



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

University of Wollongong  
**Research Online**

---

Faculty of Engineering - Papers (Archive)

Faculty of Engineering and Information Sciences

---

2011

# Managing The Multi-Agent Supply Network: Agents Relationships, Risk, and Collaboration

Abdelrahim Alnatour

*University of Wollongong, uow@alnatour.edu.au*

Peter Gibson

*University of Wollongong, peterg@uow.edu.au*

<http://ro.uow.edu.au/engpapers/1633>

---

## Publication Details

Alnatour, A. & Gibson, P. (Ed.). (2011). CBEC. UK: Cambridge.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library:  
[research-pubs@uow.edu.au](mailto:research-pubs@uow.edu.au)

# **Managing The Multi-Agent Supply Network: Agents Relationships, Risk, and Collaboration**

Abud Natour, Peter Gibson

University of Wollongong  
Wollongong NSW 2522 Australia

## **1. ABSTRACT**

This paper discusses some agency theory aspects that apply to the modern supply network. The discussion extends to cover how agency theory influences and affects business relationships in modern industrial supply networks. The underlying correlation between agency theory and the overall supply network performance is investigated by reviewing the existing literature. The paper also overviews a current research in progress, the research is concerned with performance and how it can be improved through reducing risk and improving collaboration in a multi-agent supply network. Flexibility and agency cost are proposed metrics for measuring performance from an organizational, agency perspective. The research main objective is attempting to improve overall multi-agent, supply network performance. The research focuses on how agency problem can detract from the value that a supply network can generate. In conclusion, through the application of agency theory, adjusting things like risk and collaboration in supply network will result in improved relationships between agents. Improved network relationships are expected to improve the overall performance of the network. The performance can be measured by utilizing metrics like flexibility and agency cost.

**Keywords:** Agency theory, Organizational relationships, Collaboration, Risk.

## **2. INTRODUCTION**

Over the past four decades, competitive advantage has been obtained in many industries by building supply network relationships between involved agents, this relationship building activity became known as supply chain management. In the mean while, the supply chain concept expanded to cover the supply network. According to (Swaminathan, Smith et al.

1998) a supply network is a group of autonomous or semiautonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products or services. Understanding business relationships within a supply network, as well as performance evaluation are essential prior to any attempts for improvement. Business relationships within a multiple agent network have one more dimension of complexity to them; the multiple agents can in reality be different parties interacting with each other. The agents tend to sometimes plan, think and as a result perform as individual entities within this overall supply network.

This paper emphasizes that without giving consideration to agency theory, it is likely that multi-agency will negatively impact, and degrade the supply network. With the ever increasingly competitive markets, and globalization, the dependencies and relationships between network agents are becoming more and more important (Garcia-Flores, Wang et al. 2000). On the other hand, managing the relations between network agents does not only mitigate potential losses, it also can lead to acquiring leverage and competitive advantage from multi-agency. The paper also presents the progress of a current, relevant research in progress. The research investigates how a better supply network performance can be achieved through managing agent's relationships.

Reducing risk and improving collaboration between agents can improve the network relationships. Risk can be limited through improved visibility and by redistributing power and control more evenly between agents in the supply according to (Christopher and Lee 2004). Improving collaboration is mainly achieved by sharing of information between agents (Skjoett-Larsen, Christian et al. 2003). Since visibility is the ability of agents to see what is happening in other parts of the network, both sharing of information and visibility are closely related. This means that both collaboration and reduced risk are mutually compliant with each other and that neither one of them can be achieved separately.

### 3. CONCEPTUAL FRAMEWORK

#### 3.1. Agency Theory and The Agency Problem

According to (Jensen and Meckling 1976) if agents interacting in a relationship are self interested and seeking their own benefit, there is a good reason to believe that a given agent will not always act in the best interest of other agents, this is **“the agency problem”**. The

multiplicity of agents, in the light of some human and organizational assumptions, makes way for the agency problem (Eisenhardt 1989). Agency theory is in place whenever one party (principal) delegates a task to another party (agent) and transfers the decision-making authority with this delegation (Eisenhardt 1989). There may be several opportunities for improvement wherever two or more parties engage in a cooperative effort in a supply network through aligning their goals and expectations.

Much of the existing research on agency theory addresses how it captures multi-agency effects on a supply network. Nevertheless, there is scarce theoretical or empirical research on how to measure and control the agency problem, a rather important aspect that this work sees as a great supply network improvement opportunity. This work adopts the term “Agency Problem” to describe the impact of multi-agency on a supply network; including the inherent goal conflict problem.

Arguably, multi-agency can lead to the agency problem, which can detract from the value that the supply network can generate and negatively affect its performance (Ross 1977; Eisenhardt 1989; Cohen and Baruch 2010). On the other hand, (Janssen 2005) holds an adversarial view; having a multi-agent system increases the level of flexibility in the supply network and enables supply network members to become more responsive. In the light of this paradox, both views on multi-agency can be true. In a supply network, multi-agency can have severe consequences and it is almost guaranteed that the agency problem will have a negative effect on the network, this supports the views of (Eisenhardt 1989). Still true, if networks agent-relationships are managed, multi-agency can become an advantage and the network can possibly gain leverage from the agency situation.

### **3.2. Mitigating Risk In The Supply Network**

After establishing the importance of managing supply network relationships, the paper moves to theoretically discussing how they can be managed and improved. A critical element in achieving supply chain effectiveness is establishing and nurturing trust across the supply network boundaries, particularly for relationships such as alliances between agents (Johnston, McCutcheon et al. 2004). Risk and the risk culture are some of the aspects that predominantly influences how agents interact in a supply network. The main conflict arises from how every individual agent perceives risk and how they handle it. Risk exists whenever there is a relatively high likelihood that a detrimental event can occur and that the event has a significant associated impact or cost (Zsidisin, Ellram et al. 2004). By reducing this

likelihood of detrimental events occurring, the uncertainty can be almost eliminated from the equation. (Christopher and Lee 2004) suggests that there are two ways to reduce risk in the supply network: visibility and control. If one or more agents cannot see what is going on in other parts of the supply network, they are said to have lack of visibility. Lack of visibility weakens trust and confidence in the supply network. The key to improved visibility in supply network is shared information among supply networks agents. In addition to visibility, fostering trust between agents in a supply network requires giving them the ability to take some control over supply chain operations. In looking to improve control across the wider supply network, a more collaborative approach to control is required.

(Griffith, Harvey et al. 2005) challenges the theory of “more control improves trust”. Control can be a bad thing for two reasons; 1- the supply network can only develop and improve as fast as the most dominant agent when control is not distributed evenly, or when it is concentrated, and 2- having a dominant agent with too much control weakens trust in the supply network because other agents will lack control as a result. Trust has been found to be beneficial to organizations in general by helping avoid costs incurred due to the monitoring and searching for evidence of opportunism, which can occur in the absence of trusting relations, this is the précis of Transaction cost economics (Nooteboom and Six 2003). In the same way, mitigating risk and building trust between agents will result in reduced agency cost. This is mainly because trust will minimize the need for monitoring the performance and behavior of other agents in the supply network.

### **3.3. Collaboration Between Agents**

Information flow and sharing of information between agents is very important for collaboration in the supply network. Integration is the comprehensive collaboration among supply network members in strategic, tactical and operational decision-making (Bagchi, Ha et al. 2005). Collaboration in a supply network ensures that a community of individual agents acts in a collaborative and coherent manner (Davidsson, Henesey et al. 2005). Collaboration is a way of describing relationships that embrace both conflict and partnership, implying some form of mutuality without an apparent need for lifetime commitment, as compared to using partnership to describe the relation (Vereecke and Muylle 2006).

Through joint planning and synchronization of business processes, agent-agent dyad go beyond passive information exchange and engage in proactive collaboration (Lummus, Vokurta et al. 1998). One of the requirements for collaboration on the strategic level is

having shared objectives. In theory, sharing same objectives and goals is part of the solution for the agency problem. By aligning the goals of agents within the network, collaboration can be part of the answer for the goal conflict problem that the agency theory is all about resolving. A collaboration that is achieved by sharing information in the supply network also improves visibility and trust. Improved trust and visibility reduce risk, in the same line of what was discussed by (Christopher and Lee 2004) in the previous part 3.2 on how this will improve the relationships between agents and consequently the overall performance.

### **3.4. Metrics and Performance Measurement**

Supply network metrics are crucial to supply network management and they can be used to determine whether or not the objectives of the supply network are being achieved and addressed (Otto and Kotzab 2003; Robertson 2006). Measuring performance can be utilized for monitoring expected improvements from adjusting supply network relationships and collaboration. In their model, (Otto and Kotzab 2003) have identified six different perspectives for measuring performance of the supply network. The six perspectives are systems dynamics, operations research-perspective, Logistics, Marketing, Organization and Strategy. This research also adopts that from a technical point of view, there are two alternative approaches to measure results of supply network management: making profits and reaching goals. Making profits is one of the important metrics as far as this work is concerned. One of the metrics proposed by the research reviewed in this paper to measure performance to monitor improvement is agency cost, which falls in the same category with making profits.

Organization perspective is found the most relevant to the case in hand. Metrics from this perspective are utilised in this research to measure the agency problem and its effect on supply network. Following the organization perspective, the ideal supply network supports the achievement of the overall networks goals by selecting and managing appropriate relationships between the agents within the network and between the network and its environment.

According to (Otto and Kotzab 2003) the solution, from an organisation perspective, lies in things like quality check of the relationships and replacing power with trust. Checking the quality of relationships within the supply network between agent's means to rearrange and set up those relations in an SCM-manner. (Ellram and Cooper 1993) discusses that a supply network may try to optimize its results as a whole by specifically analysing and managing the trade-offs among internal functions and between its agents. (Otto and Kotzab 2003) model

proposes transaction costs, time to network, flexibility and density of relationships as metrics from the organizational perspective. This research focuses on flexibility and transaction costs. Transaction costs is being represented as agency cost.

The flexibility of the institutional arrangement, or supply network in this case, may measure how “easily” a particular organizational set can be changed. Transaction costs is usually defined as a bundle of costs incurred by the processes of preparing routine business conduct. This bundle includes the costs of searching business partner or agents, monitoring the performance of agents, or adapting contracts. (Jensen and Meckling 1976) alternatively reintroduce the transaction cost as agency cost from an agency theory perspective. Agency cost is defined as the sum of: 1- monitoring costs incurred by the principal, 2- bonding costs incurred by the agent, and 3- residual loss. Bonding costs are costs incurred by agent to guarantee that they will not take certain actions that would harm the principal or to ensure that the principal will be compensated if he does take such actions. Residual loss is the financial value equivalent of the actual reduction in welfare experienced by the principal in the agency relationship. As previously mentioned, the research in review adopts agency cost and flexibility to measure the supply network performance in the light of agency theory and while considering supply network relationships.

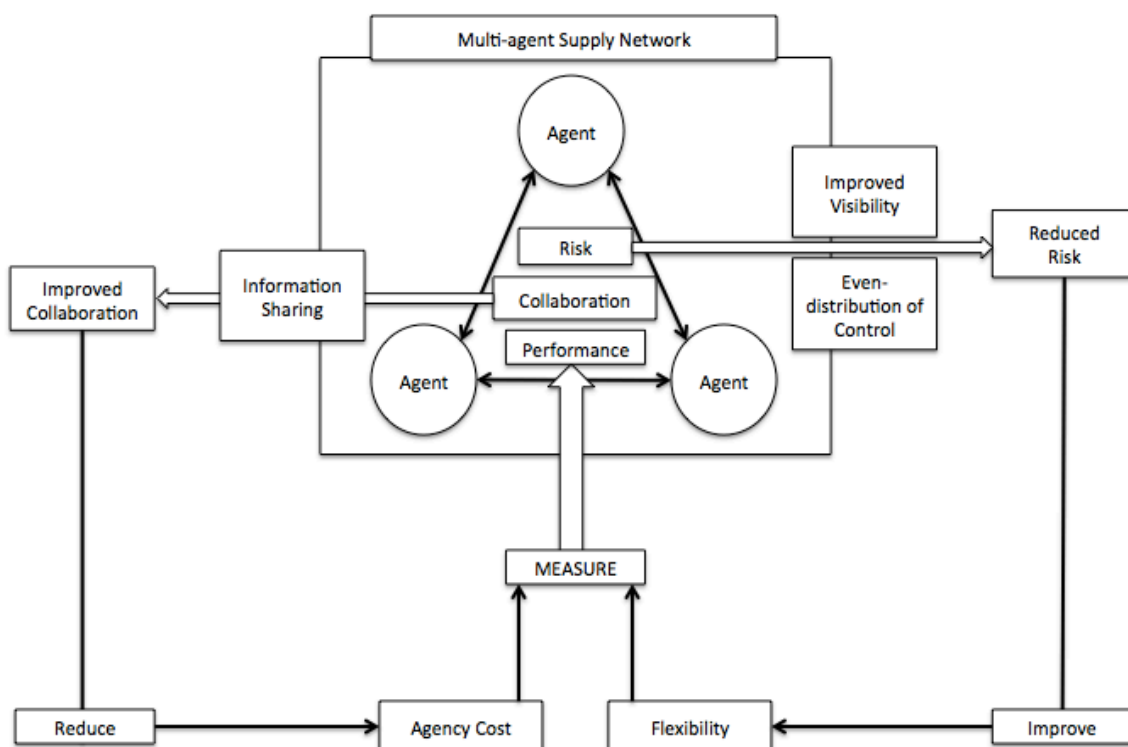
#### 4. DISCUSSION

Ignoring the component dependencies between agents in a supply network, and not managing their relationships can have costly consequences for the network and its overall performance (Garcia-Flores, Wang et al. 2000). Existing agency theory literature seem to have a well-established direction supporting the condemnation of the agency problem and its negative impact on supply network, making multi-agent systems sound undesirable and not preferable. According to (Ross 1977; Eisenhardt 1989), risk-sharing problem is one that arises when cooperating agents have different attitudes towards risk; agency theory broadened this risk-sharing literature to include the so-called agency problem that occurs when cooperating agents have different goals and vision.

It is important to answer the question of whether multi-agency can be an advantage or not, the question arises from the discussion in previous paragraph. The answer assists in better understanding supply network management and effectiveness. **Figure 1** next page illustrates

the relation between agency theory, risk, and collaboration in a multi-agent supply network. (Janssen 2005) found that the multi-agent system increases the level of flexibility in the supply network and enables supply network agents to become more responsive. This has a positive impact on the network performance, but it can only be achieved through managing the relations between agents. A big part of managing relations between agents is managing risk and collaboration in the supply network.

This paper suggests that the answer to the agency problem lies in controlling risk and encouraging collaboration in the supply network. A critical element in achieving supply network effectiveness is establishing and nurturing trust across the supply network boundaries, particularly for relationships such as alliances between agents (Johnston, McCutcheon et al. 2004). Risk in the supply network drives agent’s behaviors and attitudes. The more risk an agent can sense in the surrounding network, the more risk-averse they will become. This will change their behavior towards other agents and the whole network. The agent’s flexibility is expected to reduce as a result.



**Figure 1: Overview of current research: managing risk and collaboration, and expected effect on Supply network.**



Risk and uncertainty can be minimized through improving visibility as demonstrated in **Figure 1**. If one or more agents of a supply network have no detailed knowledge of what goes on in other parts of the network, they will face uncertainty. Hence, improving visibility and sharing information can eliminate uncertainty. Sharing information can also be means to improved collaboration between agents. According to (Skjoett-Larsen, Christian et al. 2003) the concept of supply chain management was introduced in the 1980's in accordance with the great focus on information-sharing collaboration. Collaboration changed agents relationships in supply networks from "arms-length" relations, which are characterized by distrust and competition to "strategic partnerships". In addition to visibility, supply chain confidence requires the ability to take control of supply chain operations (Christopher and Lee 2004). Paradoxically, control is not always good. Too much control, or concentrated distribution of control between agents makes for lack of trust, it can also cripple the development of the network.

Another key component for finding leverage in multi-agency in a supply network and acquiring competitive advantage is performance monitoring. Supply network metrics are crucial to supply network management and they are used to determine whether or not the objectives of the supply network are being achieved and the addressed (Otto and Kotzab 2003; Robertson 2006). Measuring performance is a way of monitoring expected improvement from adjusting supply network relationships and collaboration.

As illustrated in **Figure 1**, the relationship between agents in the supply network is surrounded by risk, with some level of collaboration between the agents. The plan is to improve supply network relationships by applying some adjustments. Reducing risk and improving collaboration achieve this intended adjustment. Reducing risk is done through improving visibility, information sharing, and trying to redistribute control more evenly. Control can be distributed evenly by giving all agents some control over the supply network processes to some extent. Collaboration in turn is improved by sharing information freely between agents. The information sharing strategy is expected to deliver on much more than just improved collaboration, information sharing also improves visibility as discussed earlier, visibility in turn replaces risk with trust and eliminates uncertainty. Once the supply network relation adjustments are achieved, the expected performance improvement is to be monitored by utilizing supply network metrics. Both flexibility and agency cost are used to monitor performance improvements. Flexibility is expected to increase by reducing risk and adopting an information sharing strategy in the network. Agency cost is expected to significantly

reduce by improving collaboration and trust. A comparison between flexibility and agency cost prior to- and after change in network relationships closes the feedback loop back to the supply network as demonstrated on **Figure 1**. A positive change in either or both metrics is an indicative of a successful attempt for improvement.

## 5. RESEARCH

The identified research problem is “the divergence between ideal and actual supply network relationship set up”. For the purpose, the following research question was set to direct the research:

*“To what extent, and how does multi-agency affect relationships, risk, and collaboration in a supply network and what is its impact on overall performance?”*

The following hypotheses were developed for the purpose of this hypotheses-testing research:

H1: *Agency problem in a given supply network will increase agency costs incurred by agents and reduce flexibility.*

H2: Agency cost and flexibility provides an accurate indication of how negatively agency problem is affecting performance in a given network.

H3: Performance can be improved by changing supply networks collaboration, and trust after understanding agency problems impact.

The research is currently still in its early stages. After developing the research question and hypotheses a thorough review of the relevant literature was carried out, the literature review is being finalized. The next step would be to start designing an electronic survey for data collection. Once the data is collected, the next step would be to analyze the data and interpret it. The outcome is expected to either support or defy the hypotheses developed.

A future suggested direction from this discussion would be:

Q1. Is multiplicity of agents in a supply network good or bad?

Q2. Does culture affect whether or not multiplicity of agents can be an advantage?

## 6. REFERENCES

- Bagchi, P. K., B. C. Ha, et al. (2005). "Supply chain integration: a European survey." The International Journal of Logistics Management **16**(2): 275-294.
- Christopher, M. and H. Lee (2004). "Mitigating Supply Chain Risk through Improved Confidence." International Journal of Physical Distribution and Logistics Management **34**(5): 388-396.
- Cohen, A. and Y. Baruch (2010). "An agency theory perspective of the Israeli labor market segmentation: past, present, and future." Human resource management review **20**(2010): 186-193.
- Davidsson, P., L. Henesey, et al. (2005). "An analysis of agent-based approaches to transport logistics." Transportation Research: 255-271.
- Eisenhardt, K. M. (1989). "Agency theory: assessment and review." Academy of management journal **14**(1).
- Ellram, L. M. and M. C. Cooper (1993). "The relationship between supply chain management and Keiretsu." The International Journal of Logistics Management **4**(1): 1-12.
- Garcia-Flores, R., X. Z. Wang, et al. (2000). "Agent-based information flow for process industries' supply chain modelling." Computers and Chemical Engineering **24**: 1135-1141.
- Griffith, D. A., M. G. Harvey, et al. (2005). "Social exchange in supply chain relationships: The resulting benefits of procedural and distributive justice." Journal of operations management, **24**: 85-98.
- Janssen, M. (2005). "The architecture and business value of a semi-cooperative, agent-based supply chain management system." Electronic commerce research and applications **4**: 315-328.
- Jensen, M. C. and W. H. Meckling (1976). "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." Journal of Financial Economics **3**: 305-360.
- Johnston, D. A., D. M. McCutcheon, et al. (2004). "Effects of supplier trust on performance of cooperative supplier relationships." Journal of Operations Management, **22**: 23-38.
- Lummus, R. R., R. J. Vokurta, et al. (1998). "Strategic supply chain planning." Production and planning Journal **39**(3): 49-58.
- Nooteboom, N. and F. Six (2003). Introduction in The Trust Process in Organisations. Gloucestershire, UK, Edward Elgar Publishing Ltd.
- Otto, A. and H. Kotzab (2003). "Does supply chain management really pay? Six perspectives to measure the performance of managing a supply chain." European Journal of Operational Research **144**: 306-320.
- Robertson, P. W. (2006). The impact of supply chain process integration on business performance. School of business management Sydney. Wollongong, University of Wollongong. **PhD**: 1-303.
- Ross, S. A. (1977). "Decision making under uncertainty." American Economic Association **63**(2): 134-140.
- Skjoett-Larsen, T., T. Christian, et al. (2003). "Supply chain collaboration: theoretical perspective and empirical evidence." International Journal of Physical Distribution and Logistics Management **33**(6).
- Swaminathan, J. M., S. F. Smith, et al. (1998). "Modelling supply chain dynamics: A multiagent approach." Decision sciences **29**(3).

- Vereecke, A. and S. Muylle (2006). "Performance improvement through supply chain collaboration in Europe." International journal of operations & production management **26**(11): 1176-1198.
- Zsidisin, G. A., L. M. Ellram, et al. (2004). "An analysis of supply risk assessment and techniques." International Journal of Physical Distribution and Logistics Management **34**(5): 397-413.