An integrated planning-simulation-architecture approach for logistics sharing management: A case study in Northern Thailand and Southern China

Pree Thiengburanathum, Jesus Gonzalez-Feliu, Yacine Ouzrout, Nopasit Chakpitak, Abdelaziz Bouras

AN INTEGRATED PLANNING-SIMULATION-ARCHITECTURE
APPROACH FOR LOGISTICS SHARING MANAGEMENT:
A CASE STUDY IN NORTHERN THAILAND AND SOUTHERN CHINA

by

Pree Thiengburanathum[1], Jesus Gonzalez Feliu[2], Yacine Ouzrout[3], Nopasit Chakpitak[1], Abdelaziz Bouras[3]
[1]College of Art Media and Technology, Chiang Mai, Thailand 50300
Email: preenet@gmail.com
[2]Laboratoire d'Economie des Transports, Institut des Sciences de l'Homme, Cedex 69363 Lyon Cedex 07, France
[3]University Lumière Lyon 2 – LIESP, 69676 BRON Cedex France

ABSTRACT

In logistics, freight transportation is a major source of income in a country's economy. One of the most popular strategies is logistics sharing, which is a complex problem due to the involved stakeholders. Moreover, the current several transport operations are extremely expensive due to the empty return. For these reasons, a decision support system is needed to enhance or predict the system optimum and the best strategies of each stakeholder in the context of logistics sharing schemas. In this paper, we will discuss how a Knowledge Management System methodology can be developed for a real case study from the project between Northern Thailand and Southern China which will be used in our study. In parallel, we will show how we model the agent from the analysed data in order to use in our Multi-Agent Simulation in the next phase. The agents will be defined such as transport agents, intermediate agents and customers, among others.

INTRODUCTION

In the freight transport relations between Northern Thailand and Southern China, the problem of empty return still occurs. The problem is complex for a stakeholder to make a right decision, because of decision elements such as price, deadline, freight availability, fresh good, and seasonally. Additionally, in these relations, several stakeholders of different origins and categories are involved. For example, we can cite mainly producers, warehouse manager, retailers, transportation companies, and logistics operators. Currently, transport operations between North Thailand and South China are expensive due to empty returns. In order to co-ordinate them for a better resource optimisation, a collaborative transport sharing approach (Gonzalez-Feliu and Morana, 2010) can be proposed. In this context, a Decision Support System (DSS) can be proposed to assist the various stakeholders in their decisions concerning resource sharing. We have planned to develop an integrated multidisciplinary Decision Support System (DSS) which combines a Knowledge Management System (KMS) and Multi-Agent System (MAS), which acts as a forecaster for short and long term operations. We would like to note that this research is on process.

The aim of this paper is to show how the shared information can be managed by a KMS to propose sharing solutions for transport cost optimisation in a case study between Northern Thailand and Southern China. First we introduce the context of case study, presenting the background issues related to this case. Second, we present the purposed methodology for the DSS supporting the logistic sharing management system. After that, we discuss the links between MAS and KMS. Finally, we will introduce the main database system of the KMS, and define the main objects, relating them to the agents that will be used later in MAS.

BACKGROUND ISSUES

According to Gonzalez-Feliu and Morana (2010), resource sharing can be defined as the joint or the alternating use of inherently finite resources. The main shared resources in logistics are information, infrastructure, management/planning tools, vehicles and human resources. These schemas involve several stakeholders that have to communicate and communicate. For this reason, decision making in resource sharing needs a strong connection to knowledge management communities (Evangelou and Karacapilidis, 2007). Xian-yun and Fu-yaun (2010) note that "Knowledge Management actually is a process in which in which it seeks for the integration of handling capacity of data and information supported by information technology with the creative and renovative capacity of an organization's members to satisfy the needs of enhancing adaptability, productivity and competitive competence, when the organization faces increasing intensification of successive environmental changes".

In order to simulate the relations between stakeholders, a Multi-Agent System (MAS) can be developed. A MAS is basically composed of agents that interact with each other in the environment, where each agent has its own goal and tries to maximize its own resources, utilization and benefits(Peer-Olag S., Uwe A., 2008). In Computer Science, there is no general consensus on the definition of agent (Peer-Olag S., Uwe A., 2008). Agent receives a message or information from an environment and other agents, the agent will have its own rule which represent its cognitive decision process, and then it will may or may not response to the message regarding to the rule it has. The accuracy of the MAS depends on the type of questions, and the accurate input data. A multi-agent system is promising as a good technology to model an organization, where people have to make a decision as a group. (Trappl et al., 2003)

CONTEXT AND RESEARCH PROBLEM

According to the Asian Development Bank (2008), the Greater Mekong Sub-region (GMS) represents the countries such as Thailand, People's Republic of China (PRC), People's Democratic Republic Lao, Cambodia, Yunnan Province, Guangxi Zhuang Autonomous Region (Guangxi), and Vietnam. The goal of the GMS programs is to increase the economic growth of countries, and this is not only in the development of transportation but also in energy, human resources, energy and trade and investment. We will focus on the North-South Economic Corridor (NSEC), illustrated by Figure 1.

FIGURE 1
**THE SUB REGION IN NSEC, BANGKOK – KUNMING CORRIDOR**

There are several transport modes available in the NSEC such as sea, road, river, air, railway, and inland waterways transportations. The rail transportation is considered to be the poorest transport mode in Thailand, the transport supports for passengers rather than goods. While the road transport is the most demanding, due to the coverage

of the network and the high ability of sender to access to the receiver. The Inland waterways transport is also important but the mode is not reliable since Mekong River is seasonally and conditionally used (Asian Development Bank, 2007).

FIGURE 2
**THE SITUATION OF EMPTY RETURN PROBLEM**
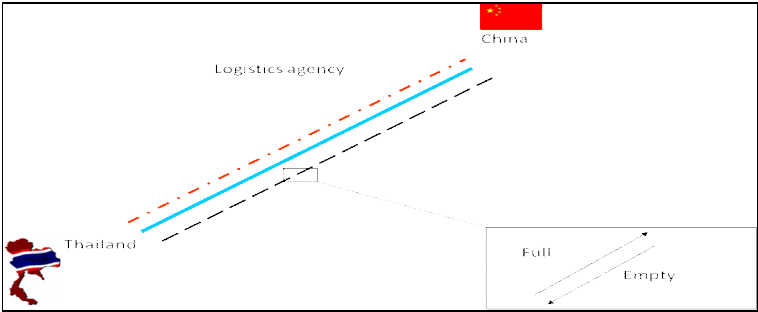
The problem of empty returns in the NSCE is the situation which this research paper focuses. In this context, logistic resource sharing is a good approach to reduce the number of empty returns and better optimise the logistics resources.

The logistics schema of the proposed approach is based on collaborative logistics sharing with an external co-ordinator (Gonzalez-Feliu and Morana, 2010). In this approach, the various stakeholders send offers and requests to a co-ordinator who manage assignment of each request to a transport operator, using the DSS which structure is presented below.

THE PROPOSED METHODOLOGY

In this section we propose the DSS general schema, based on a KMS central module that manages the information used by all the other modules (Figure 3). KMS methodologies could be used in the case study to manage/maintain the information which we received from several ways. For this reason, a data collection tool is needed to unify the collected data in order to feed the KMS. Moreover, Multi-Agent Simulator (MAS) module will be used to find transport cost optimisation sharing solutions. This module will contain, among others, machine learning techniques such as genetic algorithms or neural networks which are related to modelling the behaviour, dynamics of learning, vehicle routing and loading optimisation tools and negotiation algorithms.

FIGURE 3
THE PROPOSED METHODOLOGY
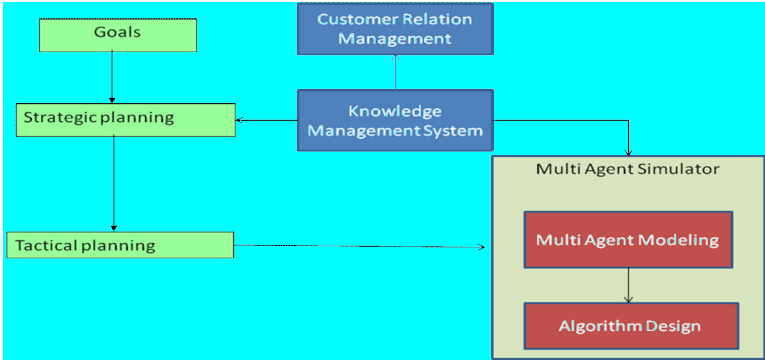
The left side of the diagram (Figure 3) represents the goals which have both strategic and tactical planning. In the middle, the KMS phase which is enhanced with CRM as a software tool, this part is acted between the Logistic and the Simulator parts. On the right side of the flowchart, it shows the Multi Agent Simulator that consists of Multi-Agents Modelling and Algorithm Construction phases.

Links between MAS and KMS

The link between KMS and MAS is a very important issue to discuss in this research. As we might know that data and information we have gathered are from various sources and in different formats and we are concerned about the quality of the data. The KMS will play a crucial role here to capture and store in an efficient way the empirical data from the incomplete information. Then, it would translate into knowledge to the simulator, in order to characterise the various agents.

To model agents, it requires the knowledge of how agents make their decisions from the real world to the simulation. Without KMS, information will be difficult to organise and maintain, and the simulator will perform poorly due to the inaccuracy parameters. It is then important to relate each set of variables that define each agent to one or more KMS objects, in order to manage efficiently the needed data. Indeed, KMS databases will contain all the information necessary to define MAS variables and parameters.

Modelling elements

Data collection process

In this section, the explanation of the process of collecting data and the difficulty of process of data collection will be discussed. Also, the reason why CRM is the solution will be provided.

Data Collection and Quality

Nowadays, the data that can be collected are presented in different document types, sources and formats. Most of them are in written forms such as a year reports, census data, field observations, strategy planning presentation and academic papers. Also, semi-directive interviews and qualitative surveys of people who involve in the NSEC program have been processed in order to find the best data collection method to our case.

Using empirical data requires a large number of high quality observations. There are some difficulties to extract the required information from the incomplete information, such that we want to have a specific data about stakeholders such as seller, customer, transport or logistic provider, but the collected data comprise a lot of information that we don't need. Moreover, the data came from different type of formats, and most of them we have to manually read throughout the document. To be able to maintain the quality and to organize the data, the CRM[1] should be used as a software tool in our framework.

CRM software is a knowledge management tool that we plan to use as data mining tool to gather data from different stakeholders. CRM software such as web application will be employed for stakeholders, so we would be able to extract the right data from the right sources, and to provide the right information to the right target stakeholder. The CRM will be connected to the KMS database system, where it could do the database operations such as INSERT, UPDATE, DELETE and so on.

We plan to use the free distribution of CRM software. The modification or adjustment will be made depending on the user and system requirements.

The main data structures

To maintain and organize the data in KMS, a database system has to be defined. The database system will be the main database system in the system, then KMS, MAS and CRM can connect throughout the processes.

---

1 CRM Customer relationship management, defined as " a company-wide business strategy designed to reduce costs and increase profitability by solidifying customer satisfaction, loyalty, and advocacy "

Regarding the case study, the definition of each objects and the relationship between them could be defined as follows.

Sender: The one whom freight is picked up.
Receiver: The one whom freight is delivered.
Logistic Operator: An operator that can be a warehouse keeper or freight forwarder.
Logistic Service: The object that provides, maintains information regarding the services. It provides service information to sender, receiver, and logistic operator.

FIGURE 4
THE MAIN DATA STRUCTURE FOR KMS
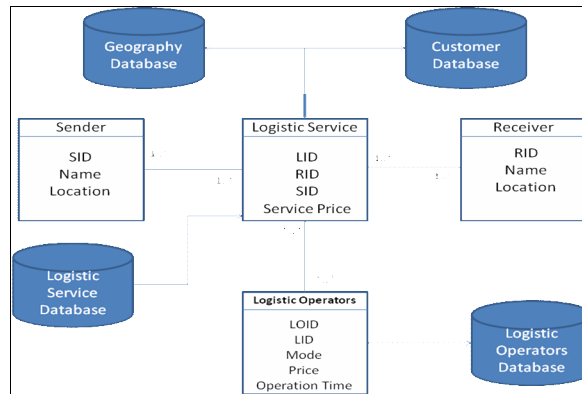
The diagram above shows how the stakeholders are related and the main database systems in the KMS. Where, The Logistics Service Object (LSO) maintains all the associated information of the sender, receiver and the logistic operators. LSO is connected to three databases (geography, customer, and logistics service database systems). LSO has its own database system. Moreover, the sender and the receiver will get the information from the LSO.

TABLE 1
**LOGISTICS SERVICE OBJECT'S CHARACTERISTIC AND VARIABLES**

Transport service	Parameters	Remarks
Origin		Location (X, Y), Pickup time, Payment details (transport payed at origin)
Destination	Location (X,Y)	
	Delivery time	
Mode	Road, Rail, Air, River	
Path	Geography	Zones travelled, countries travelled, ...
	Constraints	Route or direct transport
	Level of Assessment	Source to Destination, Scale from 1-3(1 = poor, 2 = fair, 3 = good)
	Reliability Score	Scale from 1-3(1 = poor, 2 = fair, 3 = good)
	Cost of the path	Distance, time, price, human resources
Price		Boarding entrance and Corridor fee
Track and Trace Capability		Scale from 1-3(1 = poor, 2 = fair, 3 = good)

The table above shows the Logistics Service Object (LSO) which the list of attributes represents as its behaviour.

Agent definition

In this section, we will present an overview of how the agents are interacted for a single request from the sender and the definition of the agents will be given. In the search for a set of good freight transport solutions, the MAS acts as a central core between agents and KMS. First, the sender sends a request to the MAS, and then the MAS will return a best result of which transporter he/she will be picked by communicating through several logistics service, transporter, and sender agents, as well as the KMS. At the end of the supply chain, the receiver will send information via the CRM module, and then it would process back to the KMS again. In fact, KMS plays a crucial role in preliminary phases, and in collecting and managing all data concerning the definition of each agent as well as their feedback about the various transport operations. However, in the simulation phase, it is quicker to interface directly the simulator, as shown in the example illustrated by figure 5 (one request made by a sender).

FIGURE 5
CASE WHEN CUSTOMER IS THE SENDER

Case where customer is the sender for one request
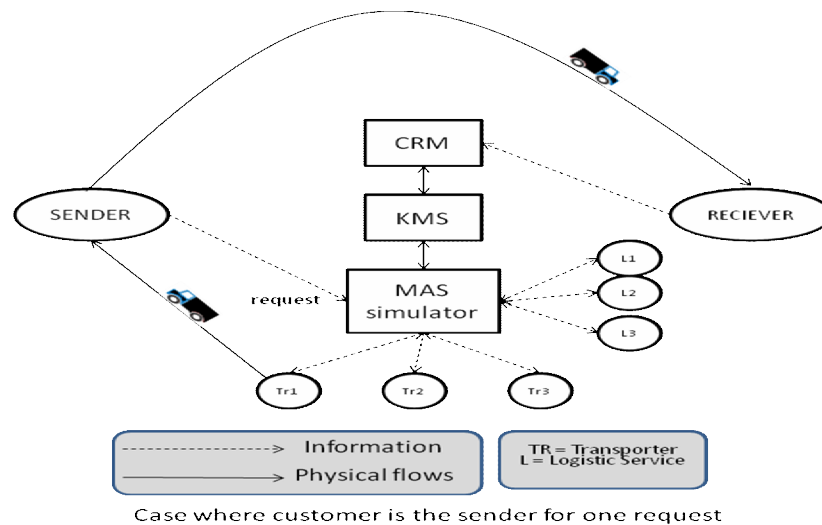
From this figure, we can observe the main agents involved in the MAS module. These agents are described as follows:

- The Transports Agents (TA) are the stakeholders that provide the transport services between an origin and a destination. It is important to know their free capacity in both trips (going and returning) in order to better manage empty returns.
- The Logistics Service Agents (LSA) are stakeholders that propose other logistics services related to freight transportation. Two main categories can be defined: freight forwarders, who will search for an external transporter, or warehouse keepers, that propose storage and cross-docking operations, among others.
- The Sender Agent (SA) is the stakeholder that is located at the origin of the transport, and is in general associated with the loader, i.e. the agent that requests a transport service.
- Receiver Agent (RA) is the stakeholder that is located at the destination of the transport, and will be one of the agents that give feedback about the transport operation via CRM.

CONCLUSION

In this paper, we have shown how the shared information can be managed by a KMS to propose sharing solutions in a context related to international freight transport. Moreover, we have discussed how KMS could be used to model the agents for MAS. . Therefore the interest of using CRM on the top of KMS has been discussed. We believe that to model behaviour of agents from real cases and to achieve the accuracy of MAS, knowledge has to be applied to support the system. Although the research is at its beginnings, we observed that the design and implementation of the main data structure in KMS will play an important role in the simulation system. Future developments of this research include the development of the multi-agent simulation module, including several behaviour and optimisation algorithms, and the application to the case study discussed above.

REFERENCES

Gonzalez-Feliu, J. et Morana, J. (2010)," Collaborative transportation sharing: from theory to practice via a case study from France". In Yearwood, J.L. and Stranieri, A., Technologies for Supporting Reasoning Communities and Collaborative Decision Making: CooperativeApproaches, IGI Publishing, pp. 1-21.

Peer-Olag S., Uwe A. (2008), "Introduction to Multi Agent Simulation", Encyclopedia of Decision Making and Decision Support Technologies, pp. 545-564.

Evangelou C.E., Karacapilidis N. (2007), "A multidisciplinary approach for supporting knowledge-based decision making in collaboration settings", *International Journal on Artificial Intelligence Tools* 16 (6), pp. 1069-1092.

Xian-yun W., Fu-yuan X. (2010), "Study of knowledge management system based on MAS, *International Conference on Networking and Digital Society*", pp. 395-398.

Trappl R., Petta, P., & Payr, S., (Eds). (2003), "Emotions in Humans and Artifacts. Cambridge", MA: MIT Press

Deyou T.,, Yanxia L., Jinguo Y. (2008), "A Multi-Agent Architecture for Knowledge Management System, Chuan Z. Fifth International" Conference on Fuzzy Systems and Knowledge Discovery.

Asian Development Bank. (2007). Country Assessment Report of Thailand

Asian Development Bank (2008).Logistics Development Study of the Greater Mekong Subregion North-South Economic corridor, Banomyoung, 2008.

Assessing Thailand's Logistics Portential in the Greater Mekong Sub-Regiom: The Case of the North-South Economic Corridor, Banomyong, 2009

Report of the study logistic between Thai and China (August 16-19, 2005), Section 4.6, 2005.

http://www.destinationcrm.com/Articles/CRM-News/Daily-News/What-Is-CRM-46033.aspx, What is CRM?, Accessing October, 2010