lower than in other developed countries (e.g. AU, UK, US; Building a Better Future, 2013). Construction industries consist of a small number of large main-contractors, a moderate number of mid-sized main contractors, a large number of small firms (10-99 employees) and an impressive number of micro firms (1 – 9 employees). The small and micro firms often act as subcontractors, or as suppliers of components, materials or services.

In New Zealand and other countries this industry faces *productivity issues* (Anderson, 2012; see also Bossink, 2009; Fairweather et al., 2009; Benton, 2010) which affects product quality and private and government spending. Moreover this industry in general is *environmentally unsustainable* (Europe: EIPRO, 2006; IMPRO 2008; US: DOE, 2009) as building activities e.g. cause waste and as building and occupancy activities are e.g. very energy-inefficient and cause physical waste and large CO2 emissions.

Firms operating in construction supply chains often experience fierce competition and bidding for contracts is often done on a lowest-cost basis and with adversarial relationships (Hinton, 2013; Benton, 2010; Morledge, 2006). This probably (see Figure 1, adapted from Pryke, p. 2) is especially the case for the 3rd and 2nd tier suppliers as 1st tier suppliers (Hinton, *ibid*; Vrijhoef, 2011; Vilasini, 2012) have more possibilities for alliances. The smaller dashed oval in Figure 1 indicates the primary research area; the larger dashed oval the wider research area.

Construction supply chains (e.g. Vrijhoef, *ibid*) are characterised by (1) make-to-order delivery, (2) unique projects and on-site production, (3) either with involved and educated clients (for a small number of large projects) or un-educated clients (for a large number of small projects), and with (4) complex relationships and exchange mechanisms. Due to this project nature

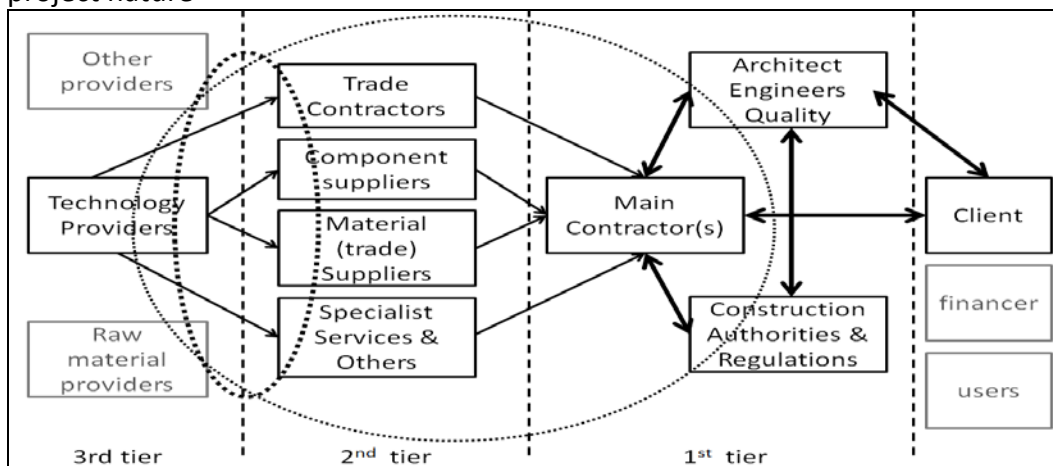


Figure 1: Main entities in a construction supply chain. The research areas are indicated by the two dashed ovals¹

direct comparisons with manufacturing supply chains for improvement purposes have a limited relevance (Benton, 2010; Pryke, 2009). Problems in construction projects could also appear in other project-based work. In her PhD thesis on two major project management approaches (Prince2 and PMBoK) Mulder (2012) found that failing (IT-) projects lack e.g. in aspects of value, trust, social, creation and motivation.

Most construction supply chains are highly fragmented with temporary contractual relationships and some argue that “construction supply chain integration may be an elusive goal” (Briscoe and Dainty, 2005), i.e. due to this high fragmentation level. This has an adverse impact on productivity and sustainability (e.g. Fairweather et al., 2009; Sheffer, 2010, 2013). The past decades have seen government and industry initiatives and research to understand and to improve the *construction industry productivity*. Construction supply chains have started using advanced process improvements techniques such as lean technologies (see e.g.

¹ Here *trade contractors* are e.g. plumbers, carpenters; *component suppliers* do supply systems (e.g. window facades or other off-site manufactured structures); *material or trade suppliers* do provide commodities (bricks, nails, cladding material); *specialist services or others* do supply secondary material (e.g. tooling) or a range of services. *Technology* may range from tangible products (machinery) or intangible products (competencies / technology know-how).

Barker, 2006). The industry also increasingly experiments with supply chain integration². The last decade has also seen such initiatives and research to understand and improve *sustainability in the construction industry*³. International reports (UK, NL, and EU) and a recent New Zealand BRANZ report (Page and Curtis 2012; p. 5) mentioned productivity improvement targets of 20%. Internationally there are equally large targets on increasing sustainability. The IMPRO report (2008; p. 99) e.g. mentioned that an emission reduction of 30 – 50% of greenhouse gases over the next 40 years would be possible. Currently the New Zealand Waste Minimisation Act 2008 (see the e.g. websites REBRI and WasteMINZ) does not pose such targets. Future New Zealand governments however could pose such targets on the construction industry.

Improving in construction is not a new theme. Agren and Wing (2013) mention a history of improvements over the last 250 years. De Valance (2010) mentioned early research of Rosefielde and Mills from 1979 on innovation in the construction industry. In the UK the

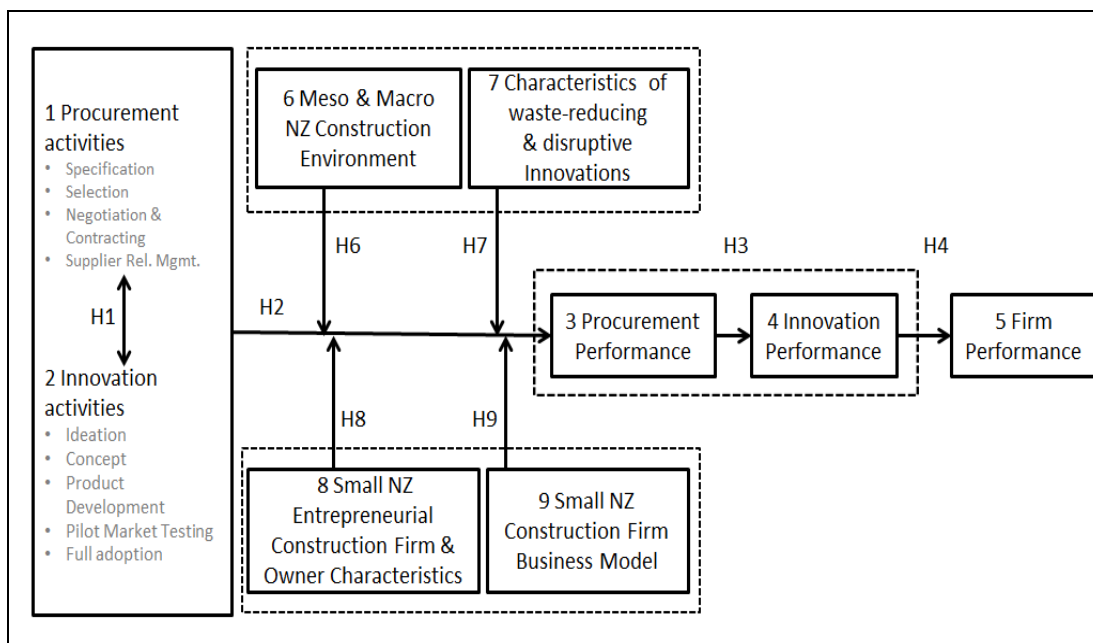


Figure 2: Conceptual framework for this PhD research

Latham report (1994) and the Elgan report (2002) both discussed the need to stimulate innovations. The US has seen similar government studies (see Benton, 2010) stressing the need for innovation. This PhD research will address *disruptive (radical, discontinuous)* innovations⁴ from the perspective of New Zealand construction firms who struggle and sometimes succeed in procuring (*acquiring, purchasing, getting access to*) and selling new technologies and processes. More specifically this research focusses on the following research question:

What is the role of procurement in small entrepreneurial New Zealand construction firms on successful waste-reducing disruptive technology innovations?

The PhD research will use a systems approach (Checkland 2000; for an introduction see French, 1995, p. 89-94). It sees the small firm holistically as a system consisting of several

² For productivity examples in NZ see BRANZ (2010), Green Building Council and Buildingvalue.NZ (2012); in AU see BRITE; in the UK see GCS (2012); in NL see Chain Integration AFNL (2010).

³ For sustainable examples in NZ see BRANZ/REBRI; in NL see Bossink (2007), Bos (2010); in AU see the BRITE and SBENRC programmes, e.g. by Manley (2007-2013); in the US see Kibert (2005), McCoy (2012), (Sheffer (2010, 2013)

⁴ Currently this proposal uses a broad negative definition: such innovations are *non-incremental*.

functional sub-systems (ibid, p. 13). Within this system the sub systems and human beings involved have with complex and confusing interactions in ill-defined situations. Checkland (ibid, p. 17) call such a system a 'soft system' as opposed to a 'hard system' with well-defined situations and relationships. (See also page 15 of this proposal).

The conceptual framework in Figure 2 (page 4; also called *analytical framework*⁵) is a graphic representation of the concepts related to the research question. In this proposal a *concept* is seen as a cluster of several relevant and related *variables*.

The framework shows two independent concepts of procurement activities (1) and innovation activities (2) of the small entrepreneurial New Zealand construction firm. The small firm performance (5) is the final dependant concept and is indirectly influenced by the intervening concepts procurement performance (3) and Innovation performance (4). These two intervening concepts are affected by four moderating concepts (6, 7, 8 and 9). These moderating concepts describe the environment (6), the characteristics of the innovation (7), of the owner and the firm (8), and of the firm's business model (9).

This framework systematically helps (Berman and Smyth, 2013) explaining the scope and direction of the research. It delimits the concepts and gives guidance for the extensive (2nd round of) literature review and for the empirical research. At the same time the concepts need clear definitions and some decisions⁶.

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2. Rationale and significance of this research

2.1 The context - Where, Who and What

As discussed above, productivity improvement in construction is generally reported as being slow and reducing its environmental impact is probably even slower. This places a burden for industry and society but also brings huge improvement and business opportunities. This PhD research is embedded within the domain of the New Zealand construction industry and is industry-sponsored for conducting research on waste-reduction within the industry. The proposal hence focuses on New Zealand with a limited cross-country comparison.

The earlier mentioned EIPRO study (2006, p. 16) indicated that occupancy activities of buildings make up between 20% and 35% of the environmental impact in most impact categories⁷. This is in line with the conclusion of the UN Environmental Programme (2010) that construction industries are responsible for:

⁵ For example by Jankowicz (2005 p. 184). This proposal uses terminology of Verschuren and Doorewaard (2010).

⁶ E.g. whether the *firm performance* is only financial or also delivers value to other stakeholders. (See paragraph 4.2). Or whether innovations are defined broadly as *non-incremental* or more narrowly as *radical/integral* (See e.g. Figure 3).

⁷ Impact categories are e.g. energy, waste, land use, smog, use of raw materials. See IMPRO, p. 21; EIPRO p. 13.

- 40% of annual natural resource consumption
- 30% of energy consumption
- 30% of CO₂, greenhouse gas emissions
- 25% of all timber use.

This proposal will investigate how these UN numbers relate to the New Zealand situation. The New Zealand construction demolition waste (MBIE, 2007) could account for up to 50% of the national amount of waste. An unpublished PhD research proposal (Van Tran, 2013, p. 1-2) studied international and New Zealand reports on physical construction waste and its negative impact. The proposal concluded that despite New Zealand industry efforts (see e.g. <http://www.branz.co.nz/REBRI>) so far the New Zealand performance has not improved between 1997 and 2013.

This PhD proposal posits that if the New Zealand construction industry wants to meet current ambitious productivity and (current & future) sustainability targets the industry must take drastic steps. Gradual improvements certainly help and must be continued but there is also a need for timely and *successful disruptive construction innovations*. (For definitions see Chapter 3).

The New Zealand construction industry has been conducting improvement activities for a couple of decades and progress so far has been slow as e.g. indicated by the report Building a Better New Zealand (2013, p. 2-3) and before that e.g. by Fairweather et al. (2009). Hence the industry identified a number of research activities as e.g. described in the Sustainable Built Environment Research report (SBER). This report from the New Zealand Green Building Council (2012) focused on industry (macro and meso level) and general client aspects and on non-commercial aspects. This research proposal however focuses on a micro-level with commercial aspects and hence the SBER report is not relevant. However, the report Building a Better New Zealand (2013) indicated a number of interesting research topics. For a part these topics relate to transactional *first-order changes* i.e. trying to improve within the current paradigm (Argyris and Schon, 1996). However a number of the identified research topics *also* relate to transformational *second-order changes*:

- *How can New Zealand develop better ways to ventilate homes that are more energy efficient and target moisture more directly? (page 11)*
- *What new materials can be developed to improve building performance by enhancing or replacing existing materials? (page 13)*
- *How might application of new technologies improve sustainability in new and existing New Zealand buildings? (page 17).*
- *What emerging technologies (offshore, onshore, within the industry, external) may have application in the building and construction sector? (page 19)*
- *How can these technologies be developed for application in the building and construction sector? (page 19)*
- *How can the construction industry capitalise on export opportunities, in terms of both products and knowledge? (page 21)*
- *What is the potential role for new and existing technologies to increase productivity? What can we learn from overseas about these technologies? (page 23)*

Such second-order changes will take a long time to diffuse in the industry, will need active and entrepreneurial management and a systems approach with multiple stakeholders. These kind of topic form the context of this PhD research proposal and hence the results of this PhD research could contribute to solving these topics.

This PhD proposal focuses on *technology (product) innovation* and not on resultant *process* innovations. Such technology innovation may either emerge from the need to realize such

process innovations downstream (demand chain thinking; technology pull) or from the focal company or suppliers upstream (supply chain thinking: technology push). Such technology innovations could be used downstream to drastically improve processes or change business models. Hence the BIM software package e.g. was a disruptive technology innovation but its implementation is a process innovation.

In this context this PhD research will not investigate rare (once-in-a-lifetime) transformational innovations as Agren and Wing (2013, p. 2-4) identified over the last 250 years on prefabrication, sub-assembly, industrialisation, and open systems. Therefore this research proposal will not focus on e.g. 3D printing in the building industry, the more as this yet is merely an invention and not an innovation⁸ with a business model. However, there is a thin line as e.g. a number of articles in the journal of Environmental Innovation and Societal Transitions (EIST) describe innovations that could in principle be subject of this research. Sustainable technology construction *innovations* are available (Altwies, 2012; Brochner, 2013; Kilbert, 2005; Noailly, 2010; Sheffer, 2010). The same holds for general construction *inventions* as a preliminary patent search (see paragraph 6.1) for this research proposal revealed. An example of such sustainable innovation is the (patented) recycling technology of gypsum board as described in Appendix VIII. Altwies (ibid) describes an example of patented energy management systems in buildings. Such technologies are either developed in-house or via innovative suppliers, or come from outside the industry (Philips, 2004; Calvi, 2011; see also below on procurement).

Two decades ago the European Union saw waste-reduction in the construction industry as a priority due to its high volume and improvement potential (Coronada 2011). This led to several European research programs and best practices which need to be studied in more detail for this proposal.

Following Bos (2010, p. 18) this proposal currently defines a *waste-reducing technology innovation* as delivering a short-term and long-term improved performance in *economic, social and environmental* terms related to waste-reduction. Generating such innovations and successfully bringing such innovations to a market is a management and business process (Davidson, 2013, p. 344). In the context of this research proposal the technology innovation itself is seen as a driver, and the process of managing the innovation as an enabler.

This research hence has a business and management focus and will see such technology innovations as context. It focuses on ambitious *entrepreneurial small firms* (Burns, 2001) who could have a potential of high growth (see OECD, 2010b, p. 9; Zortea, 2012) with their disrupting innovating activities. These firms can be game-changers and create new markets and products (See also paragraph 3.1).

The paragraph continues to discuss the balance of uncertainty and rewards with innovations, the need for innovation, the role of procurement and the open innovation concept. It describes the relevance of this research from an academic and a business perspective.

2.2 Relevance of innovation

In general innovations (see OECD, 2010a) are needed for increases in productivity and profits. However innovations have failure rates that increase with the level of newness and risks involved. A study from the consultancy firm Accenture (2013) indicated that incremental innovations will bring fewer rewards. Disruptive innovations being more risky (uncertain) can bring high levels of rewards. [will add example of failure rates & costs]. As in other countries and for a number of reasons the New Zealand construction industry is risk averse [add source

⁸ Here an *invention* is seen as a first phase of an innovation, without a business model or successful diffusion.

and examples] and as a consequence the industry might be more prone to incremental innovations.

From the above discussion and examples it is clear that *innovation* is a broad concept with conflicting sub-types and definitions (see e.g. Abbott and Jeong, 2006, p. 191). A working definition of an innovation would be *any non-obvious improvement leading to increased performance*⁹. A comprehensive set of definitions will be added in a later phase of this research. As a precursor Figure 5 shows a typology distinguishing (Slaughter, 2000; as used in Fairweather et al., 2009) between the change in the technological concepts and the organisational changes or network changes. In *italics* different terms by Sheffer (2013) and Koebel (2008) have been added. The innovation risk is low *bottom left* and high *top right*. Disruptive technology innovations in the construction industry have been the subject of a limited number of studies. The aspect of diffusion of e.g. energy-saving innovations has been studied in a PhD study by Sheffer (2010). She found the same aspects of construction supply chains as e.g. mentioned by Vrijhoef and concluded (Sheffer, 2013) that modular innovations diffuse slow and integral innovations even slower. This is in line with e.g. Fairweather et al. (2009) that disruptive innovations are more difficult to manage, than incremental innovations.

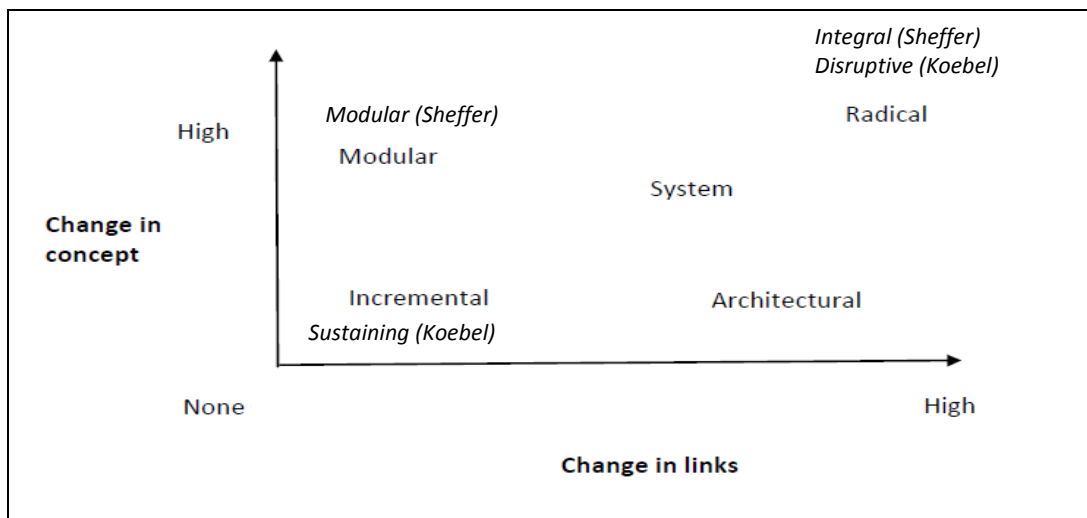


Figure 5: Construction innovation typology according to Slaughter. Added in *italics* terms of Sheffer and Koebel

There is a fair amount of research on incremental innovation within the construction industry (Manley, Hardie, McCoy, etc.) which will be discussed in a later phase of this research. There is some recent research in the field of energy-saving incremental (modular) and radical (integral) innovations (e.g. Sheffer). There is only some research on (sustainable) innovations within small construction firms (see e.g. Abbott, 2006; Fairweather et al., 2009, p. 7-15; Hardie, 2013; and Manley, 2006, 2008). Generally however there is only *indirect and partly conflicting* research on management and success of disruptive technology innovations within small construction firms. This research has as yet not found such relevant literature on waste-reduction. [Will be exemplified in the second round of literature review].

Extant established research studied so far suggests a *paradox* in that successful waste-reducing disruptive innovations can help direct stakeholders in the construction industry (firms, employees and customers, users), and indirect stakeholders in the environment

⁹ See also paragraph 4.6

(planet) and in society (people), but that it is as yet unclear *how* to realize successful diffusion of such innovations in the construction industry.

2.3 *Relevance of procurement*

Although sometimes neglected in main-stream literature on sources of innovations (see e.g. Fontana, 2012; Hulbert, 2013) innovations are often established by suppliers or co-created with suppliers. There is a large body of established procurement research on the role of *procurement within acquiring innovations* (for overviews see e.g. Calvi, 2011; Picaud, 2013; Pulles 2012; Schiele 2009; Van der Vrande 2011; the CAPS report of Monczka, 2011). From this theory it appears that the boundary-spanning business function of procurement has an important role in discovering, developing and managing such suppliers, whether they are current suppliers or potential suppliers. However, this body of research mainly discusses the role of procurement with innovations in larger firms.

Furthermore, a wide body of research describes the role of procurement in the construction industry (see the special edition of *Journal of Purchasing & Supply Management*, 2010; see e.g. also PhD theses of Bemelmans, 2012, Hinton, 2013, and Vrijhoef, 2011) but do seldom relate this to small firms procurement within the construction industry. Although small firm procurement is different from large firm procurement, in fact most research and industry best-practices on procurement in general appear to relate to large firms. (For an overview of differences see Hagelaar et al., 2014; Morrissey, 2011). Nevertheless, small firms have an important contribution to the economy (OECD, 2010ab), they are also “dominant” (Koebel, 1999) in numbers and economic output, and construction and procurement plays an important role within small firms (see e.g. Quayle, 2002; Paik, 2009). The procurement function within the small firm may be operated by the owner and one or more professionals, depending on the owner's characteristics and ambition and the complexity and uncertainty (risk) of the purchase (Hagelaar et al., *ibid*).

Extant established research is appearing on procurement within small firms (for an overview see e.g. Morrissey, *ibid*) but as yet there is *no relevant research* on the role of procurement in small construction firms.

2.4 *Relevance of open innovation*

The last decade has seen a wide body of *open innovation research*¹⁰ (e.g. Chesbrough, 2006) discussing how to acquire and manage innovations with supplying partners or customers or in networks. Chesbrough defined this as “the use of purposive *inflows* and *outflows* of knowledge to accelerate *internal* innovation and to expand the markets for *external* use of innovation, respectively” (italics added). This body of research increasingly discusses open innovations within small firms (see e.g. PhD thesis Pullen 2010; see e.g. Van de Vrande, 2009; Verreynne, 2007) and is relevant to this research proposal. In a literature review Schroll and Mild (2012) investigated current research on open innovation and concluded that the adoption of the concept is increasing but that not all firms use this concept. Moreover, there is also research that suggests that a closed innovation model (or less open innovation) will yield better results (e.g. Knudsen and Mortensen, 2010). This research proposal posits that the inbound part of open innovation concept could be too *limited* for this PhD research as procurement could also play a role within more closed innovations. As yet no open innovation research has been found on small construction firms nor on waste-reduction.

¹⁰ A synonym is *distributed innovation* (Schroll and Mild, 2012). Related terms are *supplier innovation*, *user innovation*.

Extant established research studied so far indirectly but strongly suggests that (some degree of) open innovation within small construction firms will help innovation performance. However, it is unclear *how* this can be realised.

2.5 In conclusion & who will benefit

There is evidence that successful innovations will increase firm profit, and furthermore there is evidence that procurement in open innovations plays an important role in innovations. Extant research and best-practices on sustainable innovations and on the contribution of procurement in construction firms show different, fragmented and conflicting success factors and barriers. The literature review so far found no relevant research in the context of entrepreneurial small New Zealand construction firms. It is important to better understand the relationship between procurement and innovation activities (with several moderating variables) on the performance in such firms. This understanding will then help in improving such performance.

Therefore this PhD research wants to learn what the role is of procurement in successful disruptive waste-reducing technology innovations in small entrepreneurial New Zealand construction firms.

Seeing the challenges and opportunities there is a need to solve the knowledge gap. This will be beneficial to the innovating construction firms and their business partners, to owners and occupants of buildings, and to the wider environment. Hence this PhD research has a scientific relevance, a business relevance and a social relevance.

3. On theoretical perspectives and quality, the unit of analysis

The previous paragraph discussed the rationale and significance for the research proposal. This paragraph discusses the theoretical perspective (lens) that guides this proposal and motivates the choice for the unit of analysis.

3.1 Theoretical perspective and research quality

The objective of this research is to understand the relationship between innovation and procurement activities and their impact on firm performance. Hence this research follows a Resource-Based View (RBV) perspective. However as the small firm acts within a network of other firms and as the wider environment impacts the firms' activities and performance, this research will also use Resource-Dependency Theory (RDT) (see e.g. Chicksand, 2011, p. 461-462). This implies that this PhD research will focus and limit on aspects in line with these two theories. Nevertheless the perspective may need to shift or widen when limitations or contradictions appear in the empirical phase of this research.

Research in a business environment and hence this research proposal deals with social constructs which are essentially based on generally accepted theories (Kuhn (1922-1996) as cited in Engeldorp Gastelaars, 1998, p. 14). This PhD research wants to add and test new theory based on a review of current theories and based on subsequent empirical research. Constructs from e.g. science and mathematics research deal with objective axioms and can be theorized in a positivistic manner. Such approach implies a strict separation of the researcher and his research subject and has brought great advantages in technology and science and to society in general.

Constructs in business research however are more context-based and must be *interpreted* (what Weber (1865-1920) coined as "Verstehen"). This entails a more constructivist approach which needs a close interaction of the researcher and his research objects (Delnooz, 2008; p.

68). This close interaction can entail *action research* (Lewin, 1948) where the researcher is participating (intervening) in the business practices in order to bring change. In *inclusive or collaborative research* business practitioners can discuss and build theory with the researcher. This has as advantage that business relevance increases and that the researcher can quicker reach to conclusions on the state of the research. (See Chen et al, 2013 for a recent review on collaborative research). Analysing trends in research methods in procurement Spina et al. (2013, p. 7) found that this type of research “appear to be quite under-exploited” when related to other areas of management studies and believes that this type of research “has proven to be effective in other disciplines” (ibid, p. 10). This research intends to use these research methods (see paragraph 5.3).

Such correct *interpretations* as mentioned above are useful as they help to explain and improve a certain business situation (Delnooz, ibid) to solve practical problems. When a research area is new - as in this PhD proposal - establishing correct interpretations may take some time. During the three year period of this PhD every piece of new theory must be falsified (Popper, 1902-1994) so that there is proof beyond reasonable doubt that indeed all swans are white and that there is no black swan. This is quite an audacious task to prove worldwide. This is even more so as I am *theory-loaded* with industry and teaching experience which may *not* be a blessing in disguise. This is what Hinton (2013; p. 9) in his PhD study described as pre-understanding and is related to the field of hermeneutics.

This PhD research is successful if it can provide and test new (logical) theory within the context of the (New Zealand) construction industry and discovers no local black swans. Hence I seek a constant discussion with peers and practitioners, use thorough research methodologies and use and assess PhD theses and articles from established journals.

3.2 Unit of analysis: the small entrepreneurial firm

In a relevant BRANZ study Fairweather et al. (2009, p. 9-21) distinguished three levels of units of analysis: (1) on a micro level the individual inventor, innovator, or entrepreneur (e.g. Koebel, 1999), (2) on a meso level the firm with the external environment (e.g. Toole, 1994; Koebel and Cavel, 2006), and (3) on a macro level on networks or social systems (e.g. Binder, 2008; Geels and Schot, 2007; Hassel et al 2003). This research proposal focuses on the firm level as it sees the firm as an important factor in the (networked!) construction industry.

The *small entrepreneurial New Zealand construction firm* conducting procurement and innovation activities is the unit of analysis of this research and acts as an ambitious boundary spanner (pivotal point, linking pin) for acquiring and introducing innovations *into* construction supply chains (see e.g. Gambatese, 2011, p. 508).

The OECD (2010b, p. 33) proposed the following definition: “Entrepreneurs are those persons (business owners) who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes or markets.”

This includes characteristics of *pro-active to innovation and risk, competitive aggressiveness, autonomy opportunity recognition, growth ambitions, and organisational learning* (based on Zortea, 2012, p. 147-148) to which this proposal adds *a longer term vision on how to achieve this growth* (Burns, 2001). This *high-growth entrepreneurial* approach will be a temporary transition phase in the life of a firm (see OECD, 2010a; p. 9).

This paragraph will now discuss the segmentation choice on the firm level.

In New Zealand 99.5% of the total firm population (that is 140.000 firms) have less than 99 employees (OECD, 2010a, p. 87). Micro firms form a very large proportion (93.3%) and have 1–9 employees; the small firms (6.3%) have 10-99 employees. These small firms employ 36.4% of the New Zealand work force.

New Zealand constructing firms are somewhat smaller than average New Zealand firms. This research focuses on *sub-contracting firms* with 10 – 99 employees as indicated with the two dashed rectangles in Figure 6. This type of small firm is approximately 30% of the total of New Zealand subcontractor firms. (Source: Page, 2013a, p. 16-17). Additionally and in line with Figure 1 this research also focuses on *firms mainly supplying materials or components, and specialist service providers*, which are not included in the data of Figure 4. (See also De Valance (n.d.) on a broader perspective of the industry).

In New Zealand ‘small firms’ are smaller than in most other developed countries (OECD, 2010a, p. 47). In fact the word *small* in this proposal relates more to European or American standards, as in New Zealand a firm size between 50 – 99 employees would often be called *medium*. In a New Zealand context SMEs have less than 100 employees; in Europe and Japan less than 250 employees; in Canada and the US less than 500 employees. This research will however use the term *small firms* for firms of 10–99 employees for better international comparison.

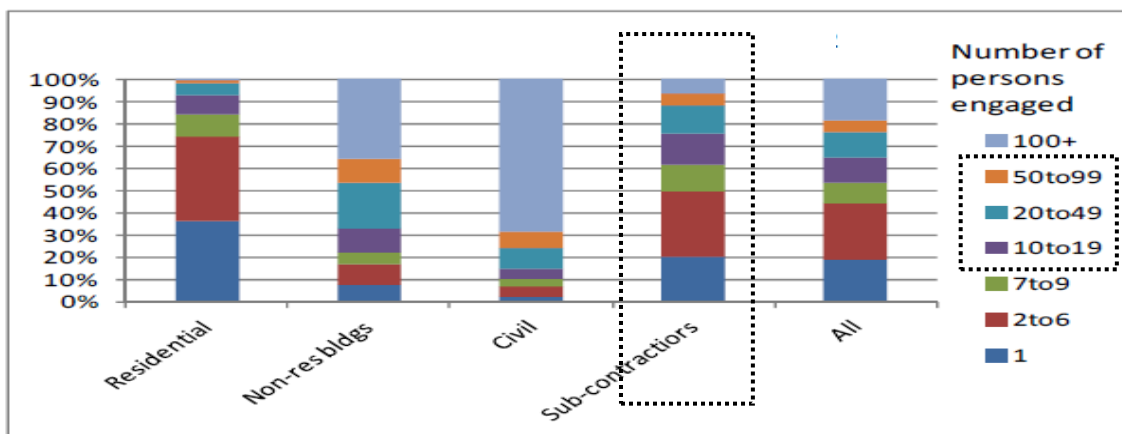


Figure 6: Construction firm size breakdown in New Zealand (data from 2012)

This research proposal currently *excludes* firms up to 9 employees as probably no functionally separated innovation and procurement activities can be discerned (in line with the reasoning of Greiner on life-cycle of companies). It also currently *excludes* firms with more than 100 employees as (a) in the New Zealand context they will probably behave as large firms, and (b) the theory of innovation and procurement activities for such firms has already been developed to a certain extent (see paragraph 2). Although Koebel and Cavel (2006) as cited in Fairweather (2009, p. 14) concluded otherwise, it is expected that these large (and more mature) firms have a less distinct entrepreneurial and innovative approach. This is supported by an OECD report (2010b, p. 16) that found that “a few highly innovative and high-growth potential small firms are more active in breakthrough innovations” [i.e. than larger firms] “not just as knowledge exploiters but also as knowledge sources”. Others however [add source!] see no clear relationship between size and entrepreneurial behaviour. Such high-growth firms are present both in low-technology and high-technology sectors (OECD, *ibid*, p. 29).

A study among Dutch SMEs (Keijzer and Bos; 2006; p. 28) mentioned that roughly 2.5% of small firms can be considered an innovative front-runner (conducting own R&D) and another 28% as an innovation developer (adopting R&D results and technologies). This Dutch study concludes that almost 60% of the Dutch small firms do not have innovation as a part of their mode of business, and this could also hold true for the New Zealand situation. A recent BRANZ survey (Page, 2013; p. 8) among 500 small New Zealand construction firms indicate

these firms see a wide range of important *incremental* savings potentials within their firms. In line with other research (see e.g. Oke et al., 2007; Zortea, *ibid*) it is understandable that such firms did not mention more drastic innovation measures related to new technology, as incremental improvements are probably more profitable (Oke, *ibid*) and less risky (see e.g. Tidd and Bessant, 2009). Following this reasoning, more drastic innovations will probably not be on their radar screen, or the few firms that are engaged in such innovations did not appear from the survey data. However this is e.g. contrary to what Baumol (2002) found: small firms often work outside dominant paradigms and can create breakthrough innovations (cited in OECD, 2010a, p. 35).

Clearly not all small firms have growth ambitions. Burns (2001) distinguished between *lifestyle* firms (owners want a secure level of income, and non-financial benefits as independence) and *entrepreneurs* (owners seek growth and increased profitability). Morrissey (2011) mentioned *survivors* as a third category (owners trying to remain in business). Probably only a minority of small firms can be considered as having a sustained entrepreneurial orientation. Furthermore, not all New Zealand entrepreneurs create growth. In a quantitative international comparison of entrepreneurship and performance Frederik and Mosen (2011; p. 202) concluded *inter alia* that “current Kiwi *entrepreneurial disequilibrium* of high entrepreneurial activity but lower economic development comes from a singular constellations of events that disfavour *creative destruction* in the Schumpeterian sense” (italics from the authors). They found that several marco factors and the lack of adequate governmental interventions hindered the creation of wealth from entrepreneurial activities, e.g. but instead “favoured lifestyle ventures that promote independence and satisfaction” (p 201). The OECD study (2010b; p. 24) confirmed that high-growth enterprises account for two to eight per cent of the total firm population. The parallel OECD multi-country study (2010a, p. 115) only found that Swiss construction firms *can* show high-growth numbers, and create wealth and jobs.

This research proposal focuses on a set of ambitious innovative firms (Zortea, 2012) that have *both* an *entrepreneurial perspective* (when trying to define new markets and products) and a *marketing perspective* (when trying to adhere to the needs of customers). This is a relative measure that will have to be defined. The technology of such firms would cause process innovations or changes in business models with customers downstream.

Following Zortea (*ibid*, p. 157) such firms are more likely to use disruptive innovations. Moreover this proposal suggests that these firms will be high or medium tech, apply for patents or use or combine new technology from outside the industry (Fairweather et al., 2009; Gambatese, 2011). These firms would also have higher profits: a recent European study (add source) mentioned an overall profit margin of 12% instead of the conventional 5%. It is difficult to estimate the exact number of these firms within the context of the New Zealand construction industry. However, there are indications that profits with New Zealand firms (Building Value, Shamubeel Equb, 2010) vary considerably.

Concluding: Small firms consist of a wide array of firms with different innovation activities and ambitions. For this PhD proposal only a small set is relevant. Also considering a patent search conducted for this research (see paragraph 6.1) the number of innovative construction firms could be 50, or even smaller. Limiting this further to *waste-reduction* could result in a small dataset that may pose methodological challenges¹¹.

¹¹ Data could come from Kompass.NZ, via BRANZ and New Zealand waste-reduction associations (like Waste-Minz), via surveys of architecture and engineering firms, via surveys of procurement departments of (larger) main constructors, and from patent data. A good purposeful case study selection in the target domain (Swanborn, 2013, p. 71) could be an issue. Gambatese (2011, p. 509) e.g. indicated that firms may not want to share information via case studies or focus groups.

4. Definition of key concepts and working definitions from literature

In line with the conceptual framework of Figure 2 (page 4) this proposal continues to describe the five main variables (in the concepts) and the four moderating variables (in the concepts)¹². It starts with the two independent combined variables. As relevant literature often has an overlap over more than one variable, the proposal discusses the remaining variables in combinations. In Figure 2 this is indicated by the dashed-type rectangulars. [In a later phase this research will narrowly define the key concepts].

4.1 Main independent variables: Procurement Activities (1), and Innovation Activities (2)

This paragraph builds on material presented in paragraph 2. Considering the holistic management style of the owner of the small firm (see Hagelaar et al., 2014) the procurement activities and the innovation activities will be conducted in an informal manner with informal interaction between key functionaries (persons and functions) within the small firm. This differs from similar activities within large firms where interaction would take place between functional departments and organized in projects or via line management.

In line with open system thinking (see p. 5) the small firm *procures (acquires, gets access to)* technology innovations (i.e. capabilities or capacities) which it then *transforms* into products, systems or services for customers downstream. On a sliding scale (e.g. Schroll and Mild, 2012) this can be done in an open innovation (collaborative) versus a closed (independent) innovation mode.

There is a time lag between identifying potential ideas (ideation) and success of the innovation (adoption) in the market. Literature sees several methods to classify the several steps from idea to success in the market (see e.g. Cooper in Tidd and Bessant, 2009, p. 314; see Trott, p. 440-441; Rogers, 2003). This research will yet in more detail have to study these steps, keeping in mind the informal and iterative innovation process within small firms and with external stakeholders. Also, the risk of failure costs will increase after each step in bringing the innovation towards the market (see e.g. Osawa & Miyazaki, 2006). As a preliminary model this proposal follows a general classification (Tidd and Bessant, *ibid*) with the following steps: *ideation, concept, development of product, first use in market, commercial (full) use in market*. Although a generally used classification (e.g. by Songip, 2013) this research must consider other typologies in a later phase as e.g. Fairweather (2009, p. 10) shed some doubts over its usefulness, especially with complex innovations.

Procurement itself is a relative new research area within small firms and does not proceed within small firms as it does within larger firms (Ramsey, 2007). As a preliminary model this proposal discerns the following strategic procurement activities (Pressey, 2009) within small firms: *specification, selection, negotiating & contracting, supplier relation management*. Other classifications, e.g. as used by Ellegaard (2006) or by Day and Lichtenstein (2007, p. 315) will be considered in a later phase. Confronting the interaction of both types of activities in a preliminary model leads to a 20-cell matrix as shown in Figure 7.

¹² In a later phase this research could distinguish between moderating variables acting as *drivers* and moderating variables acting as *enablers* (Van Echtelt, 2002). The first are external and internal factors the owner cannot easily influence but must react to, the latter are influenced (managed) by the owner.

	Specify wants or needs	Scout & Select supplier	Negotiate a contract	Manage relation with supplier
Ideation				
Concept				
Develop product				
First use in market				
Full use in market				

Figure 7: Matrix indicating possible interactions between Innovation and Procurement Activities

For an optimal interaction between the procurement activities and the innovation activities within small firms, that is for an optimal result for the small construction firm as an entity, the firm could conduct specific activities in each of the 20 cells. The exact nature of these activities will depend on the characteristics of the innovation and on other moderating concepts (as shown in the conceptual framework). In the empirical phase this research could identify best practices or management instruments related to these activities.

By way of example (Figure 8) this research proposal now discusses an involvement portfolio for supplier innovation as proposed by Wynstra (1998) in his PhD study, and relates this to the conceptual framework of Figure 2.

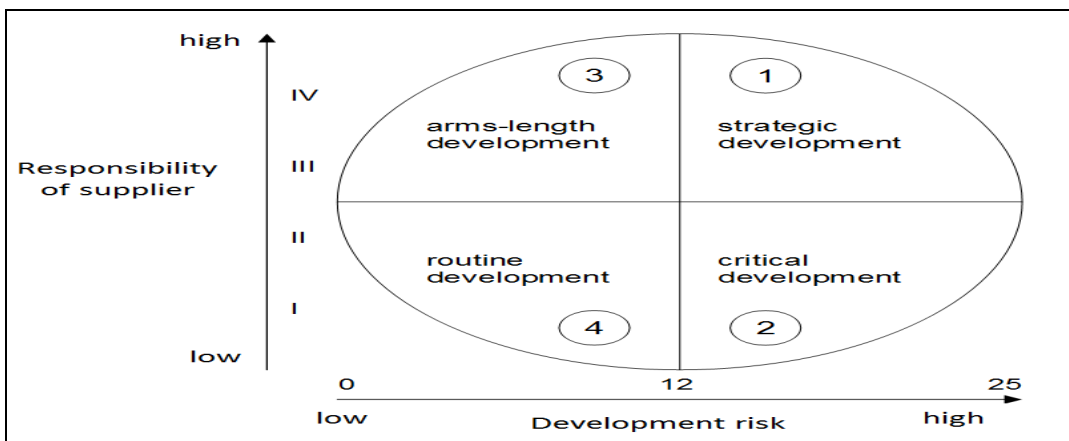


Figure 8: Supplier Involvement Portfolio (Wynstra, 1998)

Depending on the degree of responsibility to be held by the supplier (Y axis) and the degree of innovation development risk for the focal firm (X axis), according to this model in Figure 8 the firm would have four strategic development options (1-4). Each of these four options will lead to different purchasing activities. The development risk perception is moderated by the owners' experience and the firms' capabilities (variable from concept 8; see Figure 2). The responsibility held by the supplier is moderated by the owners' negotiation power but also by the stability of the relationship and past experience (variable from concept 6; see Figure 2). Several other moderating variables could have an impact as well. This simple example shows the complexity of effectively aligning procurement and innovation activities.

4.2 Dependent Performance variables: Procurement (3), Innovation (4), & the Small Firm (5)

In the daily business practice of the small New Zealand construction firm the results from the procurement activities and the innovation activities will often be closely related and will be

perceived as one result. Therefore for this thesis, it is necessary to distinguish between these two dependant variables and to define relevant measures.

This proposal posits that the procurement performance is an (intervening) independent variable to the innovation performance as a bad procurement performance will negatively affect the innovation performance.

While there is enough extant research on procurement performance measures of larger firms, such measures for small firms are relatively scarce. Johnson and Leenders (2007), Gonzalez-Benito (2007) Foerstl et al. (2013) and Hartmann et al. (2012) give overviews of different types of procurement performance but these are not directly applicable to small firms. Hence, this research proposes (Table 1) to use material from the PhD study of Adams (2005) as later amended and validated by Paik (2009, p. 363; 2011). These six procurement measures cover both efficiency and effectiveness (see Batenburg, 2007; Foerstl, *ibid*). These measures are *output performance* indicators of procurement activities. During the empirical phase of this PhD research the attention might also be drawn to *process performance indicators* and to long term and short term effects (see e.g. Van Echtelt, 2004). All six procurement measures have an indirect impact on overall firm performance via the innovation performance.

Table 1: Procurement performance measures impacting the small firm performance

1	Profit as a percentage of sales
2	Net income before tax
3	Return on investment
4	Purchased material price reductions
5	Order processing time reductions
6	Operating cost reductions

Literature describes success factors of innovations in general, but so far only Abbott (2006), Bos (2012), Gambatese (2011), Hardie et al. (2013), Rose and Manley (2012), and Songip (2013a, 2013b) have been found to describe these within a construction context. Hardie (*ibid*; p. 183) mentioned a direct variable schedule partly relevant in this context. Both Rose and Manley (*ibid*) and Songip (*ibid*) used the Rogers (2003) diffusion model. However this limited their focus on only diffusion (adoption of the innovation). Moreover, Fairweather (*ibid*) suggested limitations on the Rogers model. Contrarily, this PhD thesis also wants to measure results from earlier innovation and procurement activities. In her PhD study Pullen initially followed Cooper and Kleinschmidt (1995) and proposed the often used *percent of sales*, later (*ibid*, p. 100) she came with a more complicated measure. Gronum et al. (2012, p. 259, p. 279-282) used a measure from OECD, called the Oslo Manual.

There appears to an academic debate on innovation performance which this proposal will discuss and add later. [Add measures on innovation performance]

Table 2: Innovation performance measures impacting the small firm performance

1	
2	
3	
4	
5	
n	

In conducting sustainable innovations the firm gives economic, social and environmental benefits to its suppliers and customers, and also social and environmental benefits to other stakeholders.

Adams (2012, p. 27) narrowly defined the small firm performance “as the organisation’s relative competitiveness compared with other businesses and the ability to maintain long-term profitability and market share”.

This PhD proposal could add benefits for the wider environment on *people* and *planet*, in line with the Brundtland (1987) definition “Meet the need of the present generations without having an impact on the needs of future generations”. By way of preliminary example, the European Framework for Quality Management (EFQM) distinguished the following four measures:

- *Customer results*: the need and expectations of customers.
- *People results*: the need and expectations of people.
- *Society results*: the need and expectations of relevant stakeholders within society.
- *Business results*: the need and expectations of business stakeholders.

The related Dutch version of the EFQM model (Hardjono, 2001, 2011) goes one step further and distinguishes measures for more stakeholders:

- *Customer and partner (supplier) results*.
- *Societal results*: i.e. human rights, labour conditions, ethics and environment.
- *Employee results*.
- *Business results*: the need and expectations of business stakeholders.

As part of her PhD thesis on sustainable innovations of Dutch SMEs Bos (2010; p. 31-37) used sustainability performance measures on *product quality*, on *environmental* and *societal aspects*, and on *orientation to sustainability*. She derived her data from case study interviews with firm owners. A limitation of this method is that her results were subjective, non-financial, not from the perspective of stakeholders, and also not quantified. Nevertheless, she was able to analyse a broader perspective than just business results.

This PhD proposal has yet to decide whether firm performance would also include societal and environmental aspects. [Further research will also seek to define robust measures on sustainable / waste-reducing innovations].

Table 3: Small firm sustainable (people, profit, planet) performance measures

1	
2	
3	
4	
5	
n	

4.3 External moderating variables: *Environment (6)*, & *Innovation Characteristics (7)*

The meso (industry) and macro (wider) external environment of small New Zealand construction firms have a large impact on the daily business of these firms and on their profitability. The same holds for the characteristics of the waste-reducing innovations the small firm wants to acquire and transform into a product offering. An iterative literature review identified a wide range of moderating variables as shown in the Table below. The search term *green* is used here as a broader concept including *waste-reduction*. The search term *disruptive* is also used wider here.

Table 4: External moderating variables from Concepts 6 and 7

Macro and Meso New Zealand construction Environment (6)	Characteristics of Disruptive & Green Innovations (7)
<ol style="list-style-type: none"> 1. Market conditions related to Boom – Bust cycle (Branz); Stranded capital (Sheffer) 2. Building Code Regulation (Manley); 3. Industry initiatives / power 4. Sustainability Regulations Demands of stakeholders/clients (Hardie 2011, 2013) 5. Gov. Type of Constr Supply Chain (cf Hagelaar/Staal). 6. Support from Network (not being the chain itself) 7. Complexity of network relations (PhD Adams) 8. Procurement system; Alliances /ST adverse relationships (Kaats, Bygalle, others) 9. Negotiation Power in chain (Porter, Kraljics, Carter?) 10. % of new customers / suppliers (products) last three years (source??) 11. Sector differences? (Morrissey) 12. Supplier Involvement versus Development Risk;(PhD Wynstra 1998) 13. On partnering in construction (Bygalle) Negative Effects Customers (Gassmann) 14. Open versus closed innovation model (Chesbrough, others on small firms!) 	<ol style="list-style-type: none"> 1. (Non)-Patented (Intangible assets or not; license /support) (Manley 2005; others) 2. New to world – new to country / to industry (or to users) 3. Innovation phase (Cooper) when acquired; Diffusion (stages Rogers/Brown). 4. Incremental or disruptive (radical) to industry (users) 5. On costs (efficiency) or on quality (functionality of users) 6. Process or product or system innovation (for MC and users) 7. A one – off, or serial innovations (Gambatese) 8. short /long-term innovation supplier relation (PhD van Echtelt 2004) 9. Green aspect easily demonstrated to stakeholders (PhD Bos?) 10. Technological and economic uncertainty (PhD Melander; Fisher?) 11. Current or New suppliers (Domestic / Foreign; Schiele, Jensen. ...) 12. On the adoption or benefits of open innovation (Schroll; Knudsen; Jean)

These variables will be worked out in a later phase of this proposal. The concept of *disruptive* innovation versus *incremental* innovations (or improvements) needs further defining (See Figure 3, page 6; and e.g. Garcia, 2002; Rowley et al., 2011). One aspect here could be the *newness* (for small firm, industry, customers, country) and the *impact* on competition and customers.

This proposal will now explain some of the variables of Table 4 in *bold* as these currently appear to be more important considering the theoretical perspective. [add arguments] Research shows that environmental regulation (the Porter Hypothesis, see e.g. Ambec 2011) and customer demand (see e.g. the concept of the intelligent, informed or advanced client Manley) can hinder or stimulate innovations

The research will investigate the role of current versus *new suppliers and foreign versus domestic* suppliers. This aspect of supplier selection and management (Calivi; Schiele; Monczka, 2011?) has an impact on the success-rate to release and commercialize innovations on the market. It will investigate the *form of relationship* (Jensen, 2012; Wynstra, 1998). This research will focus on several (*sub-*) *types of disruptive innovations*. Following Slaughter (2000) and Sheffer (2013) (Figure 3, page 7) these innovations more likely need multiple stakeholders within and outside a supply chain to become successful. Incentives for small firms to innovate can be found in supportive clients and especially in performance-based building standards (Bossink, 2004; Hardie, 2011, 2013), but at the same time Manley (2008) and others (e.g. Koebel, 1999) mentioned bias of clients and regulatory inefficiencies as important innovation barriers.

This research will also focus on diffusion of *patented versus non-patented* innovations, either from New Zealand firms or available abroad. Construction patents could be purchased from commercial firms or from research institutes (see e.g. Brochner, 2013; Jensen, 2012), or could be (co)-created within the small firm itself (Manley, *ibid*). Innovations with granted or non-granted patents by nature have a new and unique aspect (Jell, 2012) and protect technology capabilities or capacities (i.e. unique know-how or unique manufacturing capacities). In a multi-case study research Manley (2008) found how small Australian construction firms use patent protection. On the other hand she also found a number of successful new technologies without patent protection and Brochner (*ibid*) found that patenting in the construction industry is difficult or could even be irrelevant. This research found (paragraph 6.1) that firms consistently file 100 patent applications annually at the New Zealand patent office, so there must be some relevance.

[This paragraph will be amended].

4.4 Internal Moderating variables: Small firms & Owners (8), and Business Model (9)

This paragraph discusses a number of variables found so-far. (See also Table 5, next page). A recent BRANZ report (Page, 2013b) mentioned that economic prospects (2013 – 2017) for New Zealand construction firms are good. Interestingly it remarks that construction firms up to six employees have larger profits than firms with more than six employees (*ibid*, p 19). In his PhD study Hinton (2013; p.120) mentioned a website of the Government of New South Wales (NSWGovt 2008) that apparently came to the same conclusion: Hinton wrote: "Margins for Main Contractors are generally low (...) sometimes as low as 1 or 2 per cent". Hinton continues on the same page "for Sub-Contractors margins are slightly better averaging between 8 and 18 per cent". This better margin for sub-contractors could limit growth ambitions and could limit willingness to take innovation risks as owners would more favour a lifestyle business approach than an entrepreneurial approach (see paragraph 3.2).

An innovation does not sell itself. The firm and its construction supply chain will have an established mode of operation (paradigm) when managing its normal business relations and risks, and will need in varying degrees opportunities, vision, leadership, means, partners, or change management when working on successful disruptive innovations. There is a wealth of literature on *hard aspects* (see also Bygballe et al., 2010) in managing procurement and innovations, but *softer aspects* are equally important (see e.g. Bossink, 2004; Kaats and Opheij, 2013; O'Connor and McDermott, 2004). The aspect of seeing and capturing opportunities is sometimes overlooked in more rational literature. As small firms have limited resources and as they act more entrepreneurially or intuitively (Burns, 2000; Verreynne, 2004) they could accidentally find opportunities. In his research Loosemore (2012) also acknowledged such serendipities with innovations in the construction industry. This aspect impacts the way small firms source (search and acquire) innovations. Several researchers (e.g. Crespin-Mazet, 2010; Hardie, 2007; Hinton, 2013; Kissy, 2009) found that in large firms aspects of the attitude of purchasers or middle management to relationships and to risks is an issue in construction industry. These aspects may also play a role in small firms. In this context Fairweather et al (2009, p. 15) cited Binder (2008) who found that innovations are resisted by "potentially affected groups who worked hard to defend their interests". Of course this is no new aspect nor specific to the construction industry, although Koebel and Cavel (2006, as again cited by Fairweather et al.; 2009, p. 14) in their US study explicitly mentioned innovation resistance from sub-contractors and construction workers.

Table 5: Internal moderating variables form concepts 8 and 9

Small firm & Owner Characteristics (8)	Small New Zealand Construction Firm Business Model (9)
<ol style="list-style-type: none"> 1. small firm structure & mgmt (departments or not, etc Meijaard) 2. procurement department or not (Morrissey 2004; James, 2011); Is procurement strategic in spend, or goods/services or SRM not (James, 2011; Pressey 2009) 3. More a Service or a Manufacturing small firm (James, 2011) 4. Size (& turnover (Paik) ; work experience & education of team (Krisnan) 5. Past innovation successes (see ...); training & learning important (James) 6. Owner holistic, or traditional on buying (Pressey) priority (Ellegaard/Quayle) 7. Mature small firm vs startup (Verreynne, and) 8. small firm Ownership (family, SBU, venture capital; sole ownership; source?) 9. Apt to chance (Bossink 2004??); innovative culture (Songip 2013) 10. Necessary (cost) or Opportunity (Comp advantage) (Cohen 1989, in Abbott 2006) 	<ol style="list-style-type: none"> 1. Owner Ambition & Motives: Entrepreneur, lifestyle, survivor (Morrissey 2011) 2. Treacy & Wiersema (1997; PL, CI, OE); 3. Ansoff on growth; Davidsson 2007 on small firm growth 4. Verreynne (2007, 2011?) on 4 types of small firm strategy. 5. See Zortea on BuMo (Entrepreneur vs only Marketing oriented). 6. Formulated procurement strategies (James, 2011; Abbott 2006) or Innovation (...) 7. Active SCM involvement or not (Brau); Open vs closed innovation 8. Attitude to innovation, change (Songip – Brown) 9. Decision making processes

[This paragraph will be amended in a later phase]

4.5 Confrontation of direct and moderating concepts from the literature review

Table 6 below shows an attempt to contrast the literature relevant to the concepts. The authors shown in bold are currently considered more relevant. The literature review is on-going and mainly being conducted in Web of Science and Google Scholar. An important part of the literature review is conducted via references and citations, via established journals and via PhD theses. The second phase of literature review will be systematically using a methodology from e.g. Tranfield (2003) or Garrard (2013).

Table 6: Literature found related to the concepts (status 22 FEB 2014)

	1 procurement Activities	2 Innovation Activities	Innovation & Procurement Performance (3,4)
5 (external) Meso & Macro New Zealand construction Environment (not necessarily construction)	Special Ed JPSM; EC2010R&C; PhD Bemelmans; Bygballe, L; Crespin-Mazet (reluctance purchasers); Dubois/Gadde; Verhoeff PhD; Zeng (networks; small firms) Hong (supply	Verhoeff PhD; Bossink; Johnsen/Philips (2010) Calvi/Picaud (disrupt) VandeVrande (2009) Dutch reports on supply mgmt in construction; BRANZ reports (idem) Winch (1998) Vilasini (on lean)	Manley /Hardie (2006, 2010, 2008) Abbott (econ motivation small firms) Whyte (motives for const inno) Rotimi PhD (2013) Hinton PhD (2013 on trust & coop in cSCM) <i>On procurement only:</i>

	1 procurement Activities	2 Innovation Activities	Innovation & Procurement Performance (3,4)
<i>or green)</i>	chain; NPD; small firms) Lee; Colombo (OI) Echelt PhD . Schiele (find inno suppliers); Wynstra PhD ; Hillebrand (2004 on OI en NPD)		Paik 2x; Hartmann (top & bottom line) , Foerstl (link maturity / performance); Saranga (on measurements); PhD Adams
6 (<i>external</i>) Characteristics of Disruptive & Green Innovations (<i>often also rel. to Construct. Ind.</i>)	Heaps of papers; Picaud, Calvi, Schiele etc Castaldi (Inno taxonomy) Knudsen (negative on OI); Gerhard (Inno Sources) Fontana (Top 100 DI) Schroll (review on OI) Chessbrough? Matthias (IO L); Hauser (Inno, L)	DeValence (informed clients); DeSouza (cSCM, waste); Sheffer PhD ea (energy savings) Hardie/Manley/Rose (4x green inno in constr small firms) VanTran (AUT; waste in NZ cSC) PhD Barker (waste in housebuilding); McCoy (2010,12); Bossink (2004); Aouad (on role of Unis; 2010); Tidd (2010 on diffusion); Bos PhD ; Alise PhD ; Simula PhD ; Luleao (2010). Fairweather (2009) Koebel	Rose; Bossink (2004, inno green, leadership); Sheffer (R&C!) Hardie / Newell (2011; factors small firms) Rogers (diffusion model) Verreynne / Gronum (R&C; small firm networks & performance) Altwies (2013; on patent counts) Gambatese and Songip (on diffusion; R&C!); Brochner (2x; patents!) Fairweather; Chrissie; Hakansson; Koskela; Kraatz; sundqvist (2x); Toole (2013); Kumar (2010); Troy (patent markets PhD)
7 (<i>internal</i>) Characteristics of Small firm s & Owners (<i>often also rel. to NZ Construct. Ind.</i>)	Paik (4x) PhD Adams (2005) Morrissey (2011) James (2011-12) PhD Ozmen (small firms do often buy as consumers)	NZ Surveys Hardie / Manley Kilip (green inno in csmall firms) Barret / Sexton (inno in small firms) Bommel (inno sources small firm /LEs, 2004)	Hardie; Davidsson (2007, small firm firm growth) Kissi (role middl mgmt O Cass Inno, mrktg, entrepr; comp advantage); James (2013, inno profit) Meijaard (on structure & mgmt, personality etc) Mokhlesian, Gajendran (Luleao) Rigby / Abbott (on link with Unis)
8 (<i>internal</i>) small New Zealand Constr. Firm Business Model		Pullen (characteristics small firm); Tomlinson; Lasagni ; DeJong (networks) Gronum ; Ver-reynne; Spithoven; Vrande; (IO) Rosenbusch (perf); Bakan;Rahman, (strat); Oke (type 2011); Syntens/EIM.	Leiponen; Davidsson (2007, firm growth); Merrilees (mgmt = enabler) Sok (=learning = enabler); Davidson (org = enabler); Zortea (entreprnr vs mrktg; 2012); Will (2007 LT vs ST); Rahman (bumo of small firms)

4.6 Working definitions of the concepts

Summarizing this chapter, Table 7 below indicates the relevant concepts with working definitions. These concepts will be defined in more detail during the second round of literature review and during the exploring interviews.

5. On the proposed design of this research

5.1 Research statement, question, objective and hypotheses

Paragraph 3 ended with the conclusion that there is strong evidence that successful innovations will increase firm profit and that procurement plays an important role in successful innovations. There is also a need for disruptive waste-reducing technology innovations within the New Zealand construction industry and such innovations often come from small entrepreneurial firms.

The successful use of such innovations will be beneficial for the firm and its business partners in the construction industry, for owners and occupants of buildings, and for the wider environment. Hence this PhD research has a scientific relevance, a business relevance and a social relevance. However, the problem is that several internal and external variables will have an impact on this success and they detailed study. Hence the (provisional) research question:

What is the role of procurement in New Zealand small entrepreneurial construction firms on successful disruptive waste-reducing technology innovations?

The answer on this question should help to:

1. Determine *current procurement activities* (i.e. determine procurement practices and strategies) on innovation activities within small entrepreneurial New Zealand construction firms.
2. Determine *value adding procurement activities* within small entrepreneurial New Zealand construction firms on innovation activities.
3. Determine how such firms *can increase (optimize) the performance of their disruptive innovations* in *economic, social and environmental terms*.
4. *Operationalize the relationship of said procurement and innovation activities into best practices and/or management instruments*.
5. *Develop and spread these new insights* in (at least) part of the firms involved in this research.
6. *Provide recommendations on further research, and on generalisations of the findings*.

From the perspective of these small entrepreneurial firms (see Figure 9 below) and from the concepts as described in Paragraph 4 this research question and objective would pose eight working hypotheses. These hypotheses help to review current literature and help with exploring interviews.

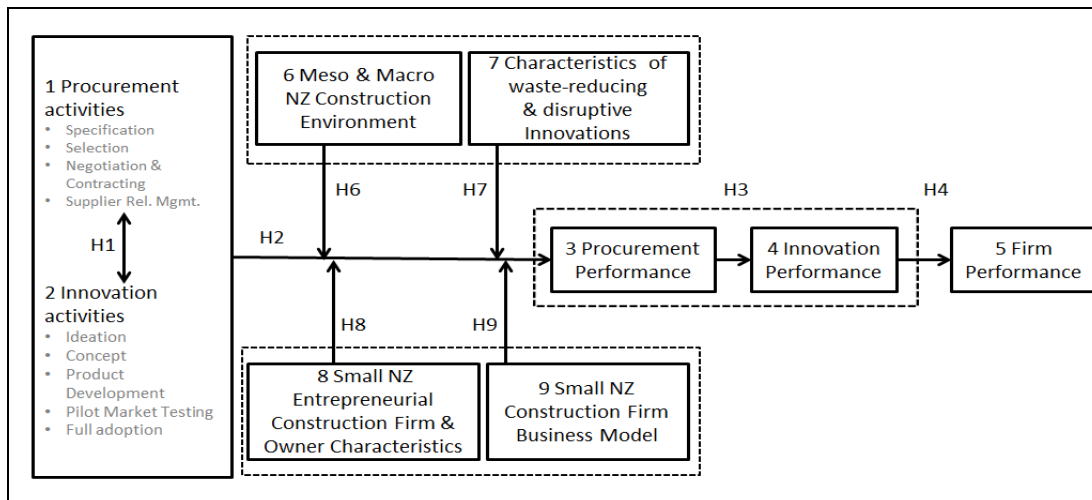


Figure 9: The conceptual framework for this PhD research (Copy of Figure 2)

This research proposal defines a *hypothesis* as a statement on a situation that can be empirical tested so that the researcher can discuss in more detail the amount of correctness of the hypothesis (Engeldorp Gastelaar, 1998, p. 349-354). Hence this research proposal uses hypotheses as a starting point for both the quantitative and the qualitative empirical research.

When testing these hypotheses new theory will emerge. The working hypotheses as stated below are as yet not bold and specific enough. In the coming two months, this proposal will structure such hypotheses, starting from the dominant variables within the concepts. The hypotheses then will lead to sub-research questions with the help of e.g. Verschuren and Doorewaard (2010, p 95-132).

H1: The innovation activities and the procurement activities need alignment.

H2: Aligned innovation and procurement activities lead to a measurable procurement performance.

H3: The measurable procurement performance leads to a measurable innovation performance.

H4: The measurable innovation performance leads to a measurable firm performance.

H6: The procurement performance is moderated by the NZ meso and macro construction environment.

H7: The procurement performance is moderated by the characteristics of the waste-reducing disruptive innovations.

H8: The procurement performance is moderated by the characteristics of the small New Zealand construction firm and the owner.

H9: The procurement performance is moderated by the small New Zealand construction firm business model.

5.3 On the proposed methodology

There is a long history of extant research on innovation and procurement in construction industry with the aim of helping the industry, so far with mixed results. This research proposal favours the fact that an unconventional research methodology could give insights hitherto not discovered (Meehan, 2013; Vrijhoef, 2007). This would need a creative but rigorous approach. One new aspect is trying to combine the traditional qualitative survey and quantitative case studies with additional Delphi-type studies.

The research design consists of three phase (see Table 8) and uses a mixed-mode approach.

Appendix V gives a more detailed overview. Annually in March and in September the progress

reports (PGR-8) will be submitted to the AUT. Progress reporting to the Hanze will be done in person in APR14; and either JAN15 or APR15; and either JAN16 or APR16.

The PhD thesis will be submitted in August 2016.

This PhD research started with desk research and analyse secondary data from New Zealand and abroad. The heart of this research will be two rounds of case studies. The exact number is yet to be determined¹³, but will probably be between 8 or 10. However survey techniques on New Zealand and Dutch datasets are also expected to make a significant contribution with questionnaires and interviews.

During the three-step research four Delphi-type studies will be conducted in line with the *world-café approach* or the *consortium benchmarking approach* as both advocated by Schiele and Krummaker (2010) and used by Hoffmann (2011) in her PhD thesis. The first two rounds of these Delphi-type studies will be more explorative (inductive); the latter two will be testing and validating (deductive). These Delphi-type studies will help strengthen (and to a certain extent generalize) the findings from the case studies. A conventional Delphi study approach consists of two or more rounds of posing questions in writing to experts, and analysing the written results which ultimately leads to increased knowledge (Verschuren and Dorewaard, 2010, p. 344; for a good Delphy study example see also Carter et al., 2000).

However, this research proposes a somewhat different approach of collaborative (inclusive) research. It will use the approach of Schiele and Krummaker (ibid) in that practioners and academics *together* will define detailed research questions and answers. The phasing of four rounds of Delphi-type studies hence ensures business relevance. This approach also considerably speeds up (Hoffmann, 2011, p. 11-12) conventional case-study research.

Although Schiele and Krummaker (ibid) state they can ensure rigor and hence can replace case studies, this PhD research will use case studies and this type of Delhi studies in combination. To ensure rigour the studies need the validity and reliability criteria as suggested by Yin (2009). This approach seems to differ from using *focus groups*. Hofmann (ibid, p. 16) described a method that will be further analysed for this research.

The *unit of analysis* operates in a commercial environment with multiple buyer-seller relations and competition on several levels. Furthermore the information obtained and discussed by the researcher will come from several informants and will often be commercially or technically confidential. Mistreatment or appropriation of any information may harm firms and professionals involved. Therefore this proposal will investigate ethical aspects. The research methodology and design will be worked out in more detail in the coming months to ascertain the appropriate quality.

6. The way forward

Although this proposal is not in its final stage it discovers a relevant and interesting research field that needs further studying.

The research has a three-phased approach. It starts phase 1 with analysing secondary data, extant literature and exploring interviews. Phase 2 comprises conducting quantitative surveys, a round of classic and a round of action-research case studies. Phase 3 is concluding the research and writing the thesis. In all three phases I intend to conduct Delphi-type studies

¹³ Quote from PPT Evangelista (2012) IFPSM Summer School: "How many cases? According to Yin (2003), in most situations 6 to 10 cases should provide evidence to support or reject propositions. Eisenhardt (1989) recommend 4 to 10 cases. The review of papers based on case study by Koulikoff-Souviron and Harrison (2005) the number of cases used ranging from 3 to 11. The review of papers carried out by Voss et al. (2002) provides evidence that the number of cases used range from 3 to 30."

involving business practitioners into the research. This multi-mode approach will help the quality of my work and will also be of practical value to the stakeholders involved. The coming months I will finalize my research statement, associated research questions and my research methodology. It is my intention to conduct relevant research which is rigorous by nature. Somewhat contrary to Van Weele and Van Raaij (2014) my rigour is *servicing* (enabling) the business and academic relevance and is not a purpose in its own. This rigour will be established by the research design and the execution. I fully appreciate the support from Fletcher Construction, from the New Zealand Auckland University of Technology (AUT) and from the Dutch Hanze University of Applied Sciences (Hanze) and from several persons in particular. Being a mature and sponsored PhD student offers a number of advantages I want to exploit in a sustainable manner. My PhD research will be beneficial to New Zealand construction industry and to stakeholders at large.

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