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Modelling Collaborative Transportation Management: Current State And Opportunities For Future Research

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ABSTRACT: Collaborative Transportation Management (CTM) aims to reduce inefficiency, improve services, and provide mutual outcome to all parties. CTM has raised significant interest of both researchers and practitioners. Sharing information is the most basic form of coordination in supply chains to integrate CTM models at strategic, tactical, and operational levels. However, little has been known about the state of the art of CTM models. This paper presents a comprehensive review on the current state of CTM models. The overview of the CTM models is organized by classifying the previous literatures on different collaborative structures and different levels of planning. This paper also presents the relevant solution techniques used for each planning level. A review on the current state of CTM models concludes by highlighting the unaddressed areas or the gaps existing in the current literatures and by suggesting directions for future research in CTM.

Keywords: Collaborative Transportation Management (CTM), collaborative structure, planning level, solution method, supply chain management, information sharing, model.

1. INTRODUCTION

Logistics nowadays is influenced by globalization in responding to changing demand of the consumer, mass production, and customization (Gereffi, 2001). The globalization increases business competitiveness and provides competitive advantages to different parties in the supply chain, especially in the transportation area. These situations along with the rising operating costs cause fierce competition among transportation companies and force them to run an efficient operation. An efficient operation requires a type of collaboration where each party involved in the transportation area has the same objective to get a better operation result and is more concerned with the optimization objectives for all of the parties involved rather than for an individual one (Mason et al., 2007).

Collaborative Transportation Management (CTM) is an emerging model of collaboration in the transportation area (Tyan et al., 2003). VICS (2004) and Li and Chan (2012) define CTM as a holistic process that not only does it bring all parties together in the supply chain to drive inefficiencies out of the transportation planning and execution process but also it improves the operating performances of all parties through collaboration. Some of the benefits of CTM are the reduction in increase load capacity usage, the travelling time, and reduction in transportation costs, particularly the back-haul costs, when two transportations combine to minimize the distance (VICS, 2004). Several researchers such as Browning and White (2000), Sutherland (2003), Esper and Williams (2003), and Bishop (2004) state the needs to incorporate CTM into logistics to avoid logistics bottlenecks, reduce inefficiency, and provide mutual benefits for all collaborative parties. In addition, CTM can reduce the inventory-holding cost, increase the responsiveness, and synchronize the activities in logistics efficiently (Ozener, 2008).

CTM in the supply chain has become a topic of great interest to researchers and practitioners. Many researchers have developed models of CTM in the supply chain that emphasizes different issues, such as on operation efficiency, cost minimization, profit maximization, or a combination of them as their objectives. However, the issues on behavioral aspects that arise from the collaborative transportation have not been explored. Although the CTM models could be used in different types of collaboration, depending on the subject and scope of collaboration, many researchers have only used the CTM models in the scope of vertical collaboration and operational level. In consequence, there are still many research areas that could be addressed to effectively consider and evaluate any possible applications of the models in different scopes of collaboration to create optimal scenarios for collaborative parties in different planning levels.

Due to the lack of CTM literatures and the aim to develop a better understanding on CTM, a systematic literature review that can point out both the importance of CTM in the supply chain and the exploration of various CTM models is required. This paper provides a literature review on the state of the art in the CTM areas, the unaddressed CTM areas, and the research gaps in CTM by classifying the previous literatures into several categories, which are based on four dimensions, such as collaborative structure, general characteristics, collaborative planning levels, and solution methodologies.

This paper is organized as follows. First, CTM is defined based on the summary of the previous literatures. Second, the methods for the systematic review are described. Third, the classification of the existing literatures is also described. Fourth, the previous literatures are examined based on the classification. Next, the discussion on the results of the systematic review is presented. Finally, the conclusion and research opportunities are presented.

2. COLLABORATIVE TRANSPORTATION MANAGEMENT (CTM)

In logistics and transportation areas, many opportunities arise from developing collaboration when firms work together to achieve common goals that bring mutual benefits to all parties (Min et al., 2005). Similar to that, Simatupang and Sridharan (2002) state that a better result for all collaborative parties can be achieved by working together through data information sharing, a joint decision making, and benefit sharing.

Under the Voluntary Inter-industry Commerce Standards (VICS, 2004), it is stated that CTM complements logistics collaboration after an order is generated via Collaboration Planning Forecasting Replenishment (CPFR). CPFR requires trading partners to collaborate on sales and demand planning activities as well as on an order placement that uses technologies to improve both the accuracy of sales order forecast and the subsequent replenishment orders. Several transportation and distribution activities that are not included in CPFR, such as: shipments, modes or carrier assignments, scheduling, tracks, and traces can be done by CTM (VICS, 2004). CTM represents a new application of logistics collaboration to ensure that the benefits of CPFR are properly executed and expanded in the transportation area.

According to Tyan et al. (2003), CTM is a new business model, which is based on information sharing in which carriers, as a strategic partner in logistic collaboration, is included. Esper and Williams (2003) state that CTM adds value to a collaborative relationship and an entire collaboration process, including transportation that provide services. In addition, Feng and Yuan (2007) and Chan and Zhang (2011) state that CTM is based on an interaction among logistics parties in order to improve the flexibility in the physical distributions and to minimize the inefficiency in the transportation components.

In this paper, CTM is defined as a transportation process which is based on the interaction, coordination, and collaboration among the shippers, receivers, and transportation service providers involved in the logistics process. The aims of CTM are not only to reduce inefficiency and cost in the transportation but also to provide mutual benefits to all parties.

3. METHOD

The research method for conducting the systematic review on CTM in the supply chain can be seen in Figure 1. The first step was conducting the web-based search from Proquest, Science Direct, SpringerLink, Taylor and Francis database, and recommendation from peers to identify the potential relevant articles, raging from Dissertation Abstracts, Papers, and Sciences Citation Index (SCI). The search used different combinations of keywords, such as: "supply chain" and "supply chain collaboration"; "transportation" and "collaborative transportation"; "collaborative formation" and "collaborative structure"; and "planning level" and "planning horizon". In addition, the keywords such as "solution method" were used to find every related article in this field. From these keywords combinations, 228 articles from different journals and publications were found. In the second step, to search for the relevant publications, the key word "CTM" was used. With the keyword, 65 articles were obtained. In this step, both irrelevant articles and the same articles were removed (some articles were obtained by using different search engines). These articles come from the database containing abstracts and the full papers.

In the third step, an in-depth content analysis to the 65 articles was performed. Based on the analysis of the titles as well as the abstracts of both the articles and the full papers, 27 of the 65 articles were selected. The 27 articles were selected because they contained the topic concerning the significance of CTM, the implementation of CTM, the contribution of various CTM models, the planning levels of CTM, and methodologies of CTM. The articles that did not contain the relevant topic on CTM were therefore excluded. The remaining 38 articles were excluded because they focused on urban transportation, not on CTM models. Figure 2 shows the distribution of the CTM literatures by year. It can be seen that in the last couple of years the number of articles has been increased. However, there has been no relevant contribution to the CTM models between 2014 and 2015.

Figure 1. Methods of Literature Review

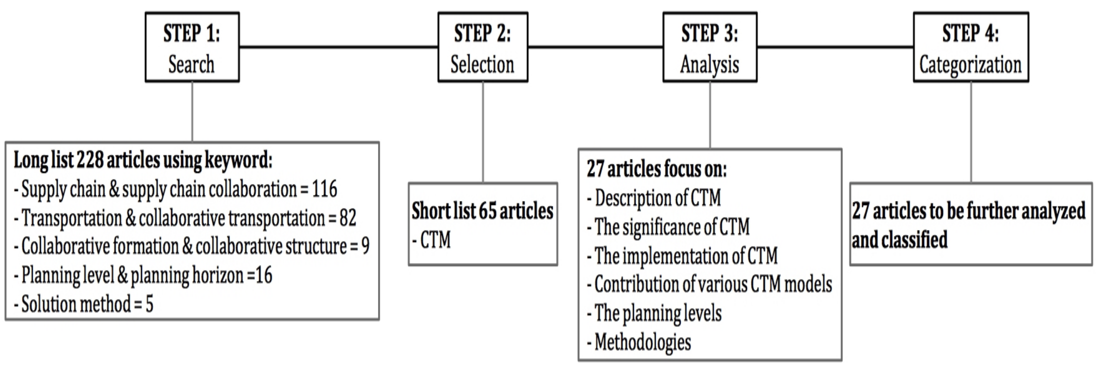
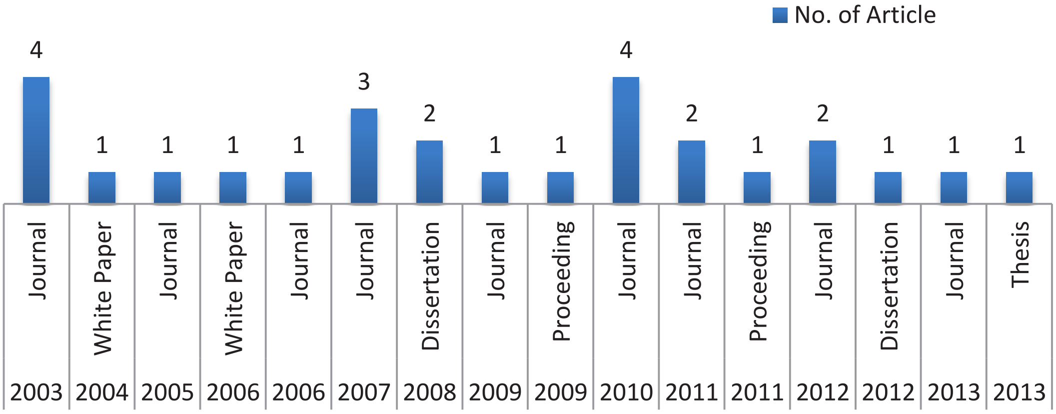


Figure 2. Literature Review by Year



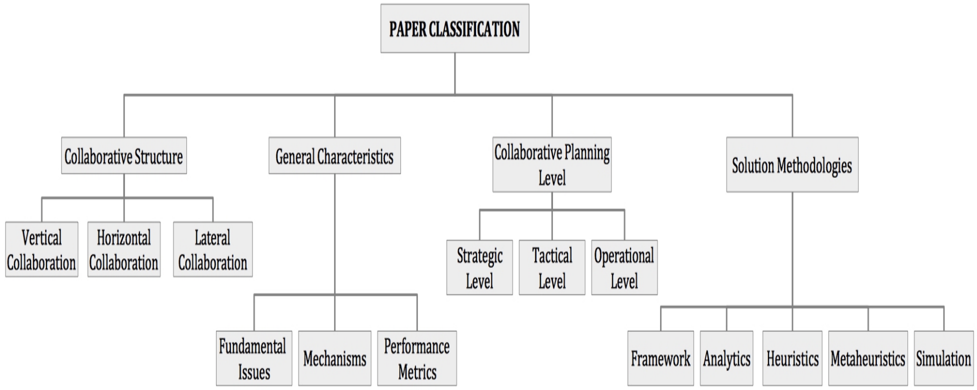
3.1 The Classification of CTM Models

Based on analysis of literatures, to systematically classify the literatures the classification framework for the literature review of CTM is based on four dimensions. The four dimensions of the classification namely collaborative structure, general characteristics, collaborative planning level, and solution methodologies. The classification of the literatures can be seen in Figure 3.

The first dimension describes the distinction between the parties involved and the scope of the collaboration made under the collaborative structure categories, i.e., vertical, horizontal, and lateral collaboration. This refers to CTM definition where the parties of supply chain as receiver, shipper, and carrier establish collaboration in transportation in several collaborative structures based on the interaction between logistics parties. The second dimension reflects the general characteristics of each collaboration and CTM models. In the previous literatures, each collaboration and CTM model were developed to understand the transportation problem and to evaluate the benefits of collaboration in transportation area for all collaborative parties. Each collaboration also caused several problems in the process. Based on analysis of literatures, CTM also employed the planning horizon and decision-making process in the collaboration process to coordinate the plans of several partners to achieve CTM objectives. Planning and decision-making process in CTM can be formulated into different planning levels, depending on the time horizon and the importance of the problem. Therefore, the third dimension of collaborative planning perspective is based on the planning decisions level, such as: strategic, tactical, and operational planning level.

The fourth dimension is used to review and classify the literatures according to the relevant solution method of each CTM model. Several methods are used to optimize and solve complicated problems related to CTM. It is very important and very challenging to find a solution method for the problems related to CTM.

Figure 3: The Classification of CTM Models



3.1.1 Collaborative Structure

According to VICS (2004) CTM focuses on enhancing the interaction and collaboration not only between the three principal parties: a shipper, a receiver, and a carrier, but also among the secondary participants such as the third-party logistics service providers (3PL). In this paper, CTM among the parties is classified into three categories: vertical, horizontal, and lateral collaboration based on a collaborative structure, depending on the parties involved and the scope of the collaboration (Simatupang and Sridharan, 2002; Soosay et al., 2006; and Zamboni, 2011).

Vertical Collaboration concerns two or more organizations, such as a receiver, a shipper, and a carrier, which share their responsibilities, resources, and data information to serve relatively similar end customers. *Horizontal Collaboration* concerns two or more unrelated or competing organizations that cooperate by sharing their private information or resources such as joint transportation mode between two carriers. *Lateral Collaboration* aims to gain more flexibility by combining and sharing capabilities both vertically and horizontally.

3.1.2 General Characteristics

CTM is formulated based on several general characteristics such as fundamental issues, mechanisms, and performance metrics. Certain issues arising from the logistics process are recorded in the previous literatures. The issues are on increasing an efficient and reliable product delivery, increasing a usage capacity, reducing cost, and increasing competitiveness. Furthermore, the mechanisms of CTM by both resources and information sharing are developed to ensure a common unity of effort and ensure benefits for all collaborative parties. Engaging the parties in CTM not only gives significant benefits for them but also improve their understanding on CTM and management of CTM. The performance metrics used by previous researchers covered cost, transportation parameters, inventory investment, and inventory level reduction.

3.1.3 Collaborative Planning Level

Several problems could be arising during the collaboration process. Because of these problems, the third category is based on the collaborative planning levels among the collaborative parties. This type of category would potentially help distinguish all parties' proper planning, decision-making, and coordination of decisions in achieving their expected goals of CTM. There are three levels of a collaborative planning proposed for each transportation problem that represent decision making process depending on the time horizon (VICS, 2004; Ilyas et al., 2005; and Meyr et al., 2005).

The first level is the *strategic level.* It functions as the front-end agreement, the foundation for the entire supply chain process, and as an essential part of supply chain management. Strategic level is classified into *strategic partnership model* and the *network model*. *Strategic Partnership Model* is a formalized agreement to develop a collaboration relationship. To make the relationship works, benefit, risk, and commitment sharing are determined, and limitations that could reduce potential benefits are identified. *Network Model* uses static route/continuous movement programs to optimize the loading management. Carriers may collaborate either with shippers and or with other carriers.

The second collaborative planning level is the *tactical level* that focuses on shipment requirements to improve transportation utilization and efficiency. Tactical level is classified into *order and shipment forecasting model* and *carrier assignment model*. The purpose of *Order and Shipment Forecasting Model* is to improve the efficiency and utilization of transportation mode, while the purpose of *Carrier Assignment Model* is to map different carrier used in the logistics process. *Carrier Assignment Model* is developed based on a shipment order.

The third collaborative planning level is the *operational level*, which covers the process flow to fulfill the customer's orders on daily basis, and it is concerned with the efficient operation. This level has three models: *scheduling model*, *route model*, and *order processing model. Scheduling Model* is developed on a daily basis based on a carrier assignment in the tactical planning level by optimizing shipments. *Route Model* is developed based on the network model in the strategic level to reduce transportation costs effectively through reduced distances and traveling time. *Order Processing Model* is developed based on an information system and a technology used to support information exchange.

3.1.4 Solution Methodologies

The current literatures indicate that many techniques have been proposed to solve problems and calculate optimization in the CTM area. These proposed solution techniques could be classified into five categories. *Framework* as the first solution technique is divided into a theoretical framework and a conceptual framework. The aim of the framework is to improve the understanding on how CTM concepts perform. *Analytics* as the second solution technique uses mathematical models that have a closed form of solution and is used to describe changes in a system. The third solution technique is *heuristics.* Heuristics is not guaranteed to be an optimal solution, but it is used to speed up the process of finding an optimal solution. The fourth solution technique is *metaheuristics*. It is a higher-level solution procedure that provides a sufficiently good solution for an optimization problem, especially for a problem with incomplete or imperfect information and having a limited computation capacity. The last solution technique is *simulation.* This technique is used to show the effects of an action on either a system or a real life.

4. FINDINGS

The review of literatures is divided into three major groups. The first group of literature review examines the state of the art of the previous literatures, which are essential for the development of the vertical collaboration. The second group of literature review examines the state of the art of the horizontal collaboration, and the last group of literature review examines the lateral collaboration. The previous literatures of each group are summarized in Appendix 1. To differentiate one group of literature review from another one, the general characteristics as decision variables, CTM models in three collaborative planning levels, and solution methods are used as the classification bases, can be seen in Table 1.

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Table 1. Classification of Literature Review

AUTHOR	GENERAL CHARACTERISTICS			CTM MODEL			SOLUTION METHOD
	FUNDAMEN-TAL ISSUES	COLLABORA-TION MECHA-NISM	PERFORMANCE INDICATORS	STRATEGIC LEVEL	TACTICAL LEVEL	OPERATION-AL LEVEL	
VERTICAL COLLABORATION							
Tyan et al. (2003)	Capacity issue, improving service levels, reducing cost, and increasing competitiveness	Information and data sharing, sharing benefit	Transportation parameters			Order Processing Model	ANALYTICS (Empirical Research)
Esper and William (2003)	Reducing cost, inefficient and unreliable product delivery	Information and data sharing	Cost saving, transportation parameters			Order Processing Model	ANALYTICS (Empirical Research)
Caplice and Seffi (2003)	Reducing cost, and increasing competitiveness	Information and data sharing, sharing benefit	Cost saving, transportation parameters	Strategic Partnership Model			ANALYTICS (Optimization-Based Procurement)
Feng et al. (2005)	Capacity issue, reducing cost, inefficient and unreliable product delivery	Information and data sharing	Cost saving, transportation parameters, inventory level/cost		Carrier Assignment Model		SIMULATION (Beer Game)
Audy et al. (2006)	Reducing cost, inefficient and unreliable product delivery	Sharing resources, information and data sharing		Strategic Partnership Model			FRAMEWORK (Business Model Coalition)
Ergun et al. (2007)	Reducing cost	Sharing resources	Cost saving, transportation parameters	Network Model			HEURISTICS (Greedy Merge Heuristics)

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Table 1. Classification of Literature Review (Cont.)

AUTHOR	GENERAL CHARACTERISTICS			CTM MODEL			SOLUTION METHOD
	FUNDAMENTAL ISSUES	COLLABORATION MECHANISM	PERFORMANCE INDICATORS	STRATEGIC LEVEL	TACTICAL LEVEL	OPERATIONAL LEVEL	
VERTICAL COLLABORATION							
Feng and Yuan (2007)	Improving service levels and reducing cost	Information and data sharing	Cost saving, transportation parameters			Order Processing Model	ANALYTICS Empirical Research)
Kayikci (2009)	Improving service levels, reducing cost, and increasing competitiveness	Information and data sharing	Cost saving, revenue, customer satisfaction, inventory level/ cost	Strategic Partnership Model			ANALYTICS (Partial Least Square)
Chen et al. (2010)	Reducing cost	Information and data sharing	Cost saving, inventory level/cost			Order Processing Model	ANALYTICS (Transcendental Logarithmic)
Silva et al. (2011)	Reducing cost	Information and data sharing, sharing benefit, and managing trust	Revenue	Strategic Partnership Model			SIMULATION (Agent-Based & System Dynamic)
Gonzalez-Feliu and Morana (2011)	Reducing cost	Sharing resources, information and data sharing, sharing risk		Strategic Partnership Model			FRAMEWORK (Logistics Sharing)
Li and Chan (2012)	Improving service levels, reducing cost, inefficient and unreliable delivery	Information and data sharing, sharing risk	Cost saving, transportation parameters, revenue, and inventory level/ cost			Order Processing Model	SIMULATION (Agent-Based)

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Table 1. Classification of Literature Review (Cont.)

AUTHOR FUNDAMENTAL ISSUES	GENERAL CHARACTERISTICS			CTM MODEL		SOLUTION METHOD
	COLLABORATION MECHANISM	PERFORMANCE INDICATORS	STRATEGIC LEVEL	TACTICAL LEVEL	OPERATIONAL LEVEL	
VERTICAL COLLABORATION						
Moll (2012)	Improving service levels and increasing competitiveness	Information and data sharing, sharing benefit	Cost saving, transportation parameters, and revenue		Scheduling Model	ANALYTICS (Empirical Research)
Wen (2012)	Increasing competitiveness, inefficient and unreliable product delivery	Information and data sharing		Strategic Partnership Model		ANALYTICS (Factor Analysis)
HORIZONTAL COLLABORATION						
Song and Regan (2003)	Reducing cost and increasing competitiveness	Sharing resources, sharing benefit	Cost saving	Strategic Partnership Model		ANALYTICS (Quasi Linier)
Nadarajah (2008)	Reducing cost and increasing competitiveness	Sharing resources	Cost saving, revenue		Route Model	METAHEURISTICS (Tabu Search & Guided Local Search)
Asawasakulsorn (2009)	Capacity issue and reducing cost	Sharing resources, managing trust		Strategic Partnership Model		ANALYTICS (Simple & Multi Regression)
Fisk et al. (2010)	Reducing cost, inefficient and unreliable product delivery	Sharing resources, sharing benefit	Cost saving, transportation parameters	Strategic Partnership Model		ANALYTICS (Linier Programming)

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Table 1. Classification of Literature Review (Cont.)

AUTHOR FUNDAMENTAL ISSUES	GENERAL CHARACTERISTICS		CTM MODEL			SOLUTION METHOD
	COLLABORATION MECHANISM	PERFORMANCE INDICATORS	STRATEGIC LEVEL	TACTICAL LEVEL	OPERATIONAL LEVEL	
HORIZONTAL COLLABORATION						
Liu et al. (2010)	Reducing cost, increasing competitiveness	Sharing resources, sharing benefit	Cost saving	Strategic Partnership Model		SIMULATION (Weighted Relative Savings Model)
Audy et al. (2010)	Reducing cost	Sharing resources, sharing benefit	Cost saving	Strategic Partnership Model		SIMULATION (Game Theory-Equal Profit Method)
Peeta and Hernandez (2011)	Capacity issue, reducing cost, inefficient and unreliable product delivery	Sharing resources, information and data sharing	Cost saving, transportation parameters, revenue		Route Model	SIMULATION (Mixed Logit-Simulation Based Maximum Likelihood)
Taherian (2013)	Reducing cost, inefficient and unreliable product delivery	Sharing resources	Cost saving, transportation parameters, revenue	Strategic Partnership Model		ANALYTICS (Empirical Research)
LATERAL COLLABORATION						
VICS (2004)	Capacity issue, improving service level, reducing cost, increasing competitiveness, inefficient delivery	Sharing resources, information and data sharing, managing trust, sharing benefit, sharing risks	Cost saving, transportation parameters, revenue, customer satisfaction, inventory level/cost	Strategic Partnership Model		FRAMEWORK (Selecting Partner)

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AUTHOR FUNDAMENTAL ISSUES	GENERAL CHARACTERISTICS			CTM MODEL		SOLUTION METHOD
	COLLABORATION MECHANISM	PERFORMANCE INDICATORS	STRATEGIC LEVEL	TACTICAL LEVEL	OPERATIONAL LEVEL	
LATERAL COLLABORATION						
Sutherland (2006)	Capacity issue, improving service level, reducing cost, increasing competitiveness, inefficient and unreliable product delivery	Sharing resources, information and data sharing, managing trust, sharing benefit, sharing risks	Cost saving, transportation parameters, revenue, customer satisfaction, inventory level/cost	Strategic Partnership Model		FRAMEWORK (Selecting Partner)
Mason et al. (2007)	Reducing cost, inefficient and unreliable product delivery	Sharing resources, information and data sharing, sharing benefit	Cost saving, transportation parameters, revenue, customer satisfaction, inventory level/cost		Order Processing Model	ANALYTICS (Empirical Research)
Ozener (2008)	Reducing cost	Sharing resources, information and data sharing, sharing benefit	Cost saving	Network Model	Route Model	HEURISTICS (Shapley Value & Mixed Integer Linier Programming)
Gonzalez-Feliu et al. (2013)	Reducing cost	Sharing resources, sharing benefit	Cost saving	Strategic Partnership Model		SIMULATION (Clustering Phase)

4.1 Vertical Collaboration

In this section, the collaboration among parties in the same supply chain, known as the vertical collaboration will be discussed. Each collaborative planning level will be discussed separately. In addition, the general characteristics and the variety of solution methodologies will be discussed.

4.1.1 Strategic Level

The strategic planning model to improve performances takes into account the long-term interests of all collaborative parties and their decisions on both suitable businesses and operational policies. Audy et al. (2006) and Gonzalez-Feliu and Morana (2011) used a similar approach to develop a framework for the strategic partnership model. Audy et al. (2006) proposed a series of business models to build a collaborative transportation coalition. Also, Gonzalez-Feliu and Morana (2011) developed a conceptual framework model that summarizes the organizational model and sharing analysis factors, including information sharing in the context of the press distribution sector in France.

The models in the above-mentioned research (Audy et al., 2006; Gonzalez-Feliu and Morana, 2011), need to be implemented and their performance indicators need to be measured to facilitate the evaluation of the strategic decisions. In Audy et al. (2006), managing trust and sharing risk were not included as a mechanism of collaboration. On the other hand Gonzales-Feliu and Morana (2011) included several types of risk (financial risk, technology risk, and policy risk) but still did not include how the collaborative parties interact and how the collaborative parties manage a trust.

Caplice and Seffi (2003) discussed the network model in which shippers could procure transportation services by underpinning the optimization of a conditional bidding for carriers so that the shippers can quantify and compare the levels of services with the carriers' rates. The approach introduced by Caplice and Seffi (2003) can be used as a marketing tool by carriers to help a better understanding for shippers' clients on how to place value on their specific services. The limitation of this research is that they only used one aspect of the process, which is a procurement that uses a bidding method. Therefore, the sharing information process, the impact of the bidding method, the interaction, and the synergies among collaborative parties are still not covered.

Wen (2012) on the other hand, used the Exploratory Factor Analysis to identify the key factors associated with CTM practices, such as the logistics capability and competitive advantage for carriers. Similarly, Kayikci (2009) showed the impact of CTM's implementation process on intermodal freight transportation by developing a path model. Both studies provide empirical evidence to support a conceptual framework regarding the impact of CTM for carriers and the implementation of CTM practices. The limitation of the research (Wen, 2012 and Kayikci, 2009) is that quantifying the benefits and impacts of CTM for carriers and supply chain partners was not carried out.

Ergun et al. (2007) used heuristics as a solution method to assist the identification of dedicated truckload's continuous moving tours for the time-constrained lane-covering problem. Ergun et al. (2007) conducted computational experiments on slightly simplified instances, in which they did not consider loading and unloading times, and they used the algorithm that ignored Hours of Service regulations. In addition, Silva et al. (2011) studied the problem of reducing freight costs in the export process between the industries of manufacture goods and the maritime carriers. They used the strategic scope of relationship to see the collaboration role of each party in response to either party-to-party interactions or each party's interaction with the environment. They used the System Dynamics (SD) and Agent Based Modeling and Simulation (ABMS) as their solution methodologies. Due to the limitation of factual data in this research, the suggested results did not represent the real world's negotiations and information sharing in them. Silva et al. (2011) also omitted both the risk and trust mechanism in the model.

4.1.2 Tactical Level

Companies make medium-term decisions at the tactical level to define the process based on a general planning at a strategic level. Feng et al. (2005) proposed a concept of CTM and a framework for evaluating CTM. They also elaborated how CTM affects the supply chain's total costs and transportation capacity utilization. The simulation of beer game model was used to consider transportation capacity. The limitation of this research is that it had no complete analysis of actual CTM to obtain more real effects on the supply chain.

4.1.3 Operational Level

The operational level deals with the day-to-day process, a decision-making, and a planning that make supply chain process run smoothly, achieve maximum benefits, and increase performances. Moll (2012) shows that a short-term timetable planning in an operational process could achieve high productivity of freight railways. However, the potential benefits are not equally divided for all collaborative parties, due to a heterogenic transportation planning process. This research contributes to a better understanding of operational level of Switzerland's rail freight and shows the applicability of research in practices. Because the approach is incompatible with the operational process of the freight railways in Europe, this research could not be used as the foundation for the implementation of collaboration on an operational strategy.

Many researchers (Tyan et al., 2003; Esper and William, 2003; Feng and Yuan, 2007; and Chen et al., 2010) pointed out that information sharing and information technology in CTM could increase performances. Feng and Yuan (2007), Tyan et al. (2003) and Chen et al. (2010) used Notebook industry in Taiwan as their case study. Tyan et al. (2003) pointed out the benefits of CTM in three performance indicators, such as: shipment volume, delivery performance, and delivery cycle time. However, Feng and Yuan (2007) used different performance indicators, such as: on-time delivery, shipment visibility, transportation cost, and tracking cycle time to emphasize the benefits of CTM. Chen et al. (2010) tried to use a different approach by developing the cost function based on an actual operation. Chen et al. (2010) showed that the higher accuracy of CTM and the higher degree of information sharing resulted in saving costs in the supply chain.

In addition, Esper and William (2003) used a different industry to point out information sharing and information technology in CTM by measuring transportation cost, on-time performance, asset utilization, and administrative cost. The limitations of this research (Tyan et al., 2003; Esper and William, 2003; Feng and Yuan, 2007; Chen et al., 2010) are that both the interaction among collaborative parties and collaborative parties' problems related to trust, technology risk, and operational risk, when associated with information technology in CTM, were not explored.

Li and Chan (2012), on the other hand, proposed the interactions among different supply chain partners under a demand disruption. This research showed that CTM was efficient to handle risk in the supply chain when a demand disruption occurred. However, this research only used a virtual company as its calculation basis. Therefore, a company that uses reliable data needs to be explored to provide better evidence on the benefits of information sharing in CTM. The limitation of conducting research in this operational level is that there is no previous studies that point out how each collaborative party interact with another party in making its decision on a delivery route.

4.2 Horizontal Collaboration

In horizontal collaboration, the total cost of supply chain is used as a key issue in performance measurement (Prakash and Deshmukh, 2010).

4.2.1 Strategic Level

The strategic level provides an overall direction by determining the objectives, developing policies, and plans based on the consideration of resource allocation and environment (Nag et al., 2007). With the same direction, Song and Regan (2003) proposed the feasibility of the auction as a basis for the procurement in the horizontal collaboration. They conclude that the auction method is more efficient than both the long-term agreement and the spot market. The limitations of this research were that Song and Regan (2003) did not explore how information sharing process in the auction process was conducted and how transportation companies could separate profitable opportunities from unprofitable ones in the auction procurement.

Asawasakulsorn (2009) developed five selection criteria, based on economic concept, to select partners to join the collaboration. There are some limitations in this research, i.e., using a non-probabilistic sampling. Therefore, the relationship among all collaborative parties could not be measured, and the benefits of collaboration could not be evaluated. Taherian (2013) developed a practical guideline for companies that intend to engage in the horizontal collaboration. Taherian (2013) evaluated the benefits of the total savings by a network synergy of 6 companies that were engaged in the horizontal collaboration. The limitation of this research is that Taherian (2013) did not evaluate the performance indicators other than the cost savings.

Audy et al. (2010) and Frisk et al. (2010), on the other hand, used a different approach to develop a policy in the strategic level by proposing an agreement among collaborative parties on how cost savings could be shared among them. Both research pointed out the cost could be shared among collaborative parties, and the impact of cost sharing could be evaluated. The limitation of the research conducted by Audy et al. (2010) is that they excluded the evaluation on how cost savings could be shared among collaborative parties. On the other hand, Frisk et al. (2010) evaluated the impact of cost sharing more comprehensively on backhauling, time periods, geographical distributions, and coalition sizes. The limitation of the research (Audy et al., 2010; and Frisk et al., 2010) is that they excluded the negotiation process when the companies have different negotiating powers. They also did not evaluate how information was shared among collaborative parties,, how collaborative parties interacted, and how trust among collaborative parties is maintained, and how cost was shared equally.

Liu et al. (2010) demonstrated a profit allocation mechanism among collaborative parties to ensure the establishment and sustainability of the alliance for small and medium sized LTL carriers. The results of the simulation for the real-life data showed the effectiveness of the proposed model. However, due to the limitation of the horizontal collaboration in the transportation industry, the research conducted by Liu et al. (2010) only used three carrier companies as its samples. Therefore, this research needs to adopt the model that is proposed for the practical application.

4.2.2 Operational Level

The decisions in this level include taking orders for shipment and the movement of goods from a point of origin to a destination point. Only two researchers (Peeta and Hernandez, 2011; and Nadarajah, 2008) developed a route models for the operational level. Peeta and Hernandez (2011) explored the LTL collaboration from the perspective of small to medium-sized LTL carriers. This research indicated that the carrier collaboration increased the capacity utilization thereby increasing the revenue of empty-haul trips and decreasing the impacts to the fuel cost. Peeta and Hernandez (2011) used a combination of multivariate techniques and the mixed logit model to determine the probability of a carrier. The significance of variables illustrates that LTL carriers are concerned with the potential economic impacts and the possibility of forming collaborative alliances. The limitation of this research is that it did not quantify and explore the impact of performance indicators of collaborative parties on the benefits for the parties engaged in the horizontal collaboration.

Nadarajah (2008), on the other hand, proposed a carrier collaboration framework in order to reduce deadhead miles and to increase carriers' revenue. In addition, this research explores CTM related to green transportation by showing that CTM can reduce congestion and pollution by using metaheuristics as its solution method. However, Nadajarah (2008) did not explore how the collaborative parties interact to one another in order to align each collaborative party's own objectives.

4.3 Lateral Collaboration

Many companies get involved in either the vertical collaboration or horizontal collaboration. However, combining both the vertical and horizontal collaboration into practice is not easy to implement. The objective of the lateral collaboration is to get the benefits from both the vertical collaboration and horizontal collaboration (Mason et al., 2007).

4.3.1 Strategic Level

VICS (2004) and Sutherland (2006) used the framework model to describe the variables that are relevant to the transportation problems by using the CTM approach as a guidance to solve the problems. According to VICS (2004) and Sutherland (2006) there are four key variables for CTM, and they explain what key enablers that facilitate the success of CTM. Both research also reported the performance benefits of CTM's pilot initiatives in various companies and settings in the U.S. starting in 1999.

Ozener (2008) developed the network model and combined it with the routing model. Ozener (2008) developed his research in three stages. At the first stage, the shippers offered continuous move routes to the carriers in return for the reduction in per mile charges. Both the second stage and the third stage will be explained on the operational level. The limitation of this study is that Ozener (2008) did not explore the negotiation process and did not explore the risk that could be arising in an uncertain condition in both the network and route model.

On the other hand, Gonzalez-Feliu et al. (2013) developed an integrated approach between the vertical and horizontal collaboration in transportation and proposed a framework to support the main strategic planning decisions from a group viewpoint. This framework evaluates a strategic planning decision based on a hierarchical cluster analysis and a decision ranking method by using five possible strategies for collaborative transportation. Gonzales-Feliu et al. (2013) showed that the method could be applied to support a group of heterogeneous decision makers in implementing collaboration strategy. However, the method was not able to capture both the real interactions and the real negotiations in the process. Its other performance criteria, such as the quality and service accuracy in a strategic decision-making also needs to be evaluated

4.3.2 Operational Level

Both the second stage and the third stage of the research conducted by Ozener (2008) relate not only to the development of the route model to reduce both the transportation and distribution cost but also to the evaluation of fair benefits sharing among them. The example is the carriers exchange loads among themselves to reduce empty repositioning and to increase truck utilization. At the third stage, under the vendor management inventory, the replenishment among customers due to their locations, usage rates, and storage capacities, may be exploited to reduce the distribution costs. This model was developed to serve the nearby customers on the same route at the same time. One result of the research done by Ozener (2008) showed that the proposed methods performed significantly better than the proportional allocation methods used in practice. Another result also demonstrated that the proposed methods are computationally efficient.

Mason et al. (2007) conducted three case studies to illustrate the advantages of collaboration among supply chain partners that used information technology system, such as: Internet and RFID. Several performances that were evaluated in this research were cost reduction, service levels, visibility, end customer satisfaction, and many others. The limitations of this research are that Mason et al. (2007) did not evaluate the transportation performance indicators, the risk arising from the information sharing and information technology, and the interaction among the parties who were engaged, and how trust was developed and maintained by each party.

5. DISCUSSION

This paper reviews 27 articles gathered from Proquest, Science Direct, Taylor and Francis database. This paper also includes athe recommendation from peers that relate to the description, implementation, planning levels, and methodologies of CTM, and contribution of various CTM models. From 27 articles reviewed show the benefits of CTM on the vertical, horizontal, and lateral collaboration. Various performance indicators are evaluated to point out the benefits of implementing CTM. Even though all of the articles point out the benefits of CTM, there are still some limitations of the previous research.

The vertical collaboration, also known as the traditional collaboration, is the most well formed type collaboration used in the area of CTM. However there are several limitations existing in the current literatures. Wen (2012), Caplice and Seffi (2003), and Kayikci (2009) developed a strategic partnership model although quantifying the benefits and impacts of CTM on the carriers and supply chain partners was not integrated into it. However, previous researchers only identified the benefits and impacts of CTM by indicating several performance indicators without analyzing the interactions and relationships of a partnership's elements, such as: commitment, trust management of collaborative parties, conflict resolution, and risk sharing. On the other hand, Silva et al. (2011) tried to explore the shortcomings of previous literatures by examining the interactions among collaborative parties and benefits of CTM.

In tactical level, only one article was found. It was written by Feng et al. (2005). They developed a carrier assignment model to evaluate effects of CTM on the supply chain, such as: total costs and transportation capacity utilization. Nevertheless, there is no complete analysis of actual CTM in evaluating upstream suppliers of manufacturers and downstream retailers or customers of the distributors to obtain more real effects of CTM on the supply chain. Moreover, no literature discusses the research in the order and shipment forecasting model.

Some research has been dedicated to develop order-processing models to point out the benefits of CTM (Tyan et al., 2003; Esper and William, 2003; Feng and Yuan, 2007; and Chen et al., 2010). However, pointing out the benefits of CTM is not enough only by presenting how CTM works in the operational level. Li and Chan (2012), on the other hand, seem to answer the shortcomings of the previous research by showing the operational interactions among supply chain partners under a demand disruption. This research only explored one risk in the supply chain and used a virtual company as its calculation basis. Several risks, such as technology risks and operational risks, arise from the collaborative transportation, particularly when it relates to the order processing model was not explored.

The horizontal collaboration has been gaining attention as a new business model that can make the transportation and logistics sector more efficient, effective, and sustainable. However, until today there are still limitations related to the horizontal collaboration in practice and research area due to its complex nature. All previous research focused on the horizontal collaboration at the strategic level only developed strategic partnership models. Asawasakulsorn (2009) and Taherian (2013) did not evaluate the performance indicators except for the cost savings on the horizontal collaboration. Audy et al. (2010), Fisk et al. (2010), and Liu et al. (2010) provided the evaluation of performance indicators on the horizontal collaboration. However, they did not evaluate information sharing process, interactions among collaborative parties, and trust management that related to information sharing among collaborative parties in order to share the cost equally.

On the other hand, Peeta and Hernandez (2011) developed a route model, but this research did not quantify and explore the impact and the benefits of CTM in the horizontal collaboration. In addition, the research done by Nadarajah (2008) showed that by conducting CTM, congestion and pollution could be reduced. The limitation of the research in the horizontal collaboration, particularly at the operational level, is that the research emphasized neither on the interaction and information sharing among all parties in the collaboration nor on how the uncertainty in operational process could impact the decision-making.

In order to manage the transportation within the supply chain setting, it is important to understand the characteristics of modern supply chain management by combining both the horizontal and vertical forms of collaboration (Mason et al, 2007). The lateral collaboration is also being exploited as a new collaboration approach to create superior value adding solutions to many supply chains. In the strategic level, VICS (2004) and Sutherland (2006) used the framework model to give guidance for a decision-making to use the CTM models in each planning level and in selecting partners for CTM, as one of the stages in the strategic level. In addition, Gonzalez-Feliu et al. (2013) developed a decision-making model in the strategic level. However, Gonzalez-Feliu et al. (2013) did not take into account the negotiation process, information sharing, interactions among collaborative parties, trusts management, and risk management as the foundations in a decision-making process.

Concerning the operational level, Mason et al. (2007) illustrates that the use of information technology will increase the performance indicators in CTM. However, he did not quantify the performance indicators. Therefore, it is difficult to evaluate how significant the advantages of collaboration for each party are. Mason et al. (2007) also did not evaluate the risks arising from the information sharing and information technology that were used by all parties, the interactions that happened among the collaborative parties, and the trust management that was built in the collaboration process. In addition to several limitations explained previously, no one has done research in the tactical level both in the horizontal and lateral collaboration. For this reason, any research in this area will give a better understanding on how CTM can be developed in the tactical level.

Based on the above-mentioned categories, there are six research gaps that are found from previous literatures. The first research gap is that many of the previous research only focused on the optimization of CTM, causing a gap in the exploration of the behaviors and the interactions among parties involved in CTM. Therefore this gap prevents a more realistic understanding on the CTM. The behaviors and interactions among the collaborative parties may significantly influence how operating systems work, perform, and improve (Gino and Pisano, 2008). The second research gap is the limitations regarding the integration of an information structure, based on information sharing, into CTM. Such integration is necessary to formulate a foundation to develop a decision in each planning level and each stage of the collaboration process in order to improve the visibility and the accuracy of a decision-making.

The third research gap is that all previous research did not explore the integration of decision-making into the models in order to get a better result in implementing CTM. Distributed decision-making among collaborative parties leads to increasing agility by synchronizing decisions for each collaborative party that has different objectives and different perspectives (Wadhwa and Rao, 2003).

The fourth research gap is that the previous literatures did not explore how to integrate different stages of the collaboration process into CTM. Interdependent stages of collaboration process among collaborative parties are necessary to be developed in order to capture the interactions among the collaborative parties involved in a transportation planning and execution processes.

The fifth research gap is that all previous literatures did not explore and evaluate the incentive alignment to share risks and benefits for all collaborative parties equally. The incentive alignment can be used as an instrument for motivating and inducing all collaborative parties involved in CTM to join the collaboration by sharing costs, risks, and rewards.

The last research gap is that all the previous literatures already explored several performance indicators to capture the benefits of CTM for all collaborative parties. However, the previous literatures did not explore and evaluate how value co-created among collaborative parties, based on customer value and customer expectations, become the benefits of CTM other than the performance metrics.

To address these research gaps, a proposed framework is developed based on the characteristics of behavior, hierarchical decision-making processes, a soft system approach, and collaborative approach.

Behavioral in Operation Management is defined as the study of human behavior and cognition and their impacts on operating systems and processes (Gino and Pisano, 2008). Carter et al. (2007) also mention that the aim of behavior in Operation Management is to understand people's decision-making processes in order to improve the operation of the supply chain. *A hierarchical decision-making process* is a decision system in which multiple decision makers are involved in a business process and in which it has a strategic, tactical, and operational levels (Liu, 2010). This hierarchical decision-making process is designed by decisions of each level based on certain rules and behaviors of each individual involved in each collaborative structure. *Soft system* is also used when facing a dynamic and unpredictable situation as well as when goals and objective cannot clearly qualify (Checkland, 2001). Soft system is applied to analyze problem situations in which human perceptions, behaviors, or actions are dominating factors so that the goals can be negotiable (Checkland, 2001). In addition, *collaboration approach,* in several stages, is used in order to capture the interactions, actions, and the effects of decision-making in CTM. The collaboration stages, namely forming, preparation, design, planning, implementation, and evaluation stage, were adopted from Dwyer et al. (1987).

The behaviors of multi-agent's hierarchical decision-making process, as the proposed framework, can be seen in Figure 4. The proposed framework helps to understand and explore the behaviors of the collaborative parties in CTM, the interaction with other parties, and the parties' abilities to make decision in strategic, tactical, and operational level in meeting the goals in each collaboration structure (i.e. vertical, horizontal, and lateral). The behavioral aspect for hierarchical decision-making process in CTM is developed in order to deliver services that lead to value co-creation of collaborative parties. In addition, the proposed framework is also developed to gain a systematic understanding of how and when different objectives and perspectives of collaborative parties affect decision-making process in each collaborative structure.

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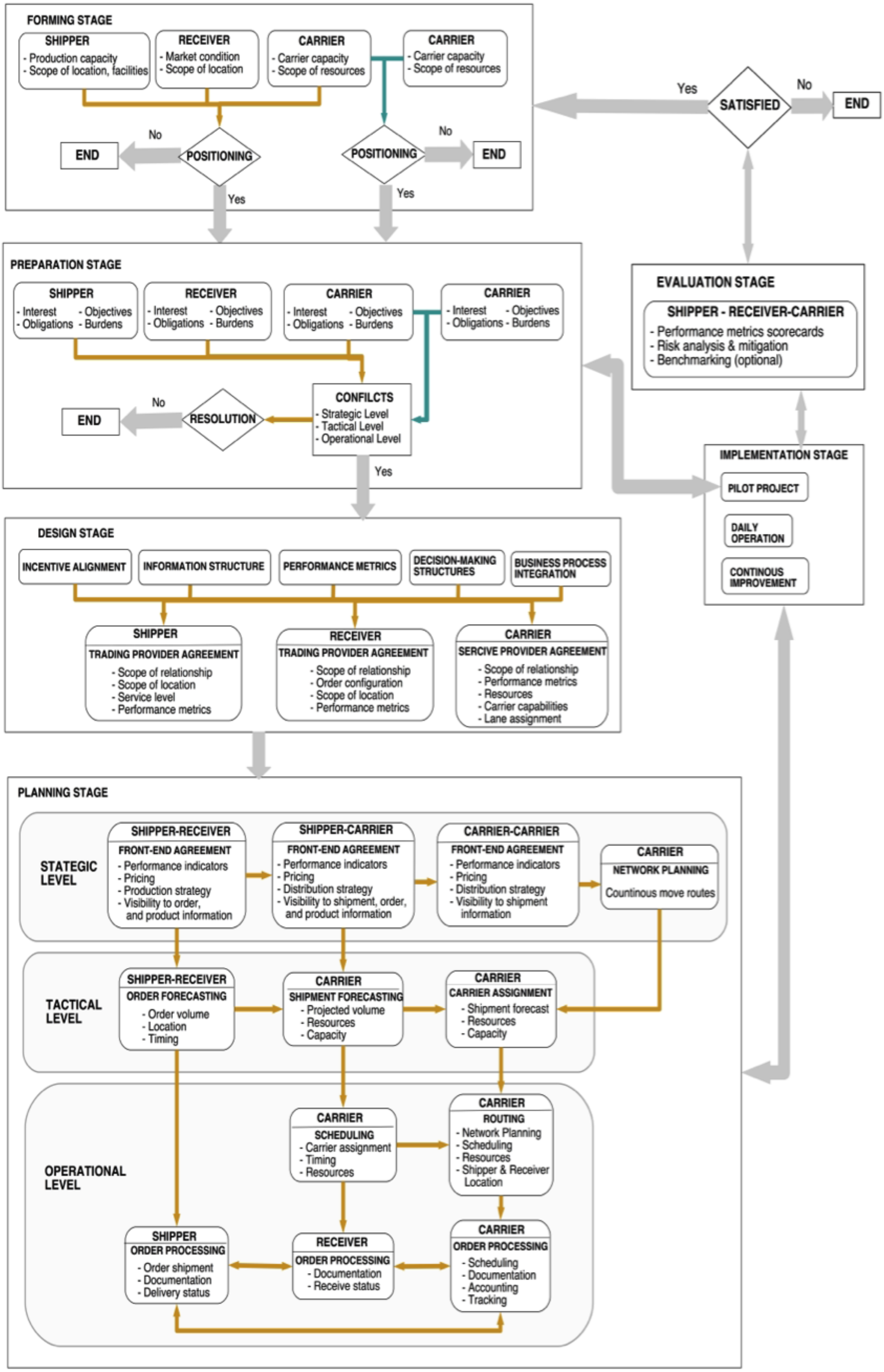
Figure 4. The Proposed Framework of The Behaviors of Multi-agent's Hierarchical Decision-Making Processes



6. CONCLUSIONS

Academics and practitioners recognize CTM as a business strategy to eliminatie inefficiencies in the transportation component. Despite the growing interest in CTM, there are several issues that remain unaddressed. There are 27 articles that have been reviewed and classified based on four categories. The first category is based on the different collaborative structures, namely: the vertical, horizontal, and lateral collaboration. The second category is based on the general characteristics of fundamental issues and collaboration mechanisms. The third category is based on the time horizons of collaborative planning levels such as the strategic, tactical, and operational level. The last category is based on the solution method used to solve the problems that are approached by CTM models. Based on the systematic reviews, several research gaps have been outlined.

Future research on CTM could be taken by developing behavioral models in order to capture the interactions among collaborative parties. Future research should also be focused on the integration of the information structure into both a collaboration process and a hierarchical decision-making. Future research can also be focused on using an incentive alignment to persuade collaborative parties to behave in ways that are best for all by distributing the risks, costs, and rewards fairly among the involved parties. In addition, how useful is the value co-creation of CTM for all collaborative parties can be evaluated.

For future research an agent-based simulation can be proposed as a solution method for a CTM model. This simulation can be used to represent all the details and behaviors of collaborative parties in each collaborative planning level. Furthermore, this simulation can also be used to re-create and enhance the ability to understand, predict, and control a decision-making for the CTM that uses a behavioral approach.

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APPENDIX 1. A List of Previous Literatures Review

AUTHOR	MAIN OBJECTIVE OF THE PAPER	APPLICATION OF THE MODELS
	VERTICAL COLLABORATION	
Tyan et al. (2003)	Analyze an effective collaboration in global supply chain (GSC) execution to reduce delivery time and improve delivery reliability.	3PL provider in a notebook computer GSC
Esper and William (2003)	Portray the holistic value of supply chain collaboration by discussing CTM and the role of information technology and its benefits.	Case study: 3PL Transplace
Caplice and Seffi (2003)	Analyze the optimization-based procurement process to securing and managing a strategic relationship.	US truckload (TL) transportation
Feng et al. (2005)	Evaluating the benefits of CTM by simulating 3-scenario model on the manufactures, distributions and carriers in supply chain.	Manufacturer-Carier-Distributor in Taiwan
Audy et al. (2006)	Design a framework to describe collaboration in transportation, and a different business models associated with collaboration in transport are proposed.	Five industrial application in wood fiber transportation
Ergun et al. (2007)	Generate optimization technology to assist in the identification of repeatable, dedicated truckload continuous move tours with little truck repositioning.	US Industry
Feng and Yuan (2007)	Analyze the application integrating CTM with enterprise resource planning (ERP) via information technology (IT) to facilitate transportation capacity planning and achieve prompt delivery within the shortest time possible.	First International Computer Inc and UPS Taiwan branch
Kayikci (2009)	Evaluate performance outcomes depend on the communication quality, long-term orientation and satisfaction, the quality of information and the intensity of joint information sharing.	Different industries in Europe both transport users and transport service providers
Chen et al. (2010)	Explore the cost difference after the computer industry introduced CTM and the association analysis between the inventory element and the transportation element.	TFT–LCD

APPENDIX 1. A List of Previous Literatures Review (Cont.)

AUTHOR	MAIN OBJECTIVE OF THE PAPER	APPLICATION OF THE MODELS
	VERTICAL COLLABORATION	
Silva et al. (2011)	Analyze the behavior of the collaboration in order to reduce freight costs.	Maritime logistics of manufacture export companies in Brazil
Gonzalez-Feliu and Morana (2011)	Develop a conceptual schema focus on socio-economic and legislative aspects in order to define the main concepts related to logistics sharing agreements that representing the most important organizational aspects.	French press distribution sector
Li and Chan (2012)	Determine the impact of CTM on the performance of manufacturing supply chains using two supply chain models (with and without CTM) in order to show the impact of CTM under demand disruption.	Virtual Companies
Moll (2012)	Identified and assessed twelve potential forms of collaborative approaches in order to improve the efficiency of locomotives and train drivers, the effectiveness of single wagon load trains, and also increase freight rail productivity.	SBB Cargo-Swiss Freight Railway
Wen (2012)	Examine the impacts of CTM on logistics capability and competitive advantage of carriers within a supply chain, and analyzes the relationships between logistics capability and competitive advantage.	The carriers and transportation service providers in Taiwan
HORIZONTAL COLLABORATION		
Song and Regan (2003)	Examine and develop a new auction based carrier collaboration mechanism for complex decision problems associated with subcontracting, bidding, and bid selection are investigated.	Trucking industry in US
Nadarajah (2008)	Develop simple examples where a firm can enhance its transportation efficiencies through Less-than-Truckload collaboration to reduced cost and improved customer service.	Less-Than-Truckload (LTL)

APPENDIX 1. A List of Previous Literatures Review (Cont.)

AUTHOR	MAIN OBJECTIVE OF THE PAPER	APPLICATION OF THE MODELS
	HORIZONTAL COLLABORATION	
Asawasakulsorn (2009)	Develop partner selection criteria during the formation stage based on economic, social perspectives, and inter-organizational system (IOS) design factors regarding trust.	Shipper and carrier company in Thailand
Fisk et al. (2010)	Evaluate sharing mechanisms and propose a new allocation method, with the aim that the participants relative profits are as equal as possible.	Forest industry in Sweden
Liu et al. (2010)	Develop the LTL collaboration game and propose allocation method to distribute profits/savings among the participants that are fair, reasonable, and easy to implement.	LTL industry
Audy et al. (2010)	Evaluate different coordination mechanisms scenarios to ensure cost and delivery time reductions as well as gain in market geographic coverage.	Canadian furniture industry
Peeta and Hernandez (2011)	Modeled LTL collaborative paradigms from the supply and demand perspectives to identify potential collaborative opportunities and encourage collaboration by increasing capacity utilization for member carriers.	Less-Than-Truckload (LTL)
Taherian (2013)	Design a practical guideline to engage in collaboration by Do-It-Yourself (DIY) approach and focus on passive collaboration by addressing how to qualify potential collaboration partners, how to evaluate the associated savings, and how to make it work.	LTL and TL shipments
LATERAL COLLABORATION		
VICS (2004)	Provides an overview of CTM, a process for bringing trading partners and transportation service providers together for the sake of "win-win" outcomes among all parties.	Various companies in US as pilot project
Sutherland (2006)	Demonstrate how supply chain partners collaborate on transportation process become more adaptable to day-to-day demand changes as well as resilient in the event of major supply chain disruptions	Various companies in US as pilot project

APPENDIX 1. A List of Previous Literatures Review (Cont.)

AUTHOR	MAIN OBJECTIVE OF THE PAPER	APPLICATION OF THE MODELS
	LATERAL COLLABORATION	
Mason et al. (2007)	Demonstrate that lateral collaboration are emerging for better transport optimization, that exploit the competitive power of collaboration, both vertically with supply chain partners and horizontally with other logistics service providers (LSPs).	The road freight transport industry in the UK and Europe
Ozener (2008)	Develop framework and evaluate collaborative approaches to identify collaborative opportunities among shippers and among carriers to reduce transportation cost and distribution cost.	Industrial gas company in US
Gonzalez-Feliu et al. (2013)	Determine collaborative freight transport, its links with supply chain management, and aims at framing an assessment method to help decision makers in strategic collaborative logistics, transport design, and planning.	LTL transport operators

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