DIRECTIONS FOR FUTURE CONSTRUCTION SUPPLY CHAIN MANAGEMENT RESEARCH IN NEW ZEALAND: A REAL OPTIONS PERSPECTIVE

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ABSTRACT

Real Options (RO) has been a universally accepted concept in a number of major industries. However, its use in the construction supply chain management (CSCM) sector has been limited. Some rare supply chain management RO studies have shown a number of limitations. First, there is a lack of a rigorous theoretical RO framework pertaining specifically to CSCM. All such supply chain management RO studies are based off RO theories or models developed for other sectors (engineering, infrastructure, natural resources). And second, attempts to extend real option to wider uses in CSCM seem premature at the present. This paper reviews all recent literature pertaining to real options and real options applied specifically to the construction supply chain management area. The study proposes a research programme pertaining to CSCM in New Zealand in order to enhance the current understanding of RO in this area and in the process develop a comprehensive theory for the RO application in New Zealand CSCM.

KEYWORDS: Construction, Econometric framework, Real options, Supply chain.

INTRODUCTION

Supply chain management is an emerging area of practice in the construction industry worldwide. It is based on similar concept that has been widely and successfully used in the manufacturing industry. There have been a number of studies that attempt to apply this concept to the construction context (for example, O'Brien, Formoso, London & Vrijhoef, 2008; Kara, Kayis & Gomez, 2008; Yim, Lee, Yoo & Kim, 2011). However, most of these studies do not fully consider the economic value of construction supply chains from the clients' perspective. Further, they have not produced any theoretical econometric models to help quantify this economic value (such as the value of deference or extension of a project). In economics, such a value belongs to an area of study called 'Real Options' (RO). In essence the RO approach is an adaptation of financial option theory into real-life projects. This concept has shown successes in a number of industries (e.g. oil & gas, mining, infrastructure, real estate) and therefore it would now seem appropriate to consider RO in the context of Construction Supply Chain Management (CSCM) (Wall, 2004; Yang & Blyth, 2007; Guma, 2008; Martinez, 2009).

Even though there have been a number of attempts to employ the RO concept in CSCM, majority of such studies are not based on any theoretical econometric RO model tailored specific to this sector (O'Brien, 2000; Neufville, 2003). Nor have they produced any significant results which can potentially lead to a successful formation of the theoretical model. As a consequence, the results produced by these studies are dubious at best. Furthermore, any extensions of real options theory in this sector are premature.

This paper aims to survey all literature pertaining to the RO concept in CSCM and define a framework for future research in this area. Longer term it is intended to develop this framework into a theoretical econometric RO model for CSCM in New Zealand. The paper begins with a background on CSCM and argues for the need of an econometric model in this sector. It then gives some information on the background of RO and its applications. Following this is a section that discusses the limitations of current RO studies in CSCM and offers future research programmes pertaining to this area; and finally concluding remarks on future directions for construction supply chain management research from a RO perspective in New Zealand.

CONSTRUCTION SUPPLY CHAIN MANAGEMENT AND THE NEED FOR A ROBUST ECONOMETRIC MODEL

Supply Chain Management

Construction Supply Chain Management (CSCM) is defined as “a system where suppliers, contractors, clients and their agents work together in coordination to install and utilise information in order to produce, deliver materials, plant, temporary works, equipment and labour and/or other resources for construction projects” (Hatmoko & Scott, 2010 p.36). It is an emerging area of practice which has been inspired by manufacturing supply chain management (MSCM). However, there are substantial and marked differences between these two disciplines. The major emphasis of MSCM is on modelling of production volume; whereas CSCM is primarily concerned with the coordination of discrete quantities of materials (and associated specialty engineering services) that must be delivered to specific construction projects (O’Brien et al, 2008).

Supply Chain Management (SCM) as a whole takes a systems view of the production activities of autonomous production units (subcontractors and suppliers in construction) and seeks global optimisation of these activities. In essence therefore the SCM *weltenschauung* is that system performance supercedes individual operation optimisation. The system view of SCM contrasts with the hierarchical approach of traditional methods, where individual activities such as planning, controlling and contracting for projects are optimised separately. Hence, SCM allows for improved understanding of firms’ production costs and capabilities (particularly under the uncertain and changing conditions that characterise modern construction sites). In turn, this understanding provides a rational basis to improve coordination and control on construction projects. As a consequence, production activities can be better planned and adjusted and, by linking to costs, contracts can be formed that promote optimal supply-chain performance (O’Brien, 2000).

In construction, SCM encompasses a wide range of related discipline areas (Hatmoko & Scott, 2010). Some typical thematic considered in a CSCM study are flows of materials, labour, information, plant, equipment and temporary works which may originate from various parties. Impacts of various CSCM practices on project performance are measured. Often, CSCM results are obtained through a combination of a survey and the development of simulation models. However, the majority of research pertaining to CSCM has been limited to logistical issues of the supply chain, e.g. quality rates, inventory, lead-time and production cost (Vrijhoef & Koskela, 1999; Vidalakis, Tookey & Sommerville, 2011), with a smaller number of studies exploring other issues such as relationships between contractor, subcontractor and supplier (Greenwood, 2001; Kale and Arditi, 2001), just-in-time (JIT) practice (Koskela, 1992; Tommelein & Li, 1999), economic perspective of CSCM (Spinler, Huchzermeier & Kleindorfer, 2002), risks in SCM (Kara et al, 2008; Yim et al, 2011), decision making in CSCM (Nemhart, Shi & Aktan, 2005; Kaare & Koppel, 2010) and costs (O'Brien, 2000).

Despite the wide-ranging themes addressed by recent CSCM research, there have not been many studies exploring the effects of clients on CSCM strategies and their implementation. This appears to be a significant 'missed opportunity' in research and, the authors contend that this is a knowledge gap that needs to be addressed. Clients are ultimately the pivotal stakeholders in the construction process. Clients create demand for the built product and provide the finance essential to sustaining the construction industry as a whole. In the final analysis it is the client that decides whether the project fulfils expectations in terms of time cost and quality. Furthermore, understanding clients' role in CSCM is essential since they need flexibility in the timing of investments, along with any subsidiary decisions related to project delivery. Consequently it would seem apparent that there is a pressing need to provide clients with the necessary financial assessment tools to be able to evaluate the potential impact of any CSCM decisions undertaken. If the modern construction industry competes on the basis of the efficacy of its supply chain, it would seem logical to develop our understanding of the economic value proposition of CSCM from the clients' perspective.

A Need for a Robust Econometric Model in CSCM

According to Vrijhoef and Koskela (1999), construction supply chains remain problematic. They continue to have significant issues with both physical waste and cost. A principle reason for this is due to myopic controls focussing on effects rather than causes. This problem is deepened further by construction's fundamentally fragmented character and its confrontational procurement, contracting and tendering environment. For instance, in a project, separate companies (and sometimes divisions of the same company) will have a tendency to manage their own parts of the process in isolation, without considering the impacts of their behaviours on other activities in the chain. As a consequence, SCM application in the construction industry may be seriously hindered. Vrijhoef and Koskela (1999) propose a number of ideas to improve CSCM. First, the SCM methodology can be redesigned by reconfiguring the supply chain's structure for each project under consideration. Second, controlling mechanisms need to be put in place to coordinate the supply chain according to the new configuration. And finally, the system has to be reviewed in order to make continuous improvements. This view has been subsequently echoed by various authors (e.g. Kara et al, 2008 or Kaare & Koppel, 2012). Christopher and Peck (2005) concur that by applying principles proposed by Vrijhoef and Koskela (1999) offers the opportunity to create resilient supply chains. Further, Christopher and Peck (2005) observed that resilience in the supply chain can be substantially enhanced through the creation of a culture of risk management assessment and management in construction organisations. By doing so, the concept of SCM can be understood by different corporate entities and risks can be identified and managed effectively.

However, O'Brien (2000) cautioned against foregoing economic values when applying SCM in construction projects. O'Brien contended that it was essential to balance the downward cost pressures introduced by commercial acuity with the benefits that may accrue from process efficiency. There needs to be a pragmatic balance between these competing forces. However in light of current CSCM studies, such consideration has been partial. In some areas of SCM application, considerations have been given to the reduction of costs (especially logistical costs), lead-time and inventory in the supply chain. In view of the large share of these costs in construction projects, such focus is fully appropriate. In other areas, the focus is on the impact of the supply chain on site activities. In such cases, the goal is to reduce site costs and duration. Here, the primary consideration is to ensure material (and labour) flows to the site for the sake of avoiding disturbances in the workflow (Vrijhoef & Koskela, 1999). Even though these considerations are useful and appropriate for the context in which they are carried out, in practice all areas in CSCM are intimately interrelated.

A classic conundrum for SCM practitioners is in establishing and improving measures of supply chain dependability. However to assess dependability of a supply chain without addressing the rationale for the construction of the supply chain (procurement system, cost criteria, non-price attribute selection etc.) would be ultimately futile. Therefore, in practice, good management and control of internal processes together with more open information flows within and between organisations can do much to help (Christopher & Peck, 2005). O'Brien (2000) suggested further research into four areas in order to improve the current understanding of CSCM. The most relevant to the current research theme concerns the development of econometric measures of supply-chain performance.

Econometric models, once developed, can generalise more specific models and test the propositions of such models. More importantly, such econometric measures allow for the generation of an empirical database that can demonstrate the performance gains that may be realistically achievable through the implementation of supply-chain management techniques. This in turn helps to speed adoption of these techniques across the construction industry.

REAL OPTIONS

Background on Real Options

One econometric measure believed to be able to incorporate managerial preferences and flexibility into the decision making process of construction project SCM is Real Options (RO). In this section we provide a background on RO and rationalise as to why this technique may be applicable for CSCM. Of all literature reviewed pertaining to CSCM, only a handful has attempted to apply the concept of ROs in their analysis in order to examine the added value of flexibility to the projects under consideration (e.g. Spinler et al, 2002; Yim et al, 2011; Nembhart et al, 2005). The concept of RO is essentially an adoption of the financial industry's Options Theory to real-life projects. This is typically in the form of different types of investments in construction, mining or oil & gas industries - hence the name 'Real Options'. The RO methodology has mainly been used for evaluation purposes. As such, it is very much suitable for a CSCM analysis from the Clients' perspective since it may be used to evaluate with/without or before/after contentions in the financial space.

RO has on a number of occasions been proposed as a technique with significant potential in the evaluation of investments under uncertainty (Nuefville, 2003; Birge, 2012). Such uncertainty is induced by constant changes in the market place and can have significant effects on the value of a project. The effect of uncertainty is that at the completion of a project or investment cycle, actual returns on an investment may have drastically different expected return. Under these conditions, RO tends to perform better than the conventional Net Present Value (NPV) methods due to the inclusion of management flexibility (Dimitrakopoulos, 2010). Managerial flexibility here arises from the fact that as new information arrives; uncertainty about market conditions and future cash flows is gradually resolved. Consequently, management has flexibility to alter the company's operating strategy in order to capitalise on favourable future opportunities or mitigate losses by deferring, expanding, contracting, abandoning or otherwise altering the project at different stages of its operating life accordingly (Trigeorgis, 1996). This flexibility allows managers to modify the project in accordance to changes. Ultimately, the management flexibility inherent in RO provides the company opportunities to maximise the upside potential while limiting the downside losses (Martinez, 2009).

Construction investments, like other real-life investments, have three important characteristics. First, the investment is partially or completely irreversible, i.e. once invested, the capital costs become totally or partially sunk. Second, there is always uncertainty over the future return from the investment. Finally, both management of a company and investors have the flexibility in timing the investment, i.e. choices between abandoning, expanding or contracting the project operations. However, traditional NPV-based project evaluation methods cannot incorporate these three characteristics (Yang and Blyth 2007) since projections of future values assume linear rates of depreciation/appreciation and 'steady state' outcomes. Essentially, RO works by adjusting for risk within the cash flow components while NPV discounts for risk at the aggregate net cash flow. This seemingly small difference allows RO to differentiate assets according to their unique risk characteristics, while the conventional NPV approach cannot (Samis, Davis, Laughton & Poulin, 2006; Samis, Davis & Laughton, 2007). Another advantage of RO over NPV is the way it handles discount rates: while NPV uses risk-adjusted discount rate, RO utilises a risk-free rate (or lending rate when risk-free rate is not available) to discount the cash flows in the evaluation of the project (Smith & McCardle, 1996; Walls, 2004; Martinez, 2009). Therefore, when applying discounting procedures, a project estimated by RO yields higher values than one estimated by the conventional NPV method. Although the difference in risk-adjustment between the NPV and RO evaluation methods appears to be nuanced, its consequences are potentially large. In the latter case, it allows senior management to use market information to determine the underlying structure of risk adjustments for uncertain variables (Samis et al, 2007).

It must be noted that the NPV and RO evaluation methods share many features. Both see assets as portfolios of uncertain cash flows received at a series of times in the future. In the absence of flexibility, the only difference between the two approaches is the manner of accounting for the effect of cash flow uncertainty on asset value. Trigeorgis (1996) recommended against scraping altogether the traditional NPV method. Using a case in the mining industry as an example, Dimitrakopoulos and Sabour (2007) found that there is a lack of procedures for testing the usefulness and advantages of RO over the static NPV method in practice. The authors hence contended "it is not yet clear whether RO can deal with the complexity of mining projects and whether it can really be applied to making decisions that can improve project value" (Dimitrakopoulos & Sabour 2007 p.1). Nonetheless, RO could become a useful tool for decision makers and investors to quantitatively analyse the impacts of uncertainty on investments (Yang & Blyth 2007).

Applications of Real Options

Real Options has been studied and has had extensive application in the natural resources industries. In mining, RO is widely used to evaluate projects under a wide range of uncertainty and risk. Risk in this industry arises from uncertainty in orebody estimations to operational uncertainty (mining and processing) to economic uncertainty (commodity prices and foreign exchange). For instance, despite recent advances in exploration and ore estimation techniques, the amount of resource within a deposit can never be known with certainty. Further, since ore quality varies substantially throughout the deposit, the assumption of constant resource extraction rate throughout the lifetime of the mine is an extreme simplification. By using RO, mining companies are able to capture the upside potentials while significantly reducing the downside risks in their positions by means of leveraging the managerial flexibility provided by this method (Martinez, 2009).

Recently, there have been a number of attempts to apply RO to the construction industry. Chiara, Garvin and Vecer (2007) studied a case concerning multiple exercise dates in a limited revenue guarantee venture in a Build-Operate-Transfer (BOT) toll road project with a fixed concession period. In this model, they consider a revenue guarantee as a particular type of real options, a discrete-exercise option. The decision process in this study is multi-stage with a return associated to each decision and the objective is to determine the optimal decision policy. Once the decision is made, the fair value guarantee, given by the expectation of the sum of the payoffs relative to the optimal stopping time, is discounted back to the present. Along this line of research, Ford, Lander and Voy (2001) investigated the strategic flexibility involved in a complex civil project. They found that using a structured real option approach in construction management can increase returns through improved project planning and management. Similarly, Rose (1998) applied RO to another BOT project, the City Link project in Melbourne, Australia. RO was used to consider the effects of interacting embedded options available to the contractor, ‘Transurban’. Rose (1998) considered key underlying risk factors and found that by deferring the payment to the Government, ‘Transurban’ was able to add an extra value to its book (which actually accounted for more than half of the firm’s market share values).

In the real estate industry, there is an extensive body of literature on RO (for example Barman & Nash, 2010; Guma, 2011). Property development companies often use land options to secure rights for a piece of land. If the value of the property is deemed to be valuable, the land will be bought; otherwise the development company simply walks away and lets the option expire. Property management companies on the other hand are more concerned with the types of tenants or types of usage the properties should offer to their tenants, e.g. commercial or residential or mixed use. Options considered in such instances are often switched options (conversion from one building type to another, e.g. from commercial building tailored to corporate clients to one tailored to retailers), or mixed lease (combination of different tenant types). The result is that there is a good understanding of the real option concept in the real estate sector. Furthermore, there is actually an econometric RO model tailored specific to the construction industry i.e. the Samuelson-McKean formula. The Samuelson-McKean formula is a system of equations suitable for calculating the real estate option values. The Samuelson-McKean formula is based on the Black-Scholes formula (Hegels, 2005; Barman & Nash, 2007). The reason for this specific requirement is due to the nature of investments in this industry: first, most real estate options, such as land option, are considered ‘Perpetual Options’. This means there is no expiration/maturity date, i.e. no time upon which the land owner looses his/her ability to build. Second, property developer has time to build. When exercising the land option, it takes time to build (and much uncertainty can exist between the decision to develop and completion of that development). Finally, the accuracy of the current value of the underlying asset is not directly observable like one in the equity market (Callagy, 2012). Thanks to this theoretical econometric model for real options pertaining to real estate, the industry has enjoyed a number of successes in applying the RO concept to practice. Moreover, from this successful foundation, the real estate industry is able to experiment with various forms or techniques that can potentially benefit the RO concept further. In recent times, there have been a number of attempts to integrating engineering-based techniques such as Monte Carlo simulation (MCS) or Binomial Tree (BT) with real options in valuing projects (Hegel, 2007; Barman & Nash, 2010). The results obtained using these techniques have been reported to be very close to the theoretical Samuelson-McKean values. It is therefore reasonably safe to say that the application of RO to the real estate industry has been a success (to a certain degree, due to the short-comings inherent in the real options methodology; but more successful than RO applications in mining or oil & gas nonetheless).

In the CSCM context, as previously mentioned, there have also been a number of attempts to employ real options. The reasons for this employment are due chiefly to the recent realisations in this sector about advantages of RO over the traditional analysis methods. In traditional SCM analyses, considerations mainly rest on a forecast of demand for products and their associated costs. Typically, such an analysis consists of a single program for a specific model focusing on the project's cost orientation (not revenue management) and the project's NPV. The result of the traditional analysis is often used to support fixed designs which offer little flexibility (often with minimal ability to change) based on the immediate 'go/no go' investment decision type (Birge, 2012). RO is anticipated to be a better alternative to this type of traditional SCM analysis thanks to its ability to account for managerial flexibility.

Nembhart and his colleagues realised the importance of this flexibility (Nembhart et al, 2005). Their research tested the idea by developing a supply chain model in which a manufacturing firm could have the flexibility to select different suppliers, plant locations, and market regions and there can be an implementation time lag for the supply chain operations. Here a real options approach was used to estimate the value of flexibility and to determine the optimum strategy to manage the flexibility under uncertainty in the currency exchange rate. However, the study found that without considering time lag impact, the value of the operational flexibility was in fact significantly overestimated (Nembhart et al, 2005). This view is not shared by other authors. For instance, Sodal, Koekebakker and Aadland, (2007) applied a RO model to the shipping industry to value the option to switch between the dry-bulk and wet-bulk markets for a combination carrier (a ship type that is capable of operating in both markets but has fallen out of favour due to high price tags). They found that due to this inherent managerial flexibility, and depending on the market conditions, the shipping company's decision to re-enter the market could well be viable.

Along this line, Spinler et al (2002) consider capacity options on non-storable goods or dated services to assess the flexibility of trading partners in a supply chain contract in responding to uncertain future market environments and at providing a hedging instrument against pronounced spot market volatility. According to the authors, this consideration is an extension of the real options theory in that not only is the study aimed at assessing flexibility as mentioned above but also analyses the efficiency-enhancing impact of contingency contracts. They found that the opportunity of long-term capacity trading and planning provides the seller with an instrument of efficient cost management resulting in lower marginal cost related to long-term capacity allocation as opposed to those associated with allocation on short-notice (Spinler et al, 2002).

Uncertainty and risk reduction is another area of consideration that RO has been widely employed (Martinez, 2009; Dimitrakopolous, 2010). However, there have been a very small number of studies exploring this area in SCM. Cucchiella and Gastaldi (2006) combined the modularisation concept with RO in order to reduce company risk in the SCM context. The concept of modularisation has also been studied in other industries (see, for example, Rodrigues & Armada (2007) and Gamba & Fusari (2009)). Modularisation is more or less based on the lean production/lean management idea. In their study, Cucchiella and Gastaldi (2006) developed a theoretical framework to test possible options which could protect the firm against risk originating from a number of uncertainty sources. They found that the firm's ability to outsource (the outsource option) indeed helped to reduce the risks facing it. Similarly, Hult, Craighead and Ketchen (2010) examined how different types of options perform in supply chain project investments in the face of high levels of uncertainty. The six main options considered in SCM are namely unlocking, stage, deferral, scale, switch use, and abandonment. The study found that performance of options varies; with some options show different values in the supply chain to those offered by firms (Hult et al, 2010).

DISCUSSION

Limitations of Supply Chain Management Real Options

Referencing the work of Tiwana et al (2007), Hult et al (2010) noted that despite RO popularity in various industries, empirical evidence has shown that there seemed to be very few RO studies pertaining specifically to CSCM. This is surprising indeed because: first, uncertainty is commonplace in contemporary construction supply chains (e.g. Kara et al, 2008); and second, there is anecdotal evidence that behaviours of some managers are consistent with real options theory when making supply chain decisions (Hult et al, 2010). Since good practices in supply chain management is important because of their direct influences on the competition in the market place, it is therefore important to develop a more complete understanding of RO and their role for decision making in the CSCM context. Specifically, this requires the development as well as empirical assessment of a supply chain option theory.

To date, all studies on RO in the CSCM context are not based on a theoretical background tailored specific for SCM. Unlike the real estate industry, where a specific real options theory has been developed for and widely accepted within the sector (the Samuelson-McKean formula), RO in the SCM area is more or less based on theories derived from other industries such as infrastructure, engineering or mining. Even though this practice may show some promising results when applying to some aspects in the supply chain pipeline, it still does not reflect the real nature of the whole construction supply chain network; nor does it prove (or disprove) the applicability of RO in CSCM. Hence, a complete theoretical understanding of this subject matter pertaining specifically to CSCM is urgently needed in order build a foundation upon which CSCM practitioners and researchers can work.

The problem of applying the real options concept to SCM without a foundation theoretical framework is exacerbated further by researchers eager to extend the RO concept in their SCM studies in order to 'enhance' its applicability. This approach is very dangerous because it is analogous to the "blind men and an elephant" situation, where different theories can emerge but all do not cover the whole issue. Therefore, it is safe to say that RO extensions, such as those of Spinler et al (2002) and Hult et al (2010), are premature.

Potentials for Research of SCM Real Options in New Zealand and Worldwide

A big, if not the biggest, challenge currently facing real option researchers worldwide is the viability and acceptability of the proposed real option theory in the CSCM area. It has been observed that it is very rare to have a new theory capable of reshaping the views of scholars and managers introduced (Hult et al, 2010). But due to successes that real option theory has offered to other industries, we believe that it can add significant value to the CSCM sector. A comprehensive RO theory tailored specifically to the CSCM sector will help to improve economic values of construction projects through their supply chains. This should add significant value to client organisations by empowering them with a good understanding of their projects as well as providing them with an additional decision making tool.

Due to New Zealand's relative small size and its innovative nature (the Kiwi ingenuity), research programme in construction supply chain real options will allow New Zealand to become world leader in this area, analogous to the likes of Japan, the world leader in the Just-in-Time concept, France (Geostatistics), the UK (Contract/Procurement Management), the USA (Real Estate real options) and Canada or Australia (natural resources real options). To this end, there is an urgent need for a research programme in New Zealand that focuses on the development of a real option theory that pertains specifically to the construction supply chain management area in order to establish the foundation for further work on this subject matter.

Potential for Future Research

A number of suggested research programmes are listed below:

a) Development of a theoretical framework
b) Testing the theoretical model on scenarios as outlined previously (by Hult et al, 2010); e.g. calculating values of phased delivery etc
c) Verification of the theoretical model (by using various RO approaches-Monte Carlo Simulation or Binomial Tree etc)
d) Extending of the theoretical CSCM RO (as in the case of Spinler et al (2002) and Hult et al (2010) and compare against their results)

These research programmes could be carried out collaboratively between universities in New Zealand in order to achieve maximum value for the construction supply chain sector. Specifically, a theoretical CSCM framework developed from this programme should be comprehensive enough to be used as a baseline for further developments. The framework should therefore be mathematically sound. As a result, experts in areas of construction supply chain management and mathematics need to work together closely in order to meet the requirement.

CONCLUDING REMARKS

This paper has reviewed all recent literature pertaining to real options and real options applied to the construction supply chain management area. While it has been universally accepted that the real option concept is useful, it is apparent that the concept is not very widely used in the CSCM sector. Of the very limited applications of RO to this sector, the results are somewhat debatable. There are a number of reasons for such limitation. First, there is a lack of a rigorous theoretical RO framework pertaining specifically to CSCM. As a result, all recent SCM RO studies are based off RO theories or models developed for other sectors (engineering, infrastructure, natural resources). While it is useful to use such models, but since they are designed to serve their specific purposes (to model options in those areas), these models may not be representative to cases applied to the CSCM sector. Second, any attempts to extend the real option concept to wider uses in the CSCM are premature due to the lack of facility to test such extensions against the base cases. While it is tempting to apply the RO concept to a wide range of areas, one must balance between that temptation and the "blind men and the elephant" pitfall because it is dangerous to develop a theory when one does not have the overall picture of what the theory should cover.

Upon finding these gaps, a research programme pertaining to CSCM in New Zealand was proposed. It is intended that the programme will help to enhance the current understanding of RO in this area and in the process develop a comprehensive theory for RO application in New Zealand CSCM. This research programme in turn will help to elevate New Zealand's credibility in CSCM research.

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