Leveraging Supply Chain Relationships – A Systemic Perspective

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ABSTRACT

Relationships among businesses (for example, vendors and buyers) are critical to success in supply chain management. Good inter-business relationships is the key to achieving supply chain objectives such as maximising customer value and reducing transaction costs, thus maximising profits. This study investigates existing theory in supply chain relationship improvement. By integrating factors that contribute to supply chain coordination using systems theory and methodology, potential long-term leverages are proposed, along with the mapping of patterns of improvement over time. Such leverages provide insight for devising supply chain relationship strategies in an efficient manner, instead of tackling improvement initiatives on a multitude of factors in isolation, as commonly featured in supply chain literature. The proposed dynamics are validated by business practitioners, whose comments and opinions are further analysed to compare and contrast with the theoretical implications. Key findings suggest that information is a top priority success factor in supply chain relationships, which should be facilitated by appropriate implementation of information technology. Such implementation is considered as a critical leverage for improvements in supply chain relationships, through its effect upon other relationship drivers including performance, trust, and commitment.

This study is based on a one-year Master of Commerce thesis project. Limitations and further research opportunities are discussed at length in this paper.

Keywords: Technology, Innovation and Supply Chain Management, Organisational Behaviour, Organisational Change

SUPPLY CHAIN MANAGEMENT

Supply chain management is a contemporary management concept. Supply chains consist of groups of businesses that process, produce, and deliver particular products from its original materials through to the point where the final product reaches the customer. Maximisation of customer value is thus a key objective. In order to satisfactorily achieve such objective, management and coordination of the business entities along the supply chain is critical.

Supply chain management (SCM) is generally defined as the “management of activities that procure materials and services, transforming them into intermediate goods and final products, and delivering the products through a distribution system.” (Heizer et al. 2004). This illustrates the basic purpose and nature of supply chains. Besides the flow of physical products, sub-assemblies, and material, information also plays an important part in supply chain operations. Definitions of supply chains by other authors, including Schroeder (2004), Raturi (2005), Gardiner (2006), Russell et al. (2006),

Krajewski et al. (2007) promoted the significance of information in supply chain management, that while physical goods and services move downstream along supply chains, a reliable flow of information regarding inventory, process capabilities and product specifications must also be facilitated upstream in order to coordinate the supply chain. A typical description of a supply chain in action is shown in Figure 1 (Gardiner, 2006).

In order to maximise customer value, coordination among supply chain partners is critical. Effectiveness in production, product flow, and communication must be ensured in order to satisfy the end users. Among academic literature, the general concept of supply chain management is well complemented by other critical 'ingredients'. These include ideas such as "coordinating activities across the supply chain" (Stevenson, 2005), "integrated approach for global supply chain and sourcing" (Gardiner, 2006), "linking the company with the operations of its suppliers, distributors, and customers" (Bozarth et al. 2006), "interconnection of organizations" and "holistic approaches" (Slack et al. 2007). These theories highlight the fact that even though the businesses along the supply chain are independent entities, they should operate as 'partners' who work in a coordinated manner in order to achieve a "greater common good" for the supply chain as a whole, thus, customer value may be maximised for the end users (Fawcett et al. 2007, Slack et al. 2007, Mangan et al. 2008, Bozarth et al. 2008). Such ideas give rise to the importance of supply chain relationships.

Supply Chain Relationships

Close supply chain relationships enable all partners along the chain to work together closely and achieve benefits such as improvements in efficiencies through better coordination, and minimisation of transaction costs via intra-and inter-organisational information sharing mechanisms (Lawrence 1999, Premkumar 2000, Lee et al. 2000, Tarn et al. 2002). A model by Fawcett et al. (2007) described supply chain relationships using the 'relationship intensity continuum' (Figure 2). The model outlines different positions of intensity in supply chain relationships, ranging from transactional, arm's length dealings all the way to strategic long-term alliances.

The 'transactional' extreme represents a loose relationship, based on multiple suppliers, cost-driven selection, and arm's length dealings, while the 'strategic' extreme on the other end represents a very close relationship, featuring long-term commitment, mutual benefits, shared resources, open communication, joint planning, shared risks/rewards, and cross-organisational teams. According to Hansen (2009), there has been an increased need in the past three decades to research on the shift from transactional (or sometimes even adversarial) relationships towards strategic, cooperative, service centred relationships between supply chain partners. The model by Fawcett et al. (2007) thus represents such evolution and betterment of relationships.

Key Drivers of Supply Chain Relationships

A survey of operations management textbooks (Krajewski et al. 2005, Gardiner 2006, Heizer et al. 2006, Fawcett et al. 2007, Russell et al. 2009) shows a sample of typical factors contributing to supply chain relationship improvement and the typical benefits expected from good supply chain performance. These are presented in Figure 3.

These contributing factors for supply chain relationships are promoted in general as independent means for improvement, with linear implications (that is, each factor should be tackled individually, and that the resulting benefits are assumed to be linear through time). As commented by Sheu (2009), studies in this field has been somewhat fragmented in that it often focuses on studying a small number of factors within a specific functional discipline.

According to systems theory (Maani et al. 2007), such linear assumptions are commonly seen in discussions including critical success factors and key performance indicators portrayed in 'lists' (as in Figure 3). This implies three key assumptions: (1) the listed factors are independent; (2) that causality is unidirectional (from cause to effect); and (3) that factors are equally important. As a result, the interrelationships among these factors are not often discussed, and major efficiencies from potential leverages among the contributing factors are somehow overlooked.

In order to resolve and minimise such potential misperceptions, this study takes a systems approach to observe the dynamics of supply chain relationships, based on four integrated key drivers derived from literature. They are Trust, Commitment, Performance, and Information/IT Use. These proposed key drivers are the result of integration and categorisation of supply chain literature surveyed, in order to minimise the issues of fragmented and linear portrayal of contributing factors to supply chain relationships addressed above. These key drivers are defined as follows. More detailed discussion of these drivers are presented in Appendix A.

Trust – the extent to which relationship partners perceive each other as credible and benevolent (Ganesan 1994, Nyaga et al. 2010).

Commitment – the exchanged belief of partners that having an ongoing relationship is the foundation for achieving or maintaining maximum efforts (Nyaga et al. 2010).

Performance - the extent to which a supply chain meets end-customer requirements, and contains operational efficiencies which can deliver that performance (Hauseman 2005).

Information and IT Use - the extent and employed means that critical information is conveyed to a party's relationship partners (Mohr et al. 1994, Nyaga et al. 2010).

All of the above are considered as key drivers of relationships in supply chain operations. In light of the significance of relationships in supply chains and such opportunities for further research, this

study aims to investigate the drivers of supply chain relationships (Trust, Commitment, Performance, and Information & IT Use) by modelling their dynamics, thus shedding light on key leverages and strategies over time for managing supply chains.

RESEARCH DESIGN

The objectives of this study are as follows:

- To explore the dynamics among supply chain relationships and its key drivers.
- To explore the behaviour of supply chain relationships and its key drivers over time.
- To identify potential leverages for supply chain relationships.

In pursuance of these objectives, this study employs methodologies including literature review, systems modelling (with causal loop diagram and behaviour over time graphs), interviews and qualitative thematic data analysis.

The proceeding of this study is based on the research model illustrated in Figure 4. Firstly, basic dynamics of IT use and supply chain relationships are elicited from research literature. Relationships among nominated drivers in literature towards supply chain collaborations are modelled using causal coop modelling techniques. These basic dynamics are then used as building blocks for an initial theoretical dynamic model, using system dynamics tools and methodologies to highlight systemic relationships through time (refer to Appendix B for a description of the causal loop methodology). Such tools and methodologies are discussed in the up-coming section. Upon completion, the initial theoretical model is presented to supply chain practitioners in interviews (supply chain/production managers of the participating companies). In two rounds of interviews with each participating company, comments, opinions, suggestions, modifications and additions to the initial model are discussed and incorporated into the final version of the model. Data regarding the participating companies' current positions in supply chain relationships and IT use are also collected.

Qualitative data collected from interviews are analysed using thematic coding methodologies, including the nVivo software for significant theme identification from interview transcripts. Analysis in this study focuses on observing, comparing, and contrasting the theoretical and practical perceptions and implementations of supply chain information technology and relationship management. Details of the methodology and research design are discussed in the following sub-sections.

The Initial Theoretical Model

The initial theoretical model illustrates the interrelationships among supply-chain relationships and the four "key drivers" discussed above. For the purpose of model building and to enhance the

comprehensiveness of the model, a number of supplementary variables are also included. These are defined in Table 1.

Linear portrayal of relationships between these factors (based on literature surveyed) are summarised in Table 2.

Based on these theoretical relationships, an initial dynamic model is constructed to comprehensively model supply chain relationships, and for validation with supply chain practitioners. A dynamic model (using causal loop techniques) portrays comprehensively the interactions among the variables addressed over time, and is effective in highlighting leverages in the system with which long term improvements may be sustained.

A Dynamic Supply Chain Relationship Model

The dynamic model is explained in this section. Components and dynamics of the model are explained in detail. These dynamics make up the initial model which is used in the first round of interviews.

R1: The REINFORCING Performance Loop

The performance loop (Figure 5) shows a reinforcing dynamic among variables, in particular, the two key variables, IT Use and SC Relationship. These two variables are portrayed to support each other in a virtuous relationship through the interactions of SC Efficiency, Performance, Collaboration, IT Investment and Capability.

R2: The REINFORCING Trust and Commitment Loop

The second loop in (Figure 6) the initial model is portrayed with the addition of three variables, Info Share, Trust, and Commitment. They show another source of reinforcement between IT Use and SC Relationship, along with Performance in R1.

R3 & R4: Reinforcing dynamics among IT Use, Info Share, Trust

By introducing two more relationships in the model among existing variables (IT Use, Info Share, and Trust), two more reinforcing loops are formed (Figure 7). The virtuous dynamics are further supported.

B1, B2 and E1: The BALANCING Transaction Costs (TC) and Security Loops

The complete initial model (Figure 8) incorporates an ‘external’ variable, Internet Environment (Security) with a positive relationship towards IT Use, and two new balancing dynamics through Savings in TC and Security Problems. The balancing loop B1 explains that as IT use goes up, more

savings in transaction costs can be achieved, thus lowering transaction costs, and therefore reducing further IT investments (since the goal of cost reduction is achieved). The reduction in further IT investment contributes less to the supply chain capabilities, and therefore contributes less to additional IT use, thus balancing the previously exponentially growing dynamic. Note that the assumptions of this balancing effect do not imply reductions in IT use. Instead, the balancing impact reduces ADDITIONAL use of IT. That is, the growth of IT use is reduced.

Another important feature of B1 is the delay effect between IT Use and Savings in TC. That means the savings happen only after a significant period of time.

The other balancing dynamic, B2 highlights that as IT use goes up, the companies involved are more exposed to security issues, which in turn reduces the level of trust between companies. This effect may hinder further increase in IT use. This dynamic, even though critical, is not assumed to constitute a major obstacle towards IT use promotion in the initial model due to the 'controllable' nature of security problems. That is, security problems are not an inherent issue in IT use. Instead, when properly controlled, security problems resulting from IT use can be minimal. Therefore, it is assumed in this model that the variable "Security Problems" is a potential source of balancing dynamics, but is currently assumed to be maintained at an insignificant level.

Based on these dynamics, the behaviour over time of supply chain relationships are illustrated in Figure 9.

Initially, (the 'early' stage) the reinforcing dynamics of the model starts to build up from the use of IT in supply chain dealings. The strength of relationships in supply chains increase modestly at this stage (initial dynamics of loops R1, 2, 3, and 4).

As the reinforcing dynamics accumulate, the system proceeds into the 'intermediate' stage (as in the flywheel analogy suggested by Collins 2001), supply chain relationships are further reinforced. Behaviour at this stage shows exponential growth.

Eventually, in the 'mature' stage, savings in transaction costs become significant (dynamics of loop B1). The key objective of cost reduction is achieved, and therefore, the level of IT use and supply chain relationships starts to plateau and maintain at a high level in the final phase.

The model presented in Figure 8 and the resulting behaviour over time (Figure 9) forms the initial dynamic model for this study. A diagram of the dynamics is presented to the participating companies during interviews, while the behaviour over time graph is not conveyed or discussed explicitly. Details about the interviews and data collection are discussed in the following section.

Model Validation – Interviews with Participating Companies

Three pairs of vendors/buyers are interviewed in this study. The selection of participating companies is based on the following criteria to ensure their suitability.

1. Participating companies should be large New Zealand organisations (FTE > 100). New Zealand subsidiaries of international companies are also considered.
2. Participating companies must be currently using information technology for supply chain dealings.
3. Representatives for these participating companies (for interviews) must be senior staff overseeing supply chain issues. They must also be familiar with their IT systems and the relationships with their major suppliers/customers.
4. Participating companies must have had information systems integrated with their business partner(s) for a reasonable period of time, in order to provide their perspective on such relationship(s) over time.

Table 3 shows a summary of the participating companies in this study. Note that the names of these companies are disguised for confidentiality.

Data collection is carried out during two rounds of interviews with supply chain/production managers of the participating companies. The focus of these interviews are to 1) discuss and validate the initial dynamic model (Figure 8), and to 2) hold open-ended discussions with the representatives about their general opinion about IT use and supply chain relationships, and about their experience with their paired vendor/buyer. Each interview meeting takes approximately 1.5 hours, where all conversations are recorded and collected as data for analysis.

DATA ANALYSIS AND RESULTS

Data collected in this study is analysed according to the three proposed research objectives:

- To explore the dynamics among supply chain relationships and its key drivers.
- To explore the behaviour of relationships and its key drivers over time.
- To identify potential leverages for supply chain relationships.

Results of the analysis provide a dynamic model and the implied behaviour over time validated by the participating companies. Along with the analysis of interview responses, insights regarding improvements of supply chain relationships and potential leverages for sustainable improvements are developed.

Validation of the Dynamic Model

The initial dynamic model is commented upon by representatives from participating companies. Validation of the model results in an updated version in light of data collected.

Results from the interviews show that the initial model is generally agreed upon by all participants, with a number of additional key dynamics. The final dynamic model is presented in Figure 10.

In the final model, two more variables are introduced:

- Power
- Equity (fairness)

Both power and equity are major themes covered in interviews. It is a common perspective that the power (size, market share, image) of either party in supply chain collaboration provides strong enhancements in relationships. For example, major retailers as buyers possess significant power in supply chain collaboration. Vendors are keen to partner with such powerful buyers for their size, market share, and thus the exposure of the vendors' products. Another important aspect about power is the company's capabilities to invest in IT. Smaller (or weaker) companies may not be able to afford costly implementation of sophisticated supply chain information systems.

Equity (fairness) is another common theme in terms of its impact on trust. All participating companies stressed on the importance of fairness in supply chain relationships, and how it forms a foundation for trust between parties.

Furthermore, data collected from participating companies resulted in the addition of two more relationships in the model:

- A positive relationship from SC Relationship to Commitment
- A positive relationship from Commitment to Trust

Thus, two more reinforcing dynamics are formed in the model, which support the virtuous dynamic between IT use and supply chain relationships.

In general, all participating companies concurred with the proposed theoretical model with the additional features discussed above. The proposed behaviour over time of variables (presented in Figure 9) are also validated.

Supply Chain Relationships and Implementations of IT over Time

To study the participating companies' perceptions on their supply chain relationships and their actual supply chain strategies and implementations, the three pairs of participating companies are hypothetically categorised into three stages, according to the theoretical behaviour over time of supply chain relationships outlined in Figure 9. An outline of such categorisation is presented in Figure 11.

The validity of such categorisation is to be observed according to the companies' opinion and perception. The purpose of this analysis is to validate the theoretical behaviour over the three stages.

The three pairs of participating companies are hypothetically categorised into the three integration phases based on their tenure in supply chain relationships supported by information technology as described in Table 3. More background details about the three pairs are discussed in Appendix C.

According to the proposed theoretical model, companies at the early stage should focus on implementations of information technology in order to enhance supply chain relationships through efficiencies, commitment, and trust. As the level of these features accumulate through time, the reinforcing dynamics underlying the model gains momentum, and thus drives the relationship and IT use into rapid growth (intermediate stage). Eventually, more and more benefits from good SC relationships starts to realise. The pressure on increasing the leverage in IT use at the mature stage is not as significant. Both the vendor and supplier reap and enjoy the benefits from supply chain collaboration in a 'stable' environment as outlined in Figure 11.

Such theoretical implications across the three stages are compared against the opinions of the participating companies regarding their current status in their vendor/buyer relationships. Elicitation of such opinion is achieved by thematic coding of the representatives' responses in interviews.

In order to be consistent with the theoretical behaviour over time, it is expected that companies at the early stage are focused on systems development, investments, and enhancements of relationships. Companies at the intermediate stage are expected to focus on furthering investments in IT, strengthening of relationships, and expectations in returns including cost savings and efficiencies. Towards the mature stage, companies are expected to focus less on systems development and investment, and more on relationship maintenance and the benefits from IT and good relationships.

Qualitative data are analysed by tallying percentage counts of the participants' themes in their responses. The following factors represent the most common themes:

- Information	- Collaboration	- Capability	- Investments
- Trust	- Commitment	- Performance	
- Relationship	- Security	- Costs	
- System	- Transaction Costs	- Innovation	

Note that the coding process takes into account responses that show significant relevance towards supply chain relationships. For example, the mentioning of how information technology enhances supply chain efficiency constitutes a supporting theme, while a comment about how additional investments in IT result in minimal improvements is not considered as a relevant theme towards supply chain relationship improvement. The key objective of this analysis is to highlight important

factors that, in the perspectives of the individual participating companies, contribute to building supply chain relationships.

Among these themes, the four most popular ones across the six participating companies are Information, Trust, Relationship, and System. The percentage counts are presented in Table 4.

Radar charts and rankings of the three pairs' key themes percentage counts are presented in Figure 12.

The ranking of key themes in responses shows, contrary to the expected results, the significance of 'information', ranking first in five out of the six participating companies, with a second ranking in the sixth company (BeerKeg). Importance is placed on the possession of information rather than capabilities to exchange information from the use of information technology, a "key driver" of supply chain relationships proposed by this study. The rankings show no clear pattern in terms of 'evolution' of relationships over time as suggested by the theoretical model, and the key theme patterns between partners in pairs are inconsistent. For instance, 'system' ranks first and second amongst buyers, while its ranking among vendors are at the bottom. The significance of individual key themes from these responses, except for 'information', are randomly distributed, and thus, shows no significant patterns.

DISCUSSIONS AND CONCLUSIONS

This study aimed to further explore supply chain relationship theory by integrating existing theories into a more comprehensive dynamic systems model. From this model, validation and further comments were obtained from businesses actively participating in supply chain dealings. Key results from this study include a validated dynamic model which outlines behaviour of supply chain relationships over time, and a general consensus among participating companies (in light of the dynamic model) that the use of IT to facilitate information sharing is a key leverage for sustainable improvement in supply chain relationships.

In summary, the initial dynamic model of supply chain relationships is validated by all participating companies, with additional reinforcing dynamics among supply chain relationship, commitment, and trust, which strengthens further the existing reinforcing dynamics in the model. Two exogenous variables are added to the model as well, with "power" positively influencing supply chain relationships, and "equity", positively influencing trust. These variables are critical for further expansion and developments of the dynamic model to enhance the theory's comprehensiveness.

With such additions to the model, the originally implied behaviour over time pattern holds true. Both the dynamics in the model and the interview responses show that the use of IT in supply chain dealings is an effective leverage for long term improvements in supply chain relationships. This is achieved through enhancements in information sharing, trust, commitment, performance, supply chain relationships, and thus collaborations, which leads to further IT investment, which reinforces further

use of IT and its impacts. With effective use of IT, its impact towards trust, commitment, performance and supply chain relationships continues to flourish until transaction costs (one of the key objectives of supply chain management) is significantly lowered.

The idea of IT use as leverage for supply chain relationships is further supported by the thematic analysis of interview responses. “Information” is shown across five out of six participating companies as the top priority for supply chain relationships (with a second ranking by the sixth company). Accurate and reliable exchange of information is enabled by appropriate information technology, which in turn, facilitates the aforementioned reinforcing impact displayed in the dynamic model.

With IT use proposed to be a key leverage of supply chain relationships, it must be made clear, however, that IT use should not be perceived as a “linear” enabler of supply chain relationships (as in most of the other supply chain theories). That is, one must not assume simplistically that the more IT used, the better the relationship gets between supply chain partners. Such leverage must be considered along with the proposed dynamic model and the implied behaviour over time, that the impact of IT use on supply chain relationships is expected to accumulate slowly at the initial stage, followed by a likely rapid growth, and finally reaching a plateau on a high level where the primary objective of supply chain operations is achieved. The assumption of constant return from additional IT use/investment is unrealistic. Instead, a pattern of diminishing returns should be anticipated.

Moreover, In light of the proposed leverage and the responses from participants, it is also important to note that while “IT use” leverages relationships, the key success factor perceived by participants is “information”. These are complementary issues and must be implemented appropriately to support each other. A good IT system is useless without accurate and timely information, and good information does not help if it is not conveyed with a reliable IT system. In short, the use of good IT systems is an enabler for effective information exchange. Improvements in supply chain relationships may eventually be achieved and reinforced as a result.

As a study based on a one-year Master of Commerce project, the findings and conclusions are limited by both time and scope. Key limitations include the coverage of theory in the dynamic model, the model building methodology, and data analysis.

Due to the limitation in time, the dynamic model is scoped to include only selected literature related to the four key drivers of supply chain relationships. The comprehensiveness of the model can be greatly enhanced by including more detailed aspects of the four key drivers and also other exogenous dynamics including the two suggested by the validated model (power and equity). The authors are currently investigating such opportunities and are starting on the extension of the model.

In terms of the model building methodology, a more comprehensive exploration of the practical supply chain perceptions can be achieved with group dynamics model building methodologies (for example, Keating et al. 1999, Akkermans 2001, Maani et al. 2011), where dynamic models are built on practical opinion, based entirely on the perceptions of the participants. The authors propose that comparisons between theory and practice may be better achieved with models created under such circumstances.

The analysis of interview responses can be greatly enhanced with more detail and depth (meanwhile, only one level of analysis is carried out on the factors towards supply chain relationships). Multi-layer thematic analysis and interpretation of interview responses can better infer on the validity of the model and the implied behaviour over time.

Finally, the authors propose future longitudinal studies on supply chain partners in order to validate and facilitate extensions of the dynamic model. Observations of supply chain dynamics over time should provide more insight in terms of general supply chain relationship theories.

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FIGURES

Figure 1 Product and Information Flows in Supply

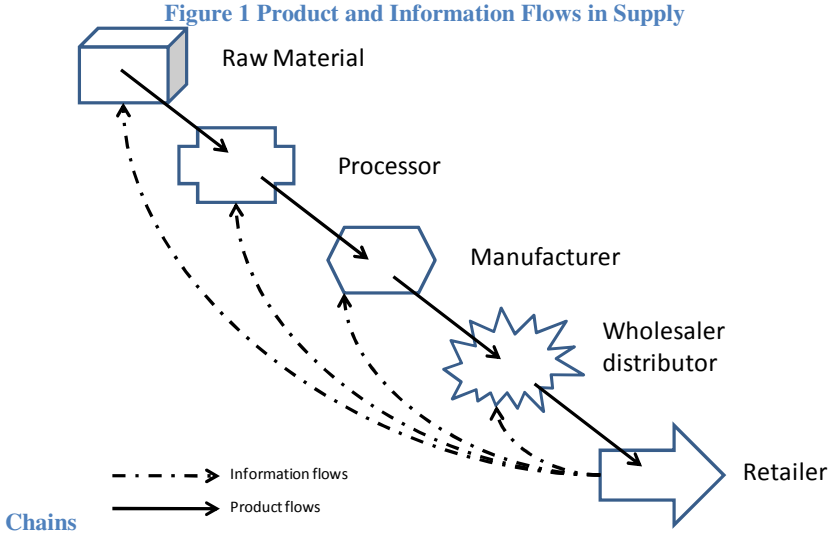


Figure 2 The relationship intensity continuum (Fawcett et al. 2007)

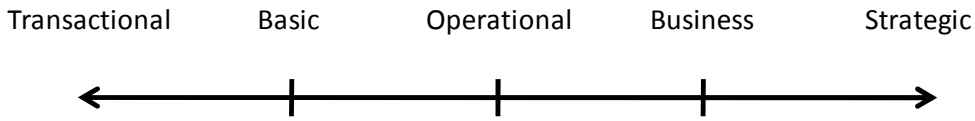


Figure 3 Sample of success factors and potential benefits of good supply chain

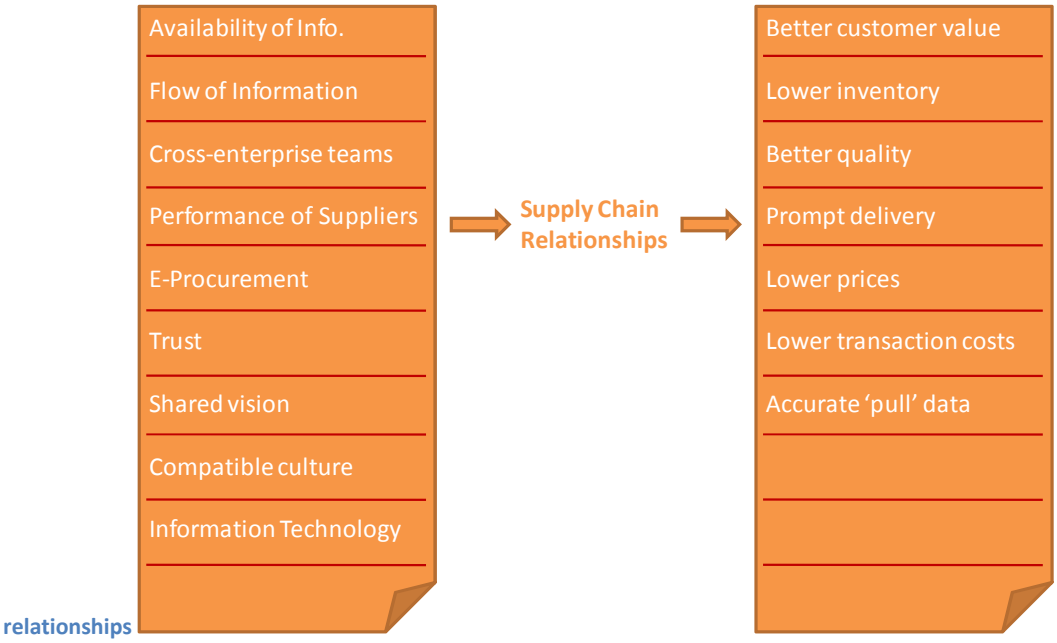


Figure 4 The research model

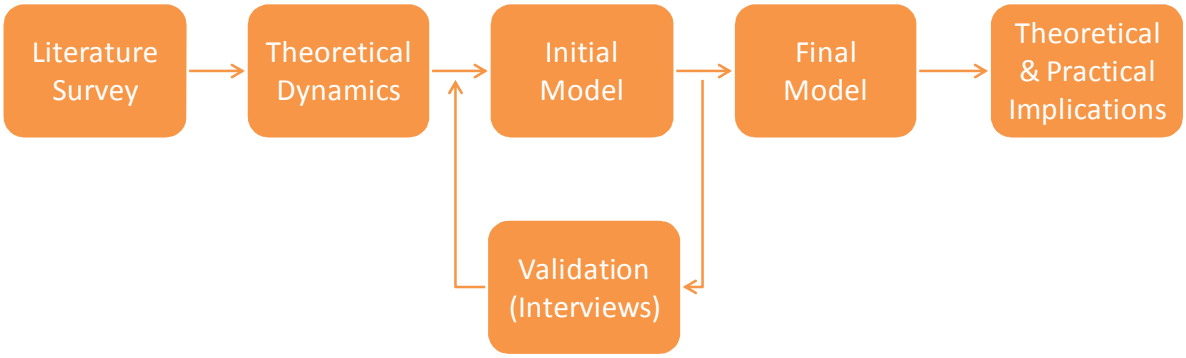


Figure 5 The performance loop

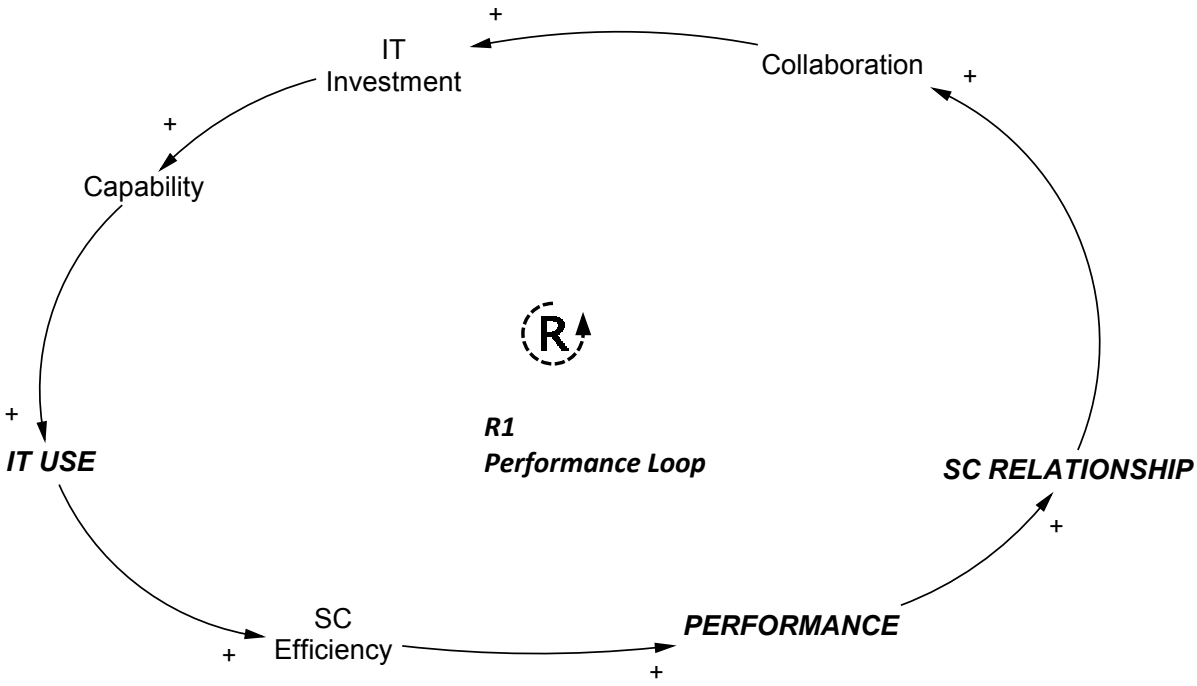


Figure 6 Trust and commitment loop

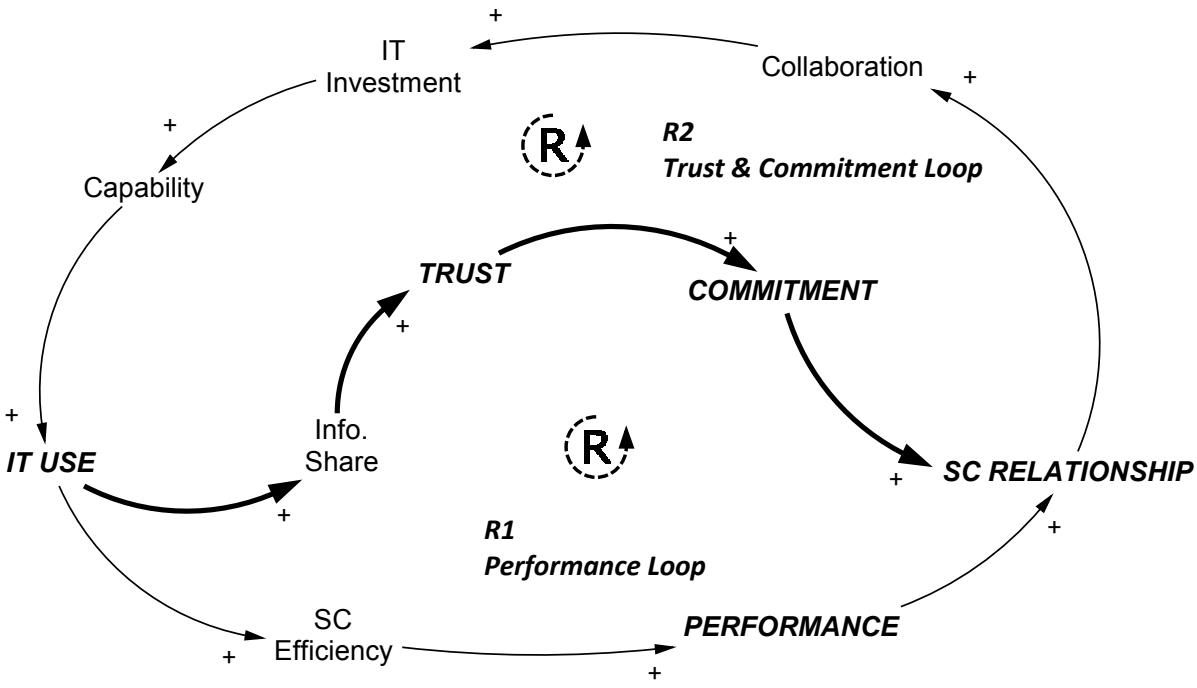


Figure 7 Reinforcing IT use, trust, and info share

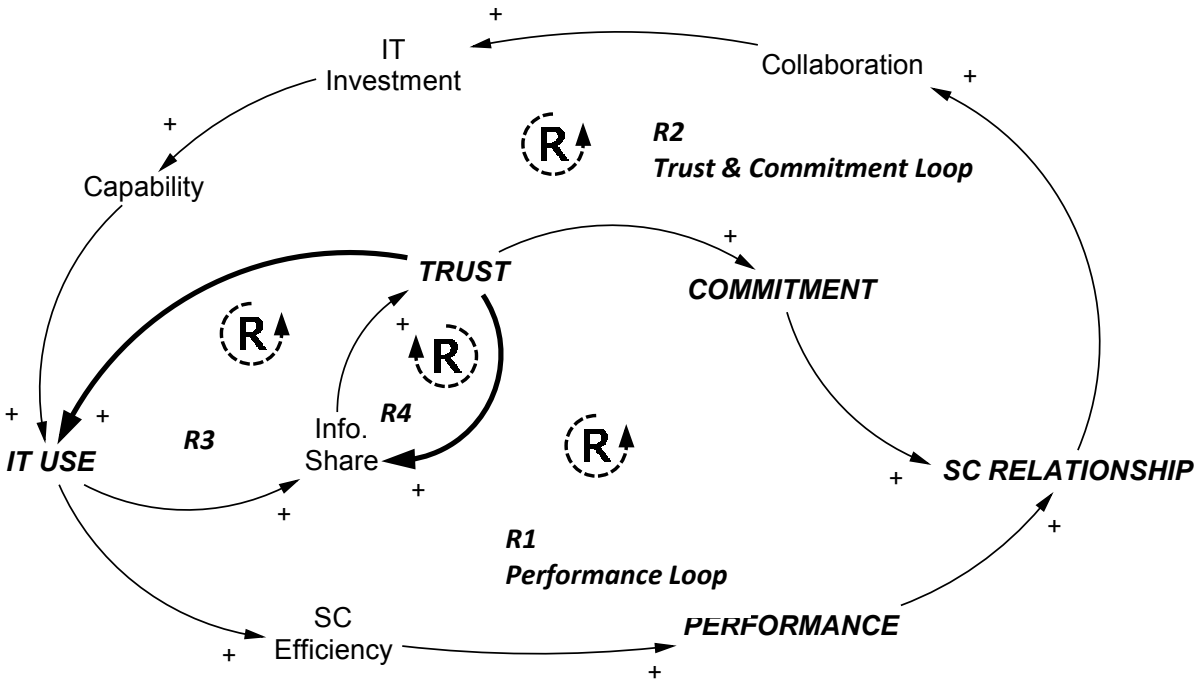


Figure 8 The complete initial model

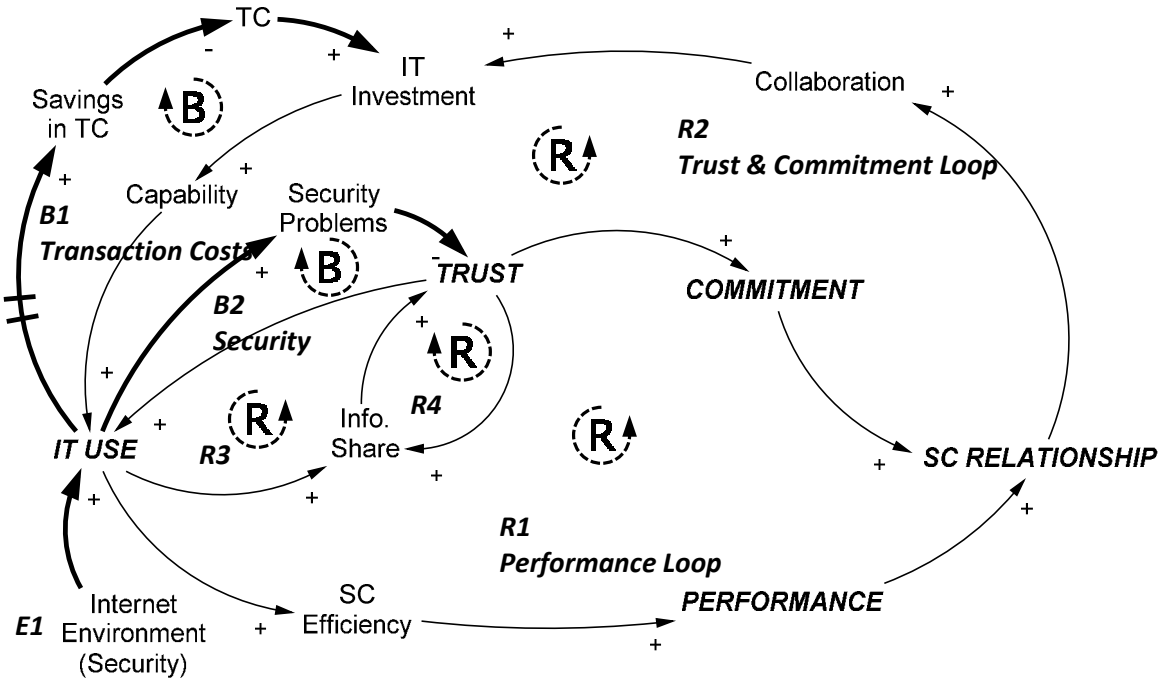


Figure 9 Behaviour of supply chain relationship over time

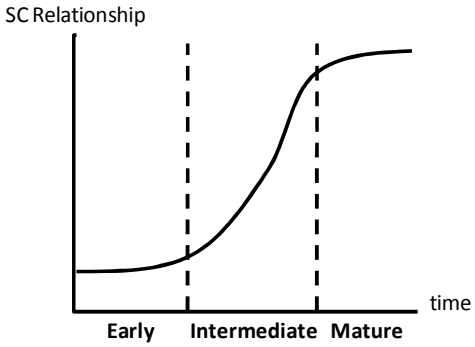


Figure 10 Final validated model

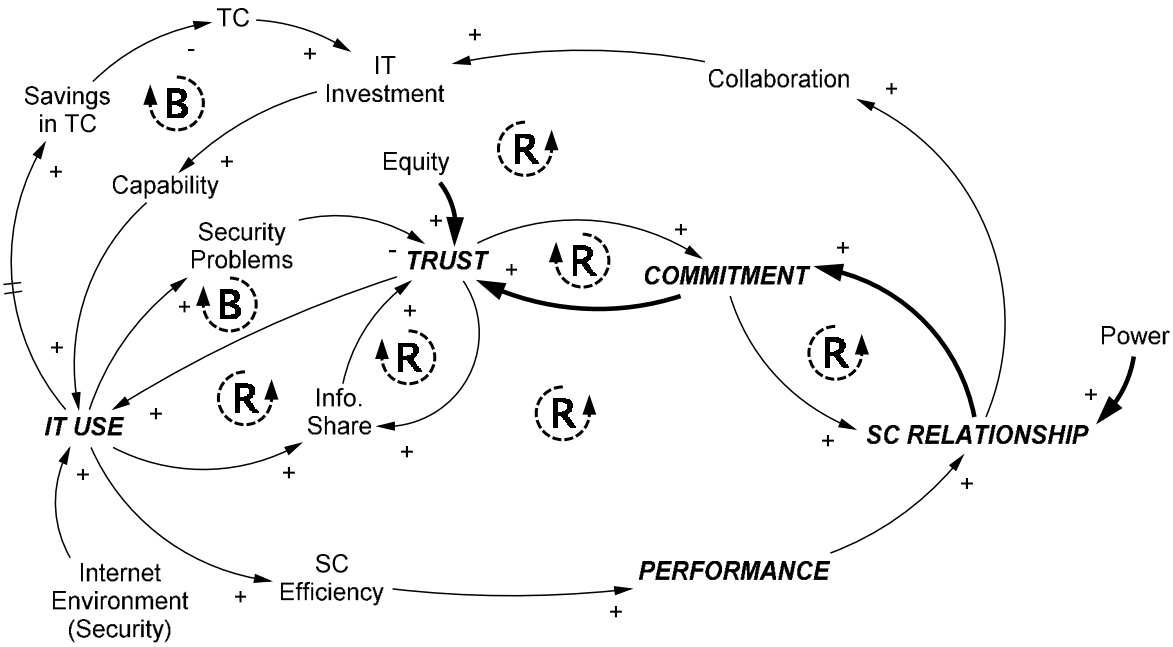


Figure 11 Categorisation of the participating company pairs

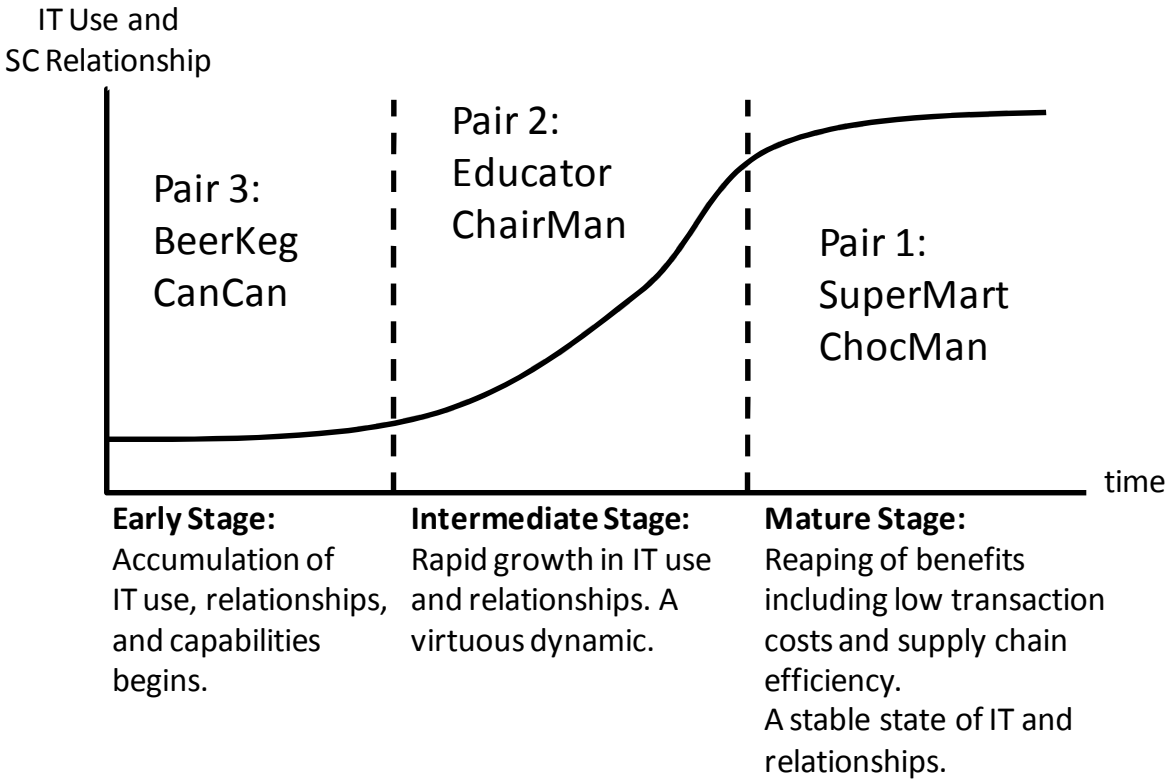
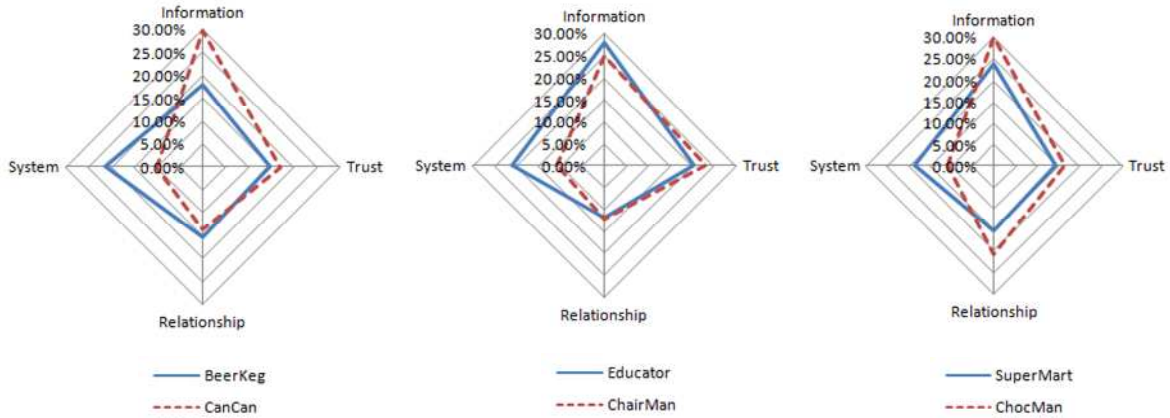


Figure 12 Radar charts and rankings of the participating company pairs' key themes



Ranking	BeerKeg	CanCan
1	System	Information
2	Information	Trust
3	Relationship	Relationship
4	Trust	System

Ranking	Educator	ChairMan
1	Information	Information
2	System	Trust
3	Trust	Relationship
4	Relationship	System

Ranking	SuperMart	ChocMan
1	Information	Information
2	System	Relationship
3	Relationship	Trust
4	Trust	System

TABLES

Table 1 Model variables and descriptions

Variable	Description
SC Relationship	The level of relationship between vendors and buyers. The higher the level, the closer they are related. Relationship is a basis of other variables including commitment, trust, and collaboration.
Trust	The level of trust is the extent to which relationship partners perceive each other as credible and benevolent (Nyaga et al. 2010). In a vendor/buyer context, both parties in trust believe that the other party is honest and competent (Ryssel et al. 2004), and that all communications and exchange of information must be held in confidence.
Commitment	Commitment is about the exchanged belief of partners having an ongoing relationship, and that the relationship is being maintained with maximum efforts from both parties (Nyaga et al. 2010). Committed parties believe that the relationship is valuable or worthwhile to work on and warrant that it endures.
Info. Share	This represents the extent that critical information is conveyed to a party's relationship partners. Information exchange in a supply chain context includes order details, inventory levels, demand and distribution data.
IT Use	The use of general supply chain technologies. This includes common supply chain collaboration information systems including Vendor Managed Inventory and Electronic Data Interchange.
IT Investment	A company's level of investment in supply chain information technology.
SC Performance	The key measure of a supply chain's performance is the ability of a company to deliver value to the products' end users.
Capability	A company's ability to perform. This includes on time delivery, quality of products, flexibility in terms of time and volume.
Collaboration	A critical success factor in effective supply chain management. In order to function as a whole, individual businesses in supply chains must collaborate in terms of communication, collaborative product design, coordination of production and delivery (Li et al. 2011).
Security Problems	This variable addresses the frequency and seriousness of data exchange security problems including accuracy and potential 'leaks' of critical and confidential trade information.
Internet Security	This variable is about the internet environment with respect to security. This involves information exchanged between companies and other forms of communications.
SC Efficiency	Efficiency of supply chain in this model is related to the ease of transferring transactional information, monitoring exchange data, and functional cooperation. (Carr et al. 2002, Grover et al. 2002)
Transaction Costs	Costs involved in company interactions in supply chains, including information exchange, procuring supplier and product information, bargaining, and policing & enforcement (Grover, 2002).
Savings in Transaction Costs	Reductions in Transaction Costs

Table 2 Theoretical supply chain dynamics

Reference	Relationships
Stuart 1997	More Commitment → Better Relationships
	More IT Investment → Higher Capability
	Higher Capability → More IT Use
	More Collaboration →More IT Investment
Nyaga et al. 2010	More Commitment → Better Relationships
	Better Trust → More Commitment
	More Info. Share → Better Trust
Min et al. 2005	Better Trust → More Commitment
	Better Trust → More Info. Share
Samadder et al. 2006	More IT Use → More Info. Share
	Better Trust → More IT Use
	More IT Use → Better Trust
Anand et al. 1997	More IT Use → More Info. Share
Dyer et al. 2000	More IT Use → More Info. Share
Lee et al. 1997	More IT Use → More Info. Share
Carr et al. 2002	Higher Internet Security → More IT Use
	More IT Use → Higher SC Efficiency
	Higher SC Efficiency → Higher Performance
	Higher Performance → Better Relationships
Grover et al. 2002	Higher Performance → Better Relationships
	Better Relationships → More Savings in TC
	More Savings in TC → Lower TC
	Lower TC → Less need for further Investment in IT
Chung et al. 2007	Better Trust → Better Relationships

Table 3 Background of participating companies

Pair	Company	Role	Industry	Description	Relationship Age (years)
1	SuperMart	Buyer	Retail	The largest super market brand in NZ	50+
	ChocMan	Vendor	Manufacturer and wholesaler	Major global confectionery manufacturer	
2	Educator	Buyer	Service Organisation	Major tertiary institution in NZ	10+
	ChairMan	Vendor	Manufacturer and wholesaler	Major furniture manufacturer in NZ	
3	BeerKeg	Buyer	Manufacturer	Major liquor manufacturer in NZ	20+
	CanCan	Vendor	Manufacturer	Mid-Large Australasian packaging manufacturer	

Table 4 Percentage counts of key themes

Themes	SuperMart	ChocMan	Educator	ChairMan	BeerKeg	CanCan
Information	23.73%	29.75%	27.96%	25.00%	17.95%	29.66%
Trust	14.41%	16.53%	20.43%	22.86%	14.53%	16.95%
Relationship	15.25%	20.66%	11.83%	12.14%	15.38%	13.56%
System	18.64%	10.74%	20.97%	10.71%	21.37%	10.17%
Total	72.03%	77.68%	81.19%	70.71%	69.23%	70.34%

APPENDIX A – DISCUSSION OF THE FOUR KEY DRIVERS OF SUPPLY CHAIN RELATIONSHIPS

Trust

Trust refers to the extent to which relationship partners perceive each other as credible and benevolent (Ganesan 1994, Nyaga et al. 2010). A reasonable level of trust is central to business relationships and can take many forms (Young 2006, Hansen 2009). These include (Sako 1990, Crousings 2002): contractual trust, goodwill trust and competence trust.

Trust can also be engendered from different sources. For example, supplier trust (ie. Toward the vendor) and supplier representative trust (ie. Toward the sales person as an individual). (Hansen 2009). Different levels and mixes of these two sources of trust can result in different impacts in business relationships.

Business partners with a high level of trust have the willingness to commit resources into the relationship as a long term investment.

Commitment

Commitment is about the exchanged belief of partners that having an ongoing relationship is the foundation for achieving or maintaining maximum efforts (Nyaga et al. 2010). A common example of commitment is the collaborative relationship between Japanese car makers and their suppliers, being the key success factor contributing to the rise of the Japanese vehicle industry in the global market since the late 1980s (Womack, 1991).

The longevity of relationships is the highlight of commitment between business partners. “Long-term orientation” is often featured in relevant literature (Anderson et al. 1992, Moorman et al. 1992, Ryssel et al. 2004), which specifies that partners committed with long-term vision commits significant resources to the relationship, which may include time, money, facilities (Sheu, 2009), and also the sharing of information including inventory levels, market demand, forecasts, and planning of changes in the future and/or anticipated disruptions on the horizon (Stuart 1997).

Performance

Supply chain performance refers to the extent to which a supply chain meets end-customer requirements, and contains operational efficiencies which can deliver that performance (Hauseman 2005). Thus the effectiveness and efficiency by how well these two goals are met are central to the performance in supply chains (Lao 2010).

The selection of suppliers based on price or costs alone is seldom seen in business-to-business relationships today (Batson 2011), while performance in other aspects of operations is commonly featured as selection criteria for vendors in outsourcing strategies. Key measures of performance include the vendors' status in terms of quality, flexibility, and delivery (Pyke 1997).

Quality is an important feature that enables operations to sustain their competitive advantage and maintain growth levels. The quality of a company's output depends not only on its own quality but also the supplier's quality (Hwang 2006). One key advantage in ensuring quality from suppliers is the efficiency as a result of the elimination of inspections on incoming goods and the process of resolving quality issues. Cusumano and Takeishi's (1991) survey of Japanese supply chain management practices shows that eliminating inspection in Japanese automobile supply chains (as a result of quality guarantees from suppliers) increased throughput and enhanced response time. Lamming (1996) also showed significant throughput enhancement when inspection can be eliminated, thus directing managers' attention to fixing production processes problems and improvements.

Flexibility, being another feature in supply chain performance, enables companies to adapt to environmental changes by building and applying resources residing in the supply base (Lao 2010). Supplier flexibility refers to the extent of responsive abilities through the use of supplier-specific capabilities. Suppliers lacking ability to react to variances effectively and with efficient utilisation of resources will limit the flexibility potential of even those capable business partners. Flexibility accrued from suppliers help companies to better manage pressures from environmental uncertainties (Lao 2010).

Performance in delivery is another important aspect in vendor selection and thus, supply chain relationships. Theories featured in Gardiner (2006) promoted two key dimensions in delivery as "speed" and "accuracy", that good performance in delivery performance must be quick and efficient in the delivery process, and also be accurately conforming to the agreed delivery schedule. Speedy deliveries arriving at the buyer way ahead of scheduled date/time is not necessarily considered as good delivery performance. Moreover, delivery performance is particularly critical in lean environments where frequent deliveries of small lot sizes are often required by buyers.

Information and IT Use

Information sharing is the extent that critical information is conveyed to a party's relationship partners (Mohr et al. 1994, Nyaga et al. 2010). It has been seen as a critical factor for collaborative relationships, beneficial to both partners, and it enables organisations to have a more efficient product flow (Anand et al. 1997, Lee et al. 1997, Dyer et al. 2000, Samaddar et al. 2006). As a result, inventory levels of material and finished products may be reduced, and thus reductions in total costs (Yu et al. 2001, Samaddar et al. 2006).

In the late twentieth century, inter-firm communication was found to be a core feature in a collaborative relationship. To some extent, it could be seen as an important strategy for an organisation to develop a relationship with suppliers (Krause 1999, Nyaga et al. 2010). Min et al. (2005) also commented that joint effort based on trust is not only the key for successful collaborative relationships, but it is also related closely to information sharing.

Information sharing is greatly enhanced by the use of information technology (IT). According to Ryssel et al. (2004), IT includes not only computer hardware, software, but also communication systems. Such systems support organisations doing business between an enterprise and outside of organisational boundaries (Jonston et al. 1988, Ryssel et al. 2004). They employ processing systems and provide communication channels for commercial transactions, information exchange and knowledge sharing between organisations (Croom, 2005). It must be noted, however, that while the

use of IT facilitates efficient information sharing, the use of IT does not augment the level of the richness of information shared (Carr et al. 2002).

IT capabilities appear to be a crucial factor for collaborative relationships (Sabath et al. 2001). Previous studies suggested the significant, positive role of IT in interorganisational collaboration. For example, IT use in buyer supplier exchanges leads to closer cooperative relationships (Bakos et al. 1993). Sriram et al. (1994) support the view that electronic data interchange (EDI) could develop closer partnerships between buyers and suppliers. Bowersox et al. (1995) highlight accuracy and timeliness as important elements of logistics information quality (Sheu 2009).

APPENDIX B - BASIC SYSTEMS MODELLING WITH CAUSAL LOOPS AND BEHAVIOUR OVER TIME IMPLICATIONS

A basic overview of the dynamic modelling methodology (causal loop diagrams) is discussed using the population model (Maani et al. 2007).

A simple population model consists of three variables: population, births and deaths. Linear relationships between these variables are:

More births → Higher population

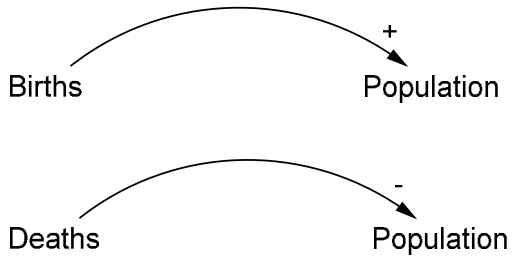
Higher population → More births

More deaths → Lower population

Lower population → Less deaths

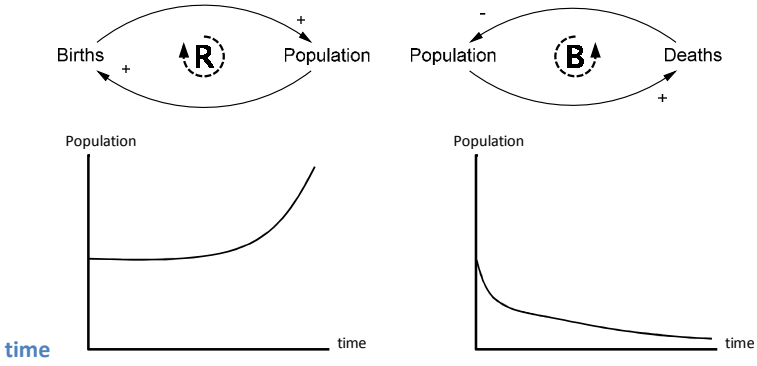
Using causal loop diagrams, the dynamics of population can be modelled over time using causal links specifying the polarity of the relationships between variables ("+" representing positive relationships and "-" representing negative relationships). Examples of such causal links between two variables are presented in Figure 13.

Figure 13 Examples of causal links



Note that the relationships portrayed in Figure 13 are still linear. In order to model the dynamics over time, such relationships are combined to form 'feedback-loops', as shown in Figure 14.

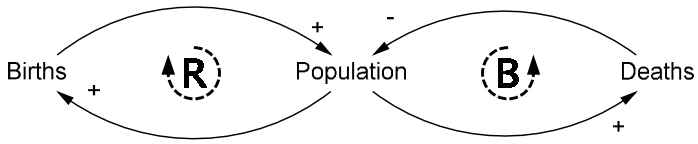
Figure 14 Reinforcing and balancing loops and their behaviour over



The "birth – population" reinforcing loop on the left consists of two positive relationships. While births contribute to population, population contributes also to births. Therefore, the behaviour over time of this feedback loop shows an exponential growth, a virtuous cycle. The "death – population" balancing loop on the right consists of one positive and one negative relationships. While population contributes to deaths (more deaths occur when there are more people in the population), deaths in turn reduces population. The dynamic of this feedback loop shows a balancing pattern, where population drops through time at a diminishing rate.

A simple population model is created by combining these two feedback loops, as shown in Figure 15.

Figure 15 The population dynamic model



Based on the parameters of the variables (such as birth and death rates, timing of births and deaths), the behaviour of population over time can be modelled using this causal loop diagram.

The causal loop modelling methodology is used in this study to model supply chain dynamics among supply chain relationships and its four proposed key drivers.

APPENDIX C – BACKGROUND OF PAIRED PARTICIPATING COMPANIES

Pair 1 (SuperMart and ChocMan) are categorised into the 'mature' stage as they are both leading companies in their industries, with integration dating back more than 50 years. Both companies had a large amount of information and operational data shared internally among branches all over New Zealand and externally with business partners. For this, critical IT systems were gradually established over the past 50 years.

The second phase of supply chain relationship, the 'intermediate' stage, is represented by Pair 2 (Educator and ChairMan). Even though their history of integration dates back only ten years (less than Pair 3's 20 years), their IT integration is more advanced. The information systems are partially integrated at multiple levels of management. Information about purchase orders, delivery progress and confirmation, and invoicing and account settlement are all enabled on the IT link. The buyer's opinion is that there is much room for improvement in their use of IT and their relationship. However, such improvements are restricted by the vendor's capabilities to further their IT investments.

Pair 3 (BeerKeg and CanCan) are considered as an example of the first phase, the 'early' stage. Even though the pair has had close dealings for more than twenty years, their inter-organisational IT integration has only been established recently to meet basic manufacturing requirements. Information exchange between the pair is mainly based on phone calls and emails (involving spreadsheet and word processed document interfaces). BeerKeg, however, currently possesses the "largest SAP system in terms of manufacturing in New Zealand", and they are planning to integrate SAP with their major customers and suppliers (including CanCan) in the next three to five years.