THE SUPPLY CHAIN FEATURES AND RISK MANAGEMENT

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Abstract:

The purpose of this paper is to investigate the research development in supply chain field, which has shown an increasing global attention in recent years. Literature survey is used to fulfill the research task which has undertaken a thorough search of articles from the web of sciences database. This shows trends of rising publications over the past 10 years.
In addition and in order to evaluate the supply chain features and their effect on the environment, we have made a survey based on setting the general criteria and the interaction between them. The survey has been shared world-wide via professionals' websites and emailing.
The survey aims to analyze the environment impact in supply chain researches and daily transportation operations.

Keywords: *Supply chain management, Sustainable supply chain management, Risk management, Supply chain risk management, congestion*

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Introduction:

In modern supply chain networks, in order to increase their competitive edge, the firms employ new strategies such as recentring their activities by outsourcing some part of their production, proposing increased diversity of products to capture the market share, focusing on flexibility and responsiveness, with longer paths and shorter clock speeds, today's leaner, just-in-time etc, these strategies augment the vulnerabilities of the firms in an uncertain environment (Gonca et al,. 2010; Jianxin, 2008; Lu, 2011).
Due to the increasing supply chain complexity, the notion of supply chain risk management has gained an increasing popularity in recent years.

Nowadays, the transportation problems and traffic management risks represent an important challenge for development and infrastructure use. In this context, it seems important to build up measuring tools for Vehicle Routing Problems (VRP), therefore, we integrate the congestion effect as a supply chain risk management concept, and we will try to measure its impact on environment using a survey.

The survey has been shared world-wide via professionals' websites and emailing and it aims to analyze the environment impact on supply chain researches and daily transportation operations. But the most important in this research project is to develop scientific tools that will allow us to decrease the traffic congestion effect which is considered as a supply chain risk factor.
In the next section, we will present a literature review conducted on the concepts of logistics and supply chain. Then in section 2, we will present the methodology proposed to evaluate the congestion effect in the supply chain.

I. Definitions and literature survey

I.1. Supply chain (SC)

The term supply chain is a relatively new addition to the lexicon of management, first used in the early 1980s when writers coined the phrase to describe an emerging management discipline (Helen and al, 2003). The literature offers a variety of definitions of supply chain.
According to (Ilham, 2008) a supply chain is defined as a network of suppliers, factories, warehouses, and distribution centers through which raw materials are procured, transformed, and delivered to the customer.

I.2. Supply chain management (SCM)

Supply Chain Management (SCM) is now a fact of life. It is also a dynamic entity that is constantly changing and evolving in response to changes in technology, competitive actions, and customer demands (Steven and al, 2006) and it is a field of growing interest for both companies and researchers (Bemmel, 2000).

The literature on SCM is plentiful (Gonca and al,. 2010) and the definition of supply chain management can be easily found from the research papers (Jianxin, 2008).
For (David and al., 2000), Supply Chain Management is the set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores so that merchandise is

produced and distributed at the right quantity, to the right locations, and at the right cime, in order" to minimize system wide costs while , satisfying service level requirements.

By (Angappa et al, 2008) SCM is defined as the coordination of resources and the optimization of activities across the value chain to obtain competitive advantages.
The goals of supply chain management are to reduce uncertainty and risks in the supply chain (Alfred and al.; 2006).

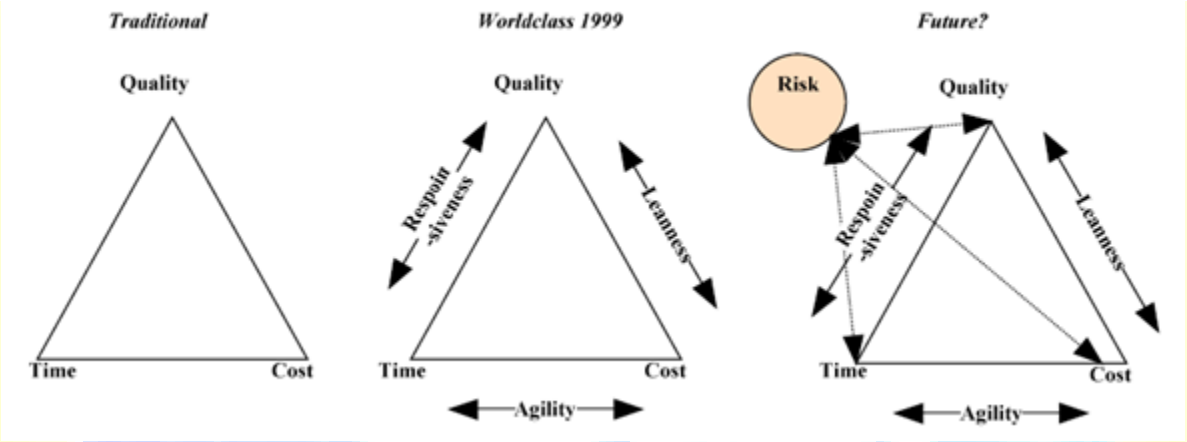

Figure1: Developing trend of supply chain (adopted from (Norrman and al, 2004))

Supply chain management without considering risk issues in a systemic perspective and their impact on the performance measures eventually lead to suboptimal results and inconsistent processes (Gonca et al,. 2010).

I.3. Supply chain risk management

Managing risk in supply chains is an important topic in supply chain management. The topic's importance is due to several industry trends currently in place: increase in strategic outsourcing by firms, globalizations of markets, increasing reliance on suppliers of specialized capabilities and innovation, reliance on supply networks for competitive advantage, and emergence of information technologies that make it possible to control and coordinate extended supply chains (Lu, 2011).

Supply chain risk management has increasingly become a more popular research area recently. Various papers, with different focus and approaches, have been published since a few years ago (Rossi et al., 2006; Iwan et al., 2009; Tang, 2010).
As we can see in the following figure, the number of articles is generally increasing during the period of 2000-2009.

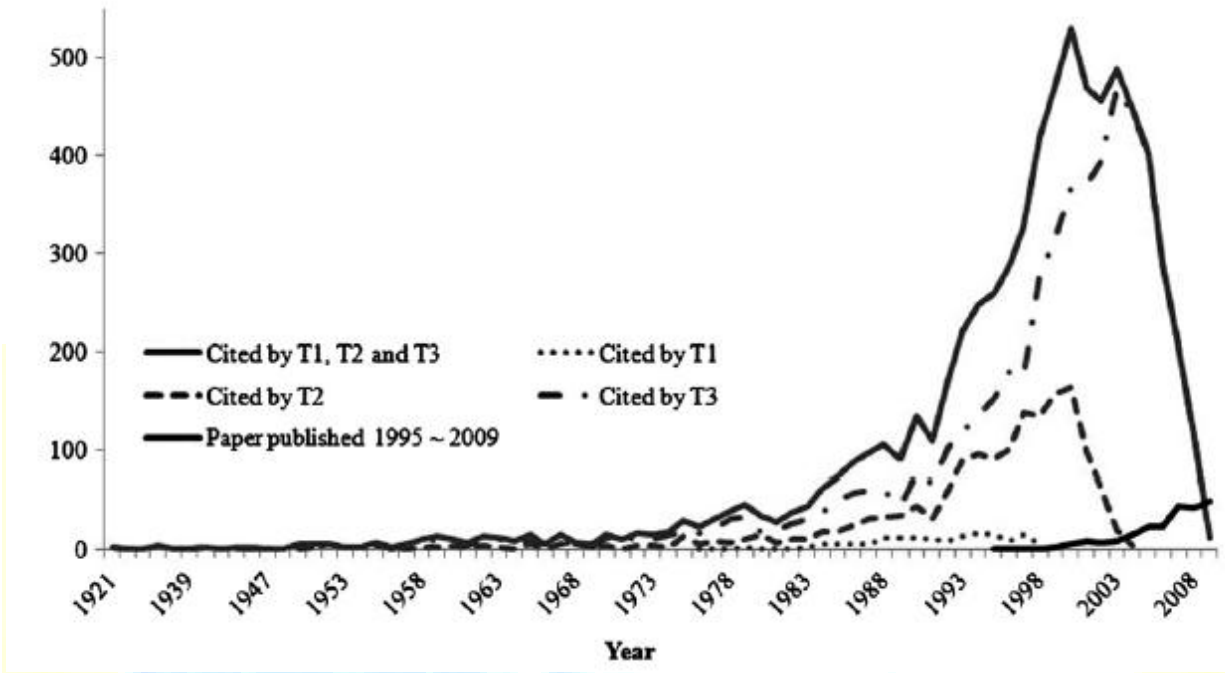

Figure 2: Development of core articles and cited articles for SCRM in 1995–2009 (adopted from (Tang and al, 2010)

In the time segment T1 (1995–1999), distinct areas such as operation management, inventory theory and lean/product introduction are the only clusters, which are also studied independently. In the time segment T2 (2000–2004), more clusters appear and some weak links have been established between clusters for risk issues. In the time segment T3 (2005 2009), the SCRM discipline shows further development, since the clusters are more integrated and many exhibit a strong connection with integrated SCRM and liability management as well as inventory management (Tang and al, 2010).

I.4. Sustainable Supply Chain Management (SSCM)

Nowadays, sustainability has become a new management principle for firms to steadily compete in the market (Kraivuth and al, 2011).

(Carter and al, 2008) define sustainable supply chain management (SSCM) as: "the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains".

There is another definition by (Seuring and al, 2008) for SSCM is that "the management of material and information flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, and stakeholder requirements into account".

A summary from (Carter and al, 2008), ***risk management*** is considered among the main factors for the sustainability of the supply chain.

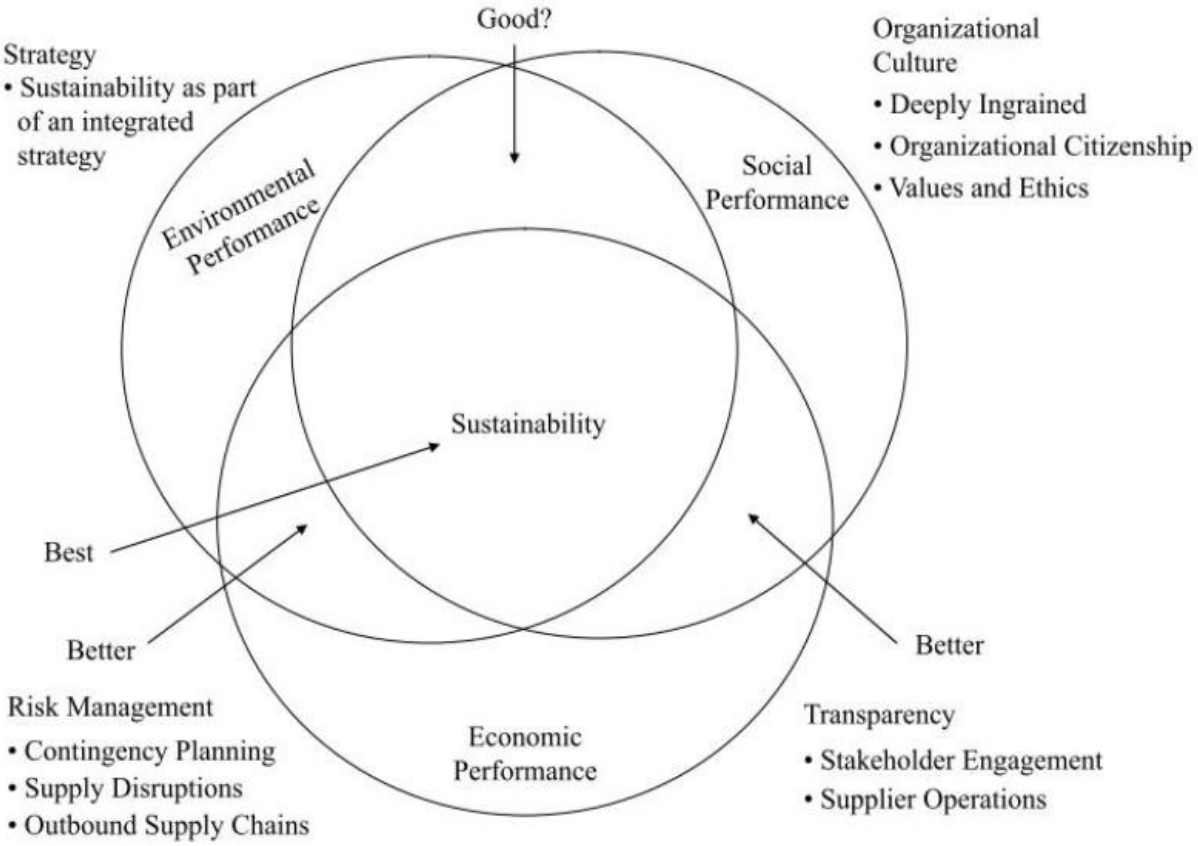

Figure 3: Sustainable supply chain management (Carter and al, 2008)

I.5. Literature survey

In order to follow the path and direction of today's newest ideas in supply chain, and gain an insight into emerging fields of research, we will start our study with an assessment of the current research in supply chain.

Web of Knowledge (WoK) is a research platform, allowing researchers to access a group of databases and web-interfaces, gives them almost what they need in their studies. Web of Science (WoS) is a web-interface of WoK, which provides access to the world's leading citation databases. Authoritative, multidisciplinary coverage includes current and retrospective journal and proceedings data in the sciences, social sciences, arts, and humanities, with back-files to 1900. The difference between WoK and WoS is based on direct answers to factual questions and also the confidence necessary to make those answers believable, via impact factors.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*
Supply chain	664	693	911	1039	1229	1496	2014	2419	3206	3091	2682	2410	1623
SCM	225	270	361	436	561	712	968	1143	1512	1404	1255	1065	735
SSCM	7	10	10	13	14	22	28	42	52	72	67	66	54
SCRM	12	8	21	25	42	57	78	120	170	167	186	142	121
City logistics	89	113	117	128	153	172	181	227	285	325	377	359	307

*Publication until 01/11/2012

Table1: Publication numbers from the web of science databases

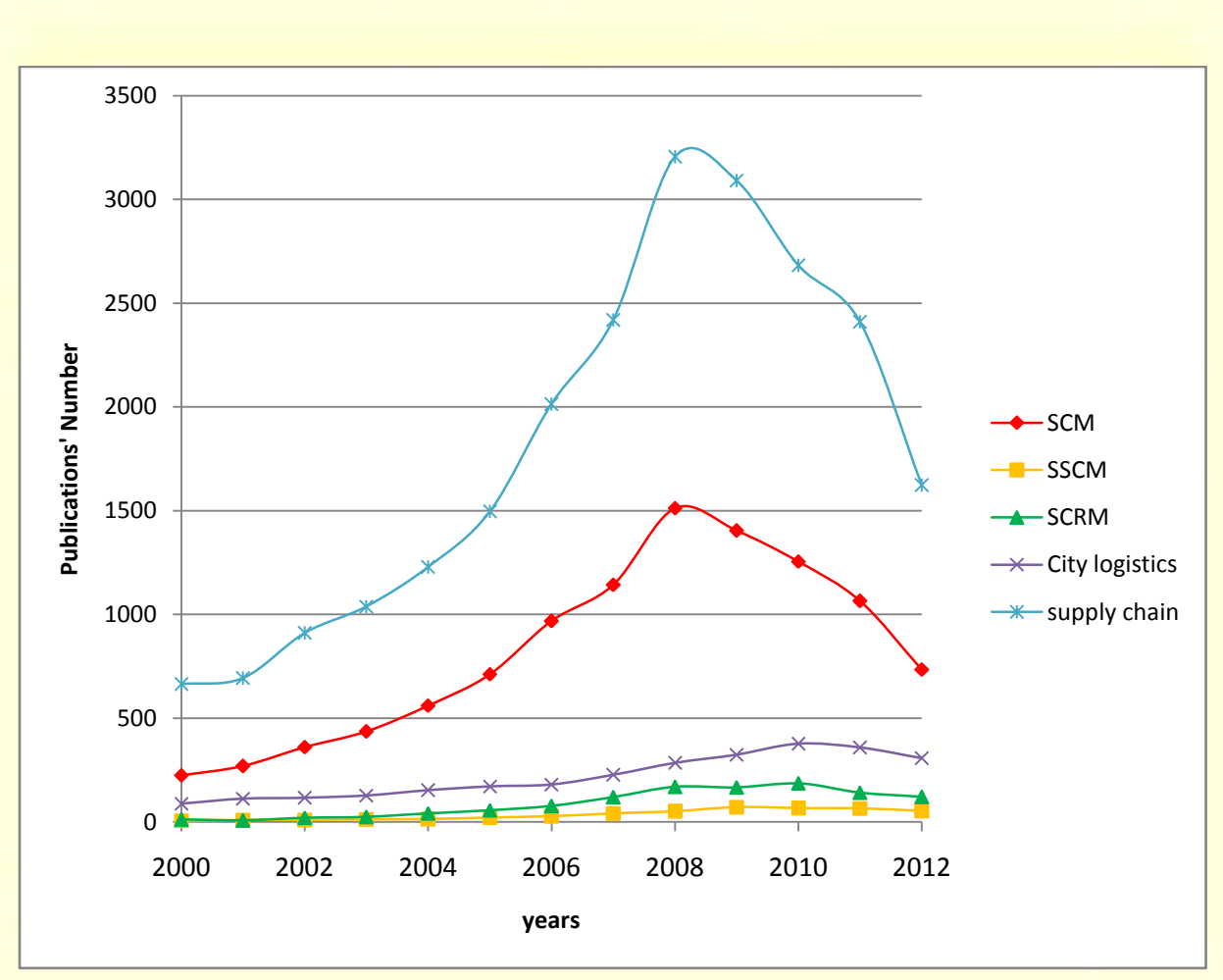

Figure 4: Supply Chain Research topics

In 2010, Supply chain risk management (SCRM) and City logistics had made a leap in the supply chain research.

II. Study case

In order to evaluate the supply chain features and their effect on the environment, we have made a survey based on setting the general criteria and the interaction between them. The survey has been shared world-wide via professionals' websites and emailing.

The survey aims to analyze the environment impact in supply chain researches and daily transportation operations. The editorial questions were based on the literature reviews and previous environmental impact analysis:

1) Do you take into consideration environmental impacts on studying logistic planning or risk management strategies?

2) How do you evaluate the following items (Quality, Time, Cost and Environment) in logistic systems and how are they important to you?

3) How do you evaluate the importance of those characteristics (Agility, Leanness, Responsiveness, Sustainability, Collaboration, and Communication) in logistic systems according to the following aspects (Quality, Time, Cost, Environment and Risk (Congestion))?

The aim of the survey, as sited below, is to examine the current behavior of supply chain with the environmental impact, and to estimate the importance of each criterion. So, using the available website tools, we consider a scale of rating based on having a mark for each one and for both issues: evaluation of current situation and estimation of the importance. In order to better analyze the transportation operations, we add a new feature risk and according to our case it is traffic congestion. Worsening traffic congestion has been identified as a supply chain risk factor, though no research has been done to assess the extent to which this has influenced corporate decision-making behavior (McKinnon and al, 2008).

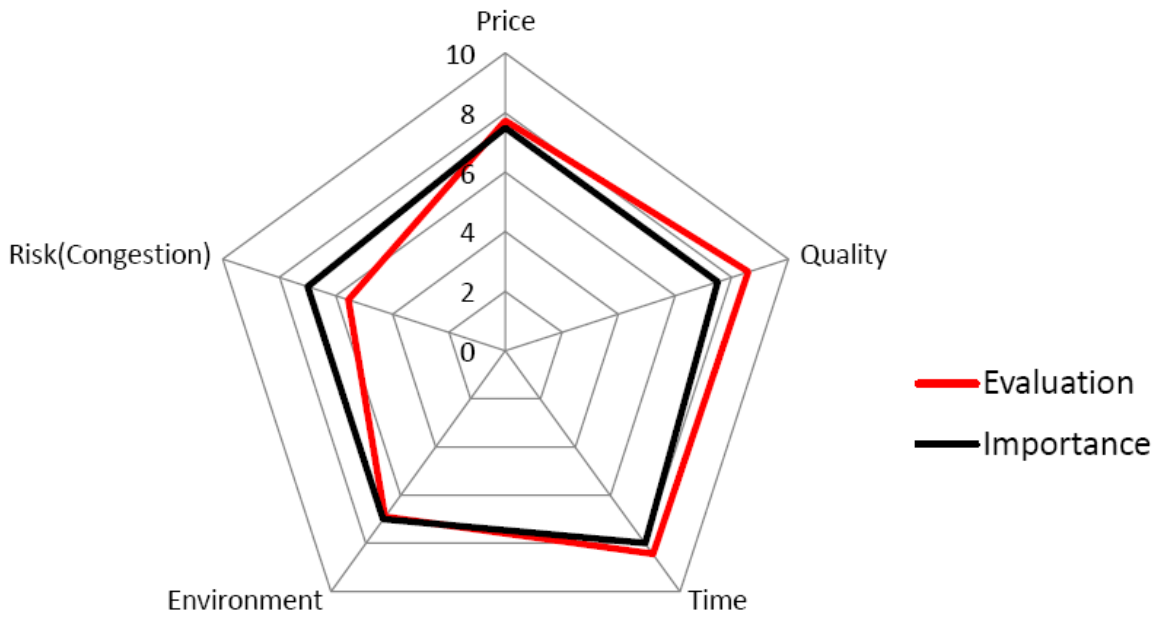

Figure 5: Survey results modeling

So, as we can see, congestion risk is underestimated in traffic managing and research, compared to the other features. The environment is also not well evaluated in studies and investigations.

City planners, officials and residents all agree that the traffic congestion is a problem faced daily in modern life. It is more difficult to agree on what kind of solutions to implement. City highway systems, infrastructures and entry points into cities, were all designed decades ago, under different theories of urban traffic measures. Planners still need to deal with the basic problem of congestion and ways of doing so, range from large-scale infrastructure projects to actions as simple as keeping the public well-informed about city route options.
But the most important point in this research project is the development of scientific tools that allow us to decrease the traffic congestion effect. We start by measuring the traffic congestion and then its environmental impact and mainly gas-emissions.

We have made a survey based on vehicle routing schedules dealing with a real-time vehicle routing problem with time windows and simultaneous delivery demands. The measurements are taken during two months with supervision of weekly updating schedules of a distribution company in a region of 225 km2, with nearly 300000 citizen and five main urban areas and two non-urban areas surrounding the region. We have studied the routing schedule of a simple vehicle responsible for delivering a large quantities of a singular known product and it is weekly updated (each day of the week corresponds to an area of the region). The urban areas are supplied on Monday, Tuesday, Wednesday, Thursday and Saturday. The non-urban areas are both supplied on Friday.

It is important to note that the study focused on a micro scale prototype. Therefore, a comprehensive network analysis is an essential part for modeling a solution to measure the traffic congestion.

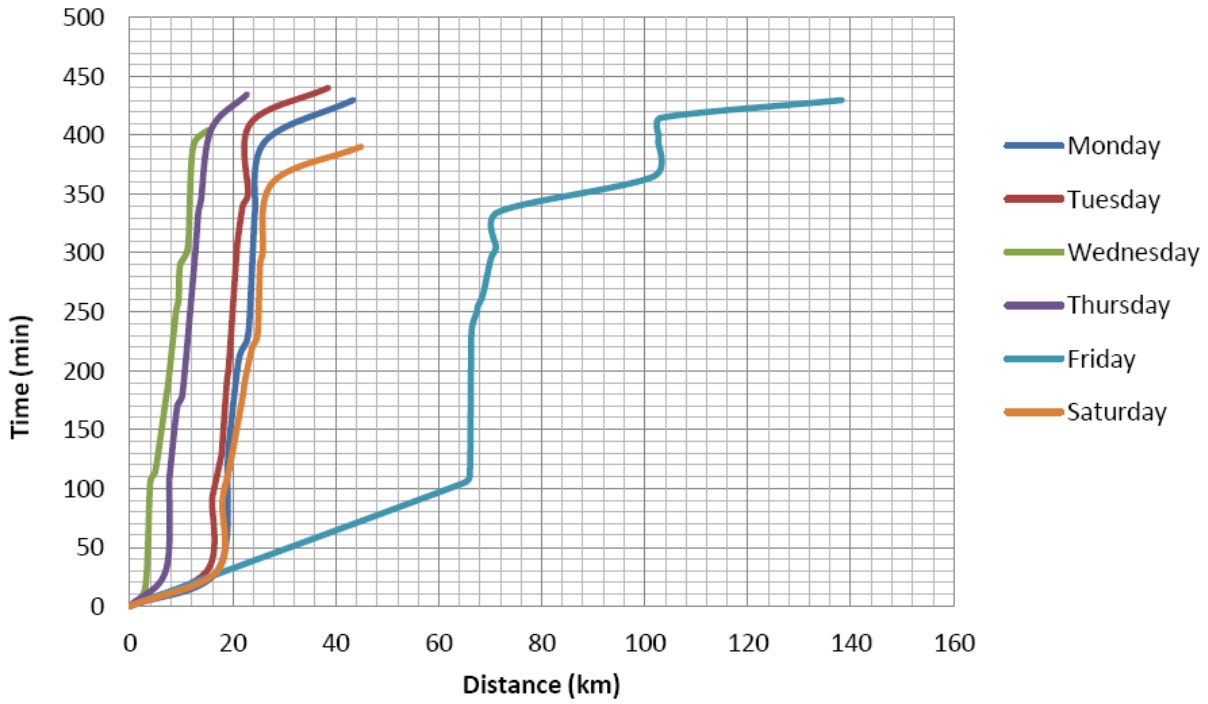

Figure 6: Routing Schedule Evaluation

Our evaluation takes into consideration time, distance, speed and vehicle capacity. So, we have taken into consideration; free capacity (due to delivering many types of products and shapes) and time duration to fulfill a demand.

We represent the results on a decimal-scale in order to represent the variables in the same graphic, so that we can analyze and compare the effects.
So the mark-scale is as follow:

* Free Capacity: Total track volume = 100%; 10% = 1/10.
* Time: work time: 8 hours/day = 480 min/day = 10/10; 60 min = 1/10.
* Distance: in our case, the max distance/day = 150 km; 15 km = 1/10.

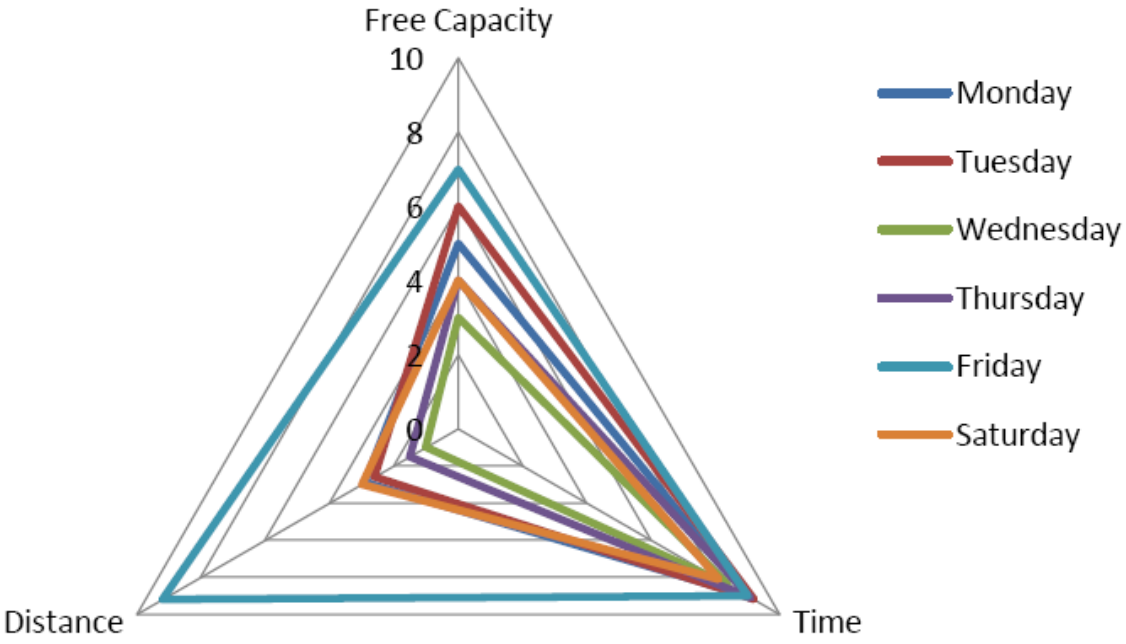

Figure 7: VRP-TW Evaluation (1)

The VRP-TW is evaluated to quantify the traffic congestion according to general routing condition. So, it is measured in a partition of time according to the following equation:

$$T_c = T_t - T_r - T_n$$

Where,

T_c: *Congestion time*

T_t: *Total time* $= a_{k0} - a_{01}$

T_r: *Net routing time* $= \sum_{j=1}^{k-1} \left(\frac{D_j}{V_j}\right)$

T_n: *Total time per notes* $= \sum_{i=1}^{K} \Delta_i$

K : *Set node number*

a_{01}= Arrival time to node 1

a_{k0} = departure time from last node k

$\frac{D_j}{V_j}$ = Routing time in section j

Δ_i = Time per node i

The previous diagram (Figure 7) represents the "marketing" features which do not illustrate the main effects of traffic congestion. So, we have to define new parameters that enable us to determine the real measure of traffic congestion. Therefore, using a decimal-scale; in a first step we represent the routing parameters in order to demonstrate the performance of each schedule (Figure 8), in a second step we represent the time parameters (Figure 9cbbcc) to reveal the traffic congestion effect.

The mark-scale is computed as follow:

* Node number: Max = 60 Node/day = 10/10; 6 node = 1/10.
* Time: work time: 8 hours/day = 480 min/day = 10/10; 60 min = 1/10.
* Time [node-node]: Max = 15 min [node-node]; X= $(\frac{15-T_{n-n}}{15})\times 10$

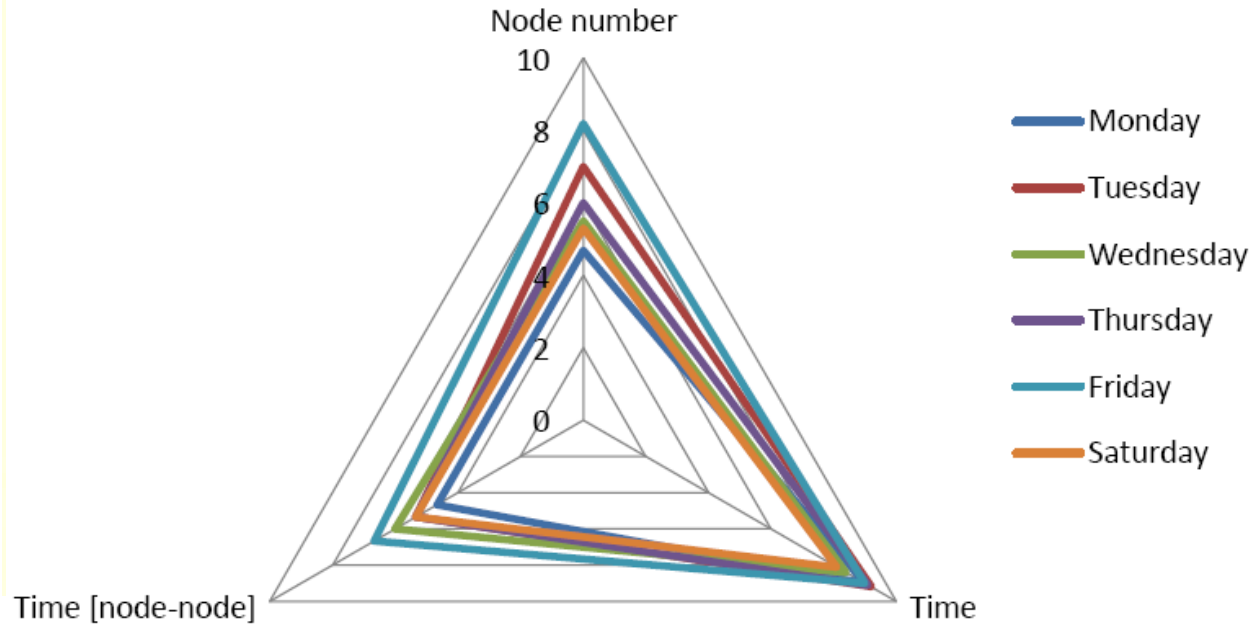

Figure 8: VRP-TW Evaluation (2)

The figure number 8 shows that the vehicle routing is free from any schedule constraints. The node number or the time from node to node does not have any effect on total time. Thus, the traffic congestion is only related to the traffic conditions, infrastructure use and specially the transport system inside urban and non-urban areas.

In addition to vehicle routing, we have to notice that the weekly update of the schedules, related to mechanical repair, order changes or stock shortage, reveal that there are no schedule constraints in the congestion time.

Figure 6 shows the estimation, in a decimal scale, of the total routing time spent in each part of the vehicle routing, the service time (net routing time + total time to deliver the orders) and the congestion time. The net routing time is equal to the total distance travelled per day inside the area multiplied by the average speed (= 60 km/h = 1 km/min), and the time to deliver the order is equal to the node number multiplied by the average time per node (specific for each area). The congestion time is the difference between the total routing time and the service time.
The mark-scale is computed as follow:

* Time: work time: 8 hours/day = 480 min/day = 10/10; 60 min = 1/10.

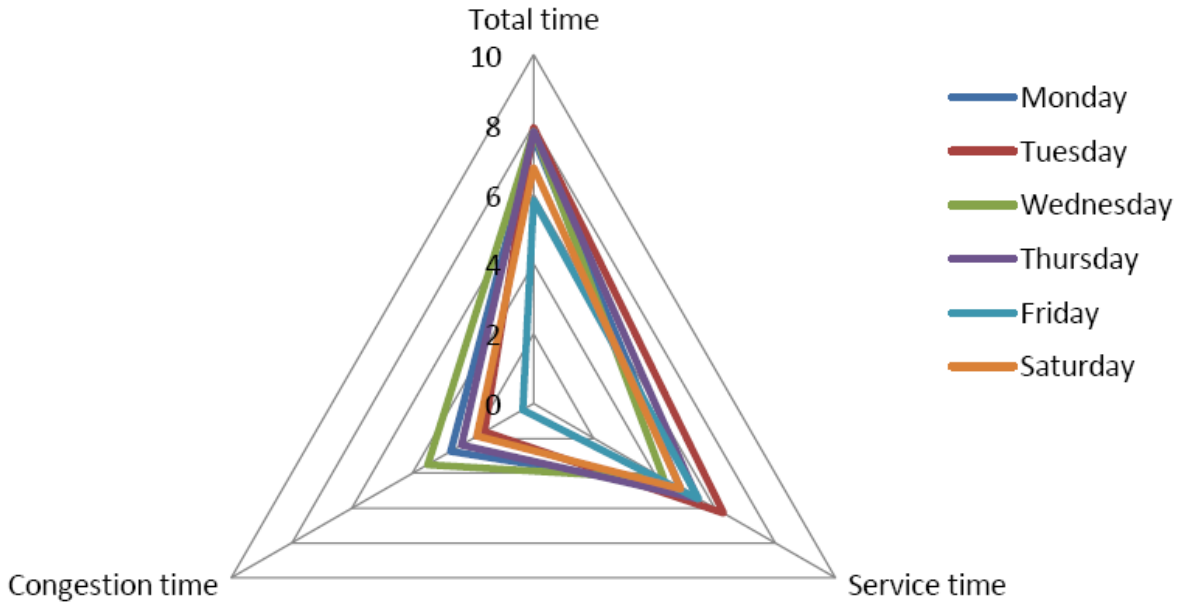

Figure 9: VRP-TW Evaluation (3)

According to the illustration, we notice that the congestion time in non-urban areas (Friday) is very low (= 6% of the total time). In the other part, urban areas are characterized by a high congestion time (> 25 % of the total time), especially the area served on Wednesday which has an important industrial and commercial activity. So, we may conclude that the traffic congestion is an important risk in the transport system and has a dangerous impact on the infrastructure use. Also, our model can be tested in other contexts such us emergency activities or simple citizen use for the distribution activities.

According to previous studies in transportation systems related to environmental impact and risk incorporation inside transport network, we have made an assessment of the main components related to the studies. The results below are a general illustration of four contexts of the researches in transportation systems:

* Environment Evaluation
* Environment Importance
* Risk Evaluation
* City Logistics Evaluation

	Quality	Time	Price	Environment
Environment Evaluation	7.5	8.5	8.5	5

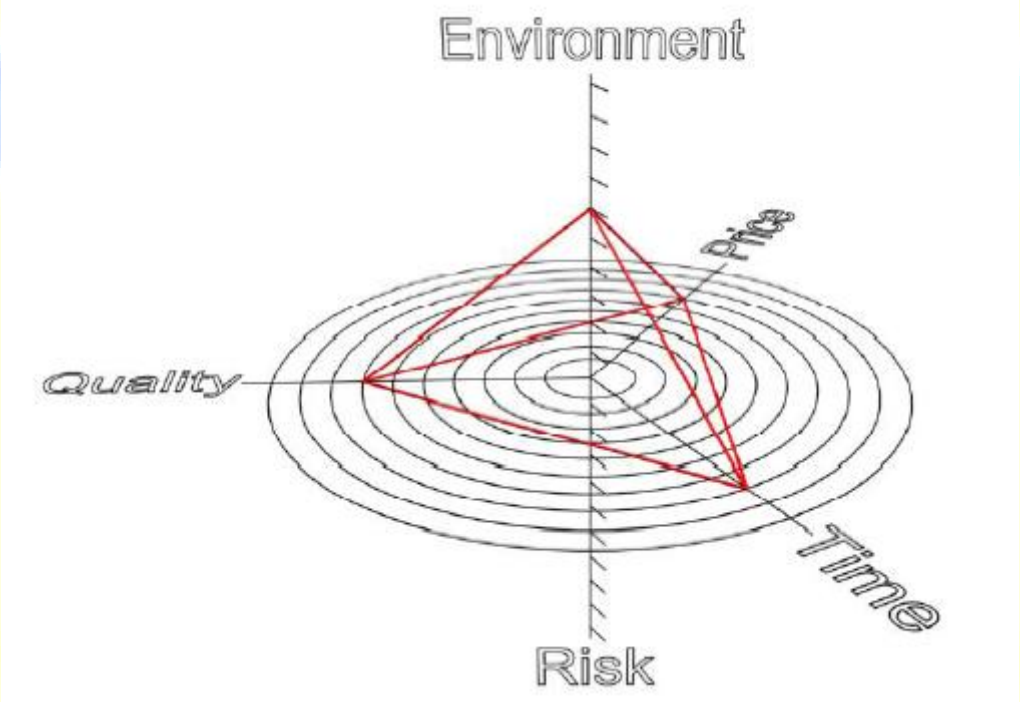

Figure 10: Environment Evaluation

	Quality	Time	Price	Environment
Environment Importance	7.5	8.5	7.5	6.5

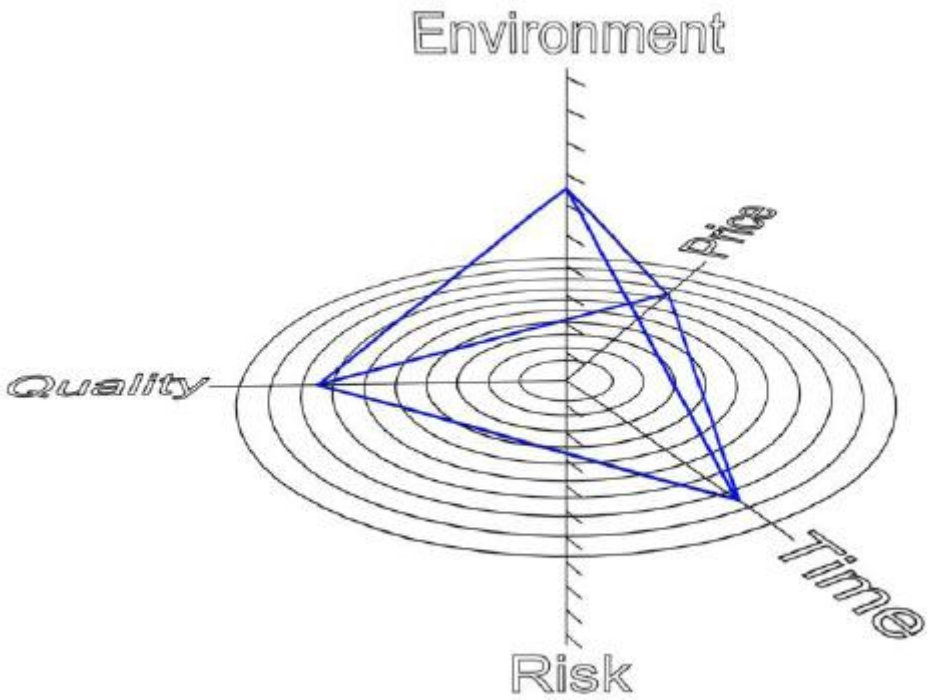

Figure 11: Environment Importance

	Quality	Time	Price	Risk (Congestion)
Risk Evaluation	6	6	6.5	5.5

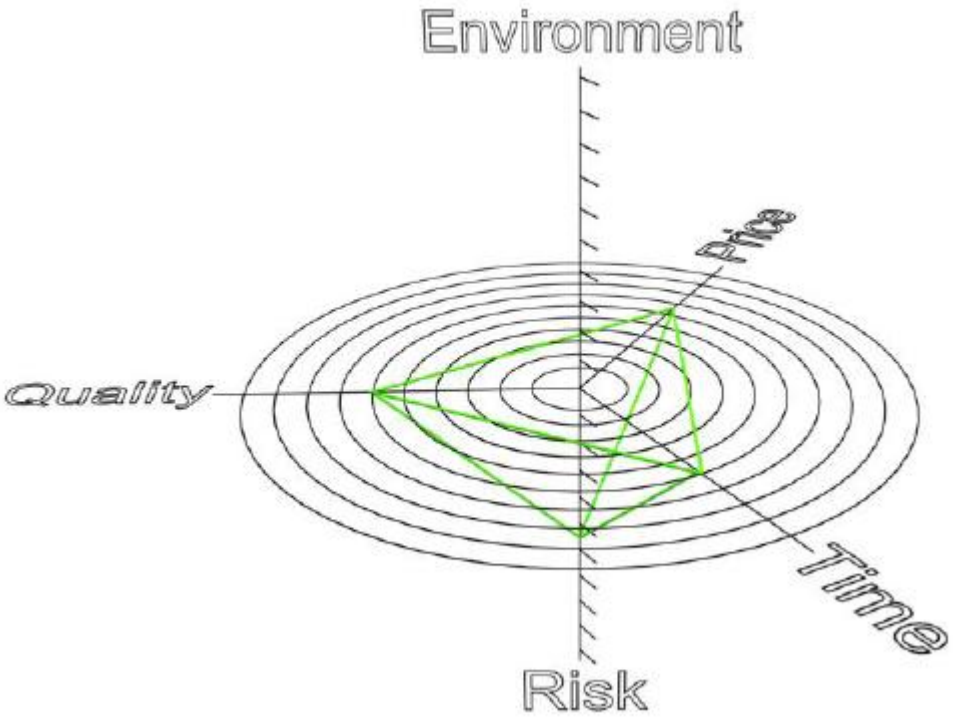

Figure 12: Risk Evaluation

	Quality	Time	Price	Environment	Risk (Congestion)
City Logistics Evaluation	7	8	7	6	6

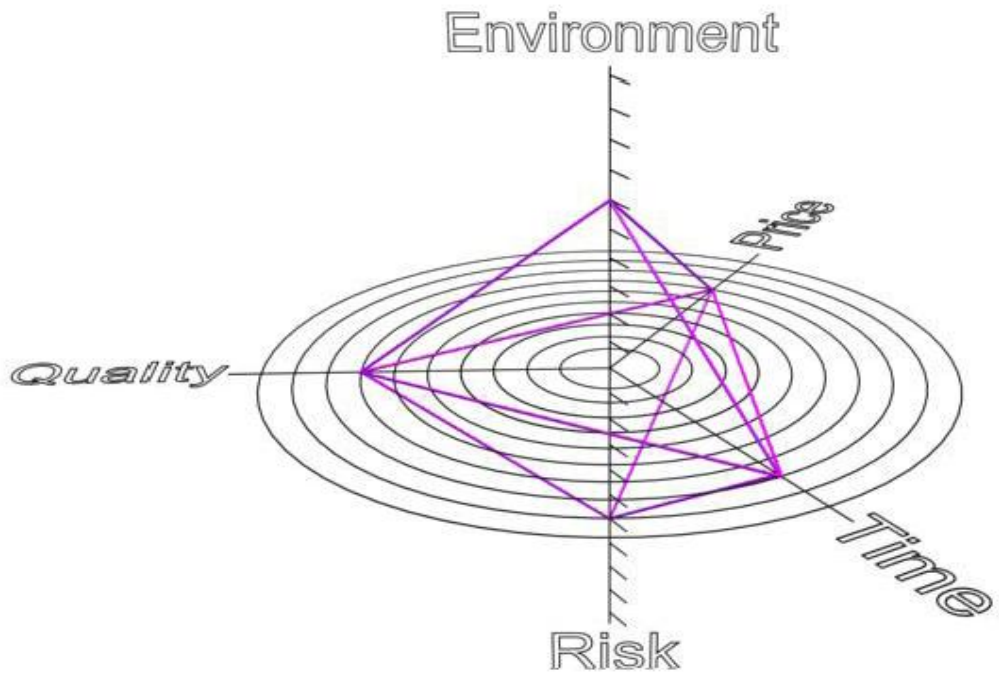

Figure 13: City Logistics Evaluation

Road congestion is often considered as the main amplifier of delays and costs in the supply chain, therefore many researchers focus on the traffic congestion and its environmental impact in order to develop a transport network more instrumented, more interconnected, and more intelligent. City Logistics is the main research topic that incorporates transport and environment, to meet the sustainability theme.
(Taniguchi et al., 2001) defined City Logistics as "the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy."

Conclusion

In this paper, we have reviewed the literature relevant to Supply chain, Supply chain management, Supply chain risk management and Sustainable supply chain management. The research tendency on the field has been investigated. The number of articles is generally increasing during the period of 2000 – 2012 and there is a big jump from 2010, indicating that the research on SCRM, SCSM attracts attentions of many researchers.
In addition, we have evaluated the environmental impact and traffic congestion which is considered as a supply chain risk factor.
We may conclude that the traffic congestion is an important risk in the transport system and has a dangerous impact on the infrastructure use.
The model proposed can be tested in other contexts such us emergency activities or simple citizen use for the distribution activities.

References

(Alfred and al, 2006) Alfred L. Guiffrida and Rakesh Nagi. (2006). Cost characterizations of supply chain delivery performance. International journal of production economics 102 (2006) 22-36.

(Angappa et al, 2008) Angappa Gunasekarana, Kee-hung Laib, T.C. Edwin Cheng. 2008. Responsive supply chain:Acompetitive strategy in a networked economy. Omega 36 (2008) 549 – 564

(Bemmel, 2000) J.H. van Bemmel. (2000). Optimization Problems in Supply Chain Management Thesis the erasmus university rotterdam on the authority of the rector magnificus

(Carter and al, 2008) Carter, CR and Rogers, DS. 2008. "A framework of sustainable supply chain management: moving toward new theory", International Journal of Physical Distribution & Logistics Management, Vol 38, No. 5, pp. 360-387.

(David and al., 2000) David Simchi-Levi, Philip Kaminsky and Edith Simchi-Levi. (2000). Designing and managing the supply chain : concepts, strategies and case studies. Second edition (book)

(Gonca et al,. 2010) Gonca, T., et Gulgun, A. (2010). Risk assessment and management for supply chain networks: A case study. Computers in Industry 61 (2010) 250–259

(Helen and al, 2003) Helen Peck, Jennifer Abley, Martin Christopher, Marc Haywood Richard Saw, Christine Rutherford and Mark Strathern. 2003. Creating Resilient Supply Chains: A Practical Guide Report produced by the Centre for Logistics and Supply Chain Management, Cranfield School of Management. 2003.

(Ilham, 2008) Ilham Kissani.2008. A Contribution to supply chain design under uncertainty. Thesis Laval University Québec. 2008

(Iwan et al., 2009), Iwan, V., Suhaiza, Z. et Nyoman, P. (2009). Supply Chain Risk Management: Literature Review and Future Research. 16 International Journal of Information Systems and Supply Chain Management, 2(1), 16-33, January-March 2009

(Jianxin, 2008) Jianxin, X. (2008). Managing the Risk of Supply Chain Disruption: Towards a Resilient Approach of Supply Chain Management. 2008 ISECS International Colloquium on Computing, Communication, Control, and Management

(Lu, 2011) Lu, S. (2011). Research on Supply Chain Risks Management by Simulation Analysis. Proceedings of the 7th International Conference on Innovation & Management.

(Kraivuth and al, 2011) Kraivuth Kraisintu and Ting Zhang. 2011. The Role of Traceability in Sustainable Supply Chain Management. Department of Technology Management and Economics

Division of Logistics and Transportation CHALMERS UNIVERSITY OF TECHNOLOGY Göteborg, Sweden, 2011 Report No. E2011:085

(McKinnon and al, 2008) Alan McKinnon, Andrew Palmer, Julia Edwards and Maja Piecyk. 2008. Reliability of Road Transport from the Perspective of Logistics Managers and Freight Operators. Final report by Logistics Research Centre Heriot-Watt University Edinburgh, UK

(Norrman and al, 2004) Norrman, A. and Jansson, U.(2004) Ericsson's Proactive Supply Chain Risk Management Approach after a Serious Sub-Supplier Accident, Int. J. of Physical Distribution and Logistics Management, Vol. 34, No. 5, pp.434–456.

(Seuring and al, 2008) Seuring, S and Muller, M (2008), "From a literature review to a conceptual framework for sustainable supply chain management", Journal of Cleaner Production, Vol 16, p. 1699–1710.

(Steven and al, 2006) Steven A. Melnyk, Rhonda Lummus, Robert J. Vokurka and Joseph Sandor.(2006). Supply chain management 2010 and beyond: Mapping the future of the Strategic Supply Chain. A report

(Tang and al, 2010) Ou Tang and S. Nurmaya Musa. 2010. Identifying risk issues and research advancements in supply chain risk management. International Journal of Production Economics (2010).

(Taniguchi and al, 2001) Taniguchi, E., RG Thompson, T. Yamada and R. van Duin (2001). City Logistics---Network Modelling and Intelligent Transport Systems, Pergamon. Logistics City --- Modélisation des réseaux et de systèmes de transport intelligents, Pergame.