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A Software Platform to Support Collaboration in Express Delivery Services

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ABSTRACT

The express delivery industry in China has seen rapid growth in recent years. The majority of the express delivery companies can still be classified as medium-sized enterprises (SMEs). They are not just limited in terms of size, but also in terms of funds available for investment and in area of service coverage. Many such SMEs have chosen to collaborate so as to enhance their competitiveness. The current approach is to collaborate with another company located in a different city, and so effectively extend operations to inter-city delivery. However, this twosome type of collaboration has created problems in delivery efficiency and security. The main reason for such problems seems to be lack reliability in collaboration. The problem is compounded by a lack of affordable software tools to support such collaborations. A new approach to supporting collaboration among SME express delivery companies is proposed in this paper. The proposed approach involves an "m" to "n" collaboration relationship, with each city served by a multi participation network of companies. An agent-based system is also proposed to support and facilitate the multi-forwarders activities, and at the same time efficiently manage the collaborative relationships amongst participants. The proposed approach is demonstrated using a small case example.

INTRODUCTION

The express delivery industry has been one of the fastest-growing industries in China, with an average annual increase of over 20% for the past 5 years. In 2011, China's express delivery networks handled some 3.67 billion pieces, ranking 3rd (after the USA and Japan) in number of deliveries for any country world-wide. In value terms, 2011 was a 75.8 billion RMB (USD12 billion) business for the industry (State Post Bureau of China, 2012). According to industry analysts, the surging popularity of China's e-commerce business will result in an increased demand for express delivery services that will far exceed capacity in the next five years.

There are 4,036 courier, shipping and express delivery companies in the USA, and the average number of employees per company is believed to be in the range 1,000-4,999 (BizCompare.com, 2013). An average number of employees in such a range suggests that the vast majority cannot be classified as SMEs. In Japan 99.5% of the express home deliveries were handled by the 5 big companies in 2011 (Ministry of Land, Infrastructure, Transport and Tourism, Japan, 2013). In contrast, close to 90% of China's 30,000 express delivery companies are SMEs, see China Association of Warehouses and Storage (2005) and Zhi (2006). China's express delivery SMEs

are by definition limited in size, and many do not have sufficient funds to invest in the latest Information Technology. They were originally established as intra-city express providers servicing a defined area or a single city. These SME express companies gradually realized that in order to improve growth, or even survive in the highly competitive express delivery market, they would have to expand their services to inter-city deliveries, otherwise their local market share will eventually be lost to the larger inter-city companies, which includes many of the well known large multinational delivery names. This is the main reason why many of the SME express companies located in different cities have had to collaborate by engaging in a mutual sender-forwarder relationship, and thus effectively enabling them to enter the inter-city market. In comparison with local deliveries, in 2011 inter-city deliveries were 3.3 times the volume and 6.7 times the value (44.59 items and 6.59 billion RMB), see State Post Bureau of China, 2012. However, as such pair-wise collaborations have created problems in terms of both efficiency and security. There appears to be two main reasons as to why these problems have arisen:

- Most of the collaborative systems used are inadequate, mainly because a pair-wise collaboration involves only one company in each city and service standards may be neglected because of an absence of competition.

- Comprehensive software appears to be lacking that can support such collaborative operations and at the same time provide (1) the necessary online freight tracking services and (2) adequate performance measurement mechanism to capture actual daily service performance and turn into comparable credits.

OBJECTIVE AND RESERCH METHODOLOGY

It is clear to the authors that China's express SMEs can benefit by establishing and maintaining collaborative networks of alliances in each city; and this provides the impetus for this paper, in which we propose an agent-based software platform to support the collaborative networks of express SMEs in China. The agent-based system developed will also be able to serve as an e-business portal, and will facilitate the formation of alliances of companies amongst the collaborating express SMEs. The system should also enable SMEs to provide more reliable and efficient inter-company forwarding for door-to-door inter-city express delivery services, and all this should in turn enhance their ability to compete with their larger rivals.

Our research began by studying the current collaboration practice and the major issues faced by the SMEs express delivery companies in China. This was largely based on reference materials including previous academic research and reports from industry associations. In addition, interviews were conducted with industry experts to solicit their opinions. The root causes and drawbacks of current collaboration were analyzed and the concepts of a new collaborating mode were established. Because of the current state of development and needs, China's express industry parcels are mostly small in weight and size, and commonly packed in irregular and even squeezable shapes. Loading factors such as weight and dimension are usually not considered or recorded in the log of daily operations, and are not considered in measuring handling efficiency. It was therefore necessary to establish a complete set of performance measurement factors that could be incorporated into the proposed collaboration mode. System development and specification together with in-depth case analysis were conducted to test the overall collaboration flow of in proposed system and its response to practical situations

COLLABORATION AMONGST EXPRESS DELIVERY SMES

In the international express delivery industry, collaborative efforts between SMEs in freight forwarding have been generally considered as positive and have also enabled overall efficiency to rise for all those involved (Bernal, 2002). This finding is supported by other more recent studies (Hong & Liu, 2007; Hong et al., 2007; Huang et al., 2010), and they all come to the general conclusion that the SMEs express delivery services in China have gained considerable clout by establishing domestic alliances, and can gain even more clout by consolidating such alliances.

The Current Approach to Collaboration

Current practice is for express delivery SMEs to collaborate by establishing pair-wise partnerships with other local forwarder in different cities, and thus extending their reach to inter-city freight service. An example is shown in Figure 1, where a Beijing-based local express company has a single collaborator in each of the major cities. In this situation, the Beijing-based local express company and, for example, a Shanghai-based local express company becomes each other's domestic parcel forwarders in their respective home cities. For the actual transportation (air, rail or motor carriers) between the two cities the companies will use the services provided by a third-party. In this type of operation structure, an 'a-b' inter-city delivery channel is built and both companies can benefit by sharing inter-city delivery profits and in turn raising overall competitiveness by capturing more business. This type of collaboration requires a stable and reliable collaborative relationship, forcing each of the two companies to almost act as one. This type of collaboration is widely used by express SMEs in China, the majority being local truckers (Niehues et al., 2007). By adopting this type of collaboration, over 60% of the express delivery SMEs are able to provide inter-city door-to-door delivery services, with the final part of the delivery effectively becoming a local delivery (State Post Bureau of China, 2007).

Experience indicates that such transshipping operations between two companies add much more uncontrollable variability to the whole delivery process, especially if done without adequate support from computer systems. In this type of collaboration a company will handle freight from both its own local network and from its inter-city partners. Experience also indicates that some companies, quite naturally, give its own local freight higher priority at the expense of its inter-city partners. The overall performance of such networks depends heavily on the attitude of the companies involved, and mutual productivity enhancement can only be gained through high commitment to the alliance (Bernal et al., 2002). Such strong commitments are often hard to maintain when only a signature on an informal contract is the only binding force. Also, by conducting daily tracking and quality control using telephones, mostly to push late freight forward and to deal with lost items, may not lead to an overall effective collaborative relationship (Yang 2003). As a result, many complaints have been reported concerning delivery inefficiency and security problems when the delivery process is governed by such loose relationships.

Figure 1: Existing pair-wise (1 to 1) collaboration forwarding networks.
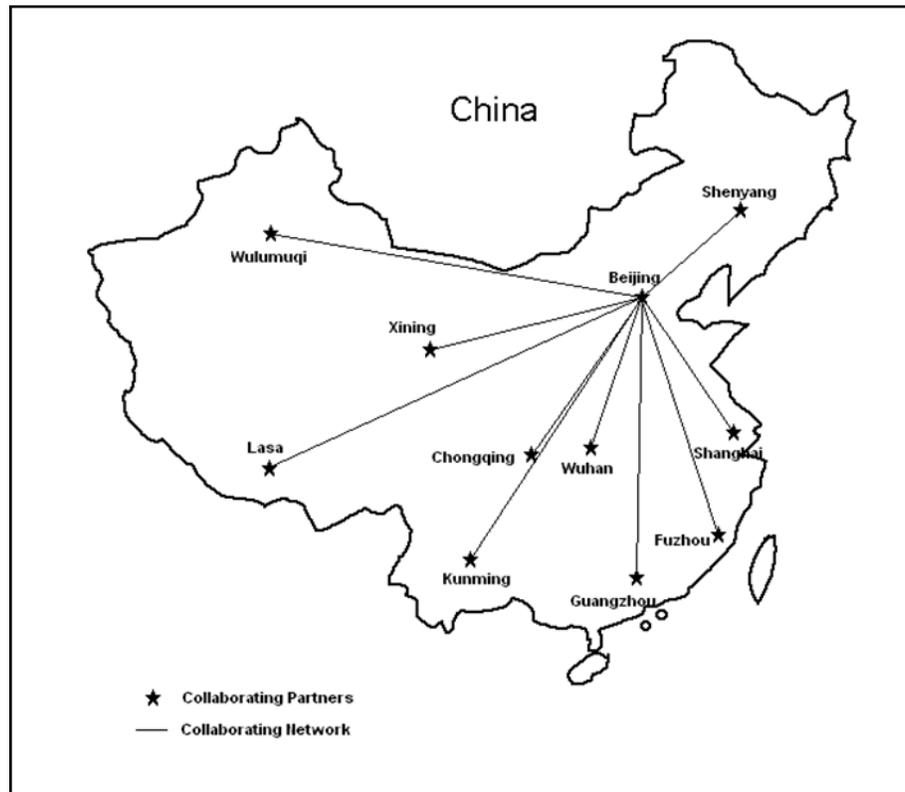
*Review of literature on agent-based systems for express SMEs' collaboration*

Agents and multi-agent systems (MAS) are gaining popularity in a wide range of manufacturing and logistics applications. An MAS is generally defined as a system composed of a population of autonomous agents (Wooldridge and Jennings, 1995) that cooperate under common rules, and at the same time pursue their own individual objectives. In today's logistics and supply chain environment, many tasks are distributive and dynamic in nature, and the application of agent-based computer systems is the only feasible way to control such tasks.

In recent years, much effort has been spent on the application of MAS to support the operation of e-commerce and virtual organization (Garcia-Sanchez et al., 2009; Castro-Schez et al., 2010; Huang et al., 2010). Nevertheless, the literature seems to contain only a few reports on the application of agent-based systems in the express delivery industry. Many third party logistics companies (3PLs) also provide express delivery services as discussed by Jung et al. (2008) and Wang & Sang (2005). The main focus of these systems tools is on building a smoother and better integrated relationship along the supply chain between 3PLs and their customers. Such tools, however, are generally not directly applicable to problems faced by the very much smaller SMEs in China's express delivery industry. A number of research projects on freight-forwarding have been reported (Özsomer et al., 1993), but most of them seem to be applicable only to air (Bowen and Leinbach, 2004) and sea transport (Wong et al., 2010), are applicable only to forwarders in an international context, and focus mainly on export and import regulations and operations. Domestic freight forwarding does get a very brief mention in literature (Luo and Findlay, 2002),

but such studies can only be described as preliminary ideas that may form a basis for more in-depth studies.

In most of the abovementioned agent-based studies reported in the literature, a virtual market place business model is presented to all buyers and sellers of logistics services, including freight forwarding, express delivery, etc. Such business models enable buyers and service providers to negotiate provision for appropriate logistics services through agents, by using computer supported mechanisms and procedures. This enables companies that are geographically dispersed, and possibly not well known to many others, to contribute in achieving a more effective nation-wide business network. However, the implementation often raises difficult issues concerning data integrity and data security that must be resolved. It also seems that the agent-based architecture used in e-marketplaces is not suitable for implementation in the context of our problem. The collaboration model proposed in this paper differs from other models in that it requires delivery companies to exercise a high degree of trust and in turn develop long-term business relations with the companies in the alliance.

Figure 2: Proposed (m to n) collaboration network.
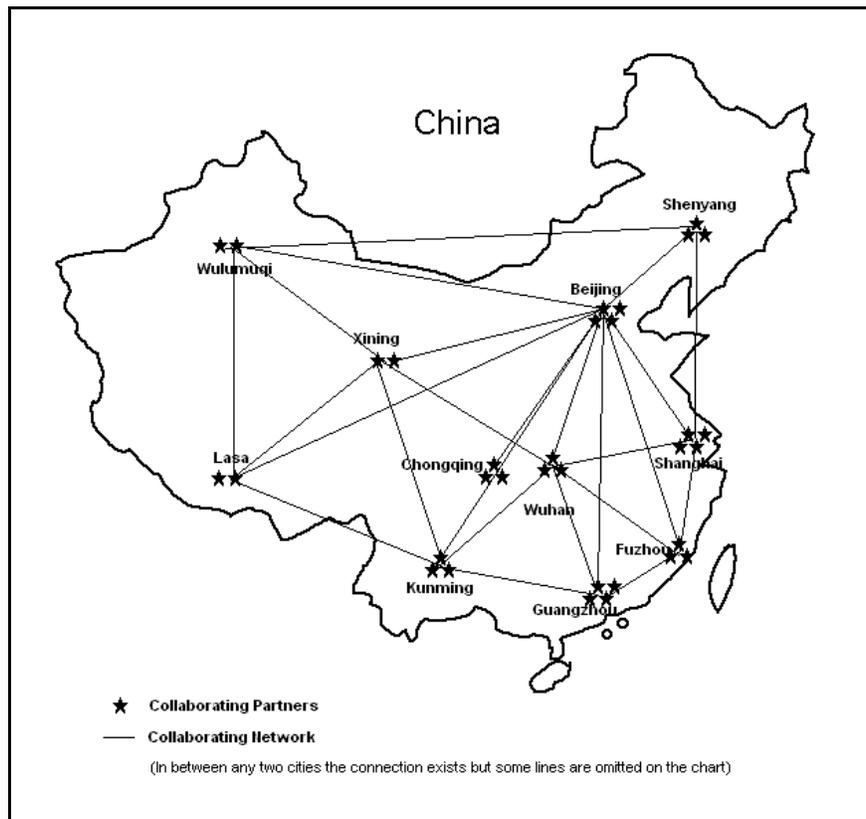
The Proposed Collaboration Mechanism

A new and rather novel mode of establishing collaboration among SME express delivery companies is proposed as shown in Figure 2. Here more than one alliance company is involved in the same delivery region. When compared with the existing practice shown in Figure 1, the new pattern allows for more than one company (forwarder) to enter the alliance in same delivery

region. This effectively extends the existing pair-wise (1 to1) alliance into a multiple "m" to "n" alliance. The major advantage is that it brings an element of competition into the alliance, and should in turn motivate companies to improve all aspects of their forwarding services. Efficient companies can therefore gain extra orders at the expense of the less efficient ones. However as the final delivery of freight must be physically handled by only one forwarder, the companies operating in the same destination will need to compete for the final delivery task. The proposed system assigns of tasks to the forwarders based on historical performance. The performance of the companies in the alliance assessed form historical records of actual deliveries. The system stores such historical data and retrieves it to produce a priority list of potential local forwards to whom a new delivery should be assigned. The general criteria for performance evaluation includes forwarding circle time, lost/damaged rate, etc.; the actual performance measurement mechanism is described in detail in Section 3.3. In the proposed system, each service provider can decline incoming orders at any time of the day, and thus should be able to provide service quality by staying within its daily capacity limits.

By determining priorities in this manner, the most uncontrollable factor in current practice-forwarding service quality - is expected to improve considerably, since the companies must compete for orders and the allocation is determined automatically by the computer based on past performance. In contrast to the current practice of using rules specified in the contract and human monitoring, the proposed platform will be able to offer a more independent and performance based allocation of delivery orders.

AGENT-BASED SYSTEM ARCHITECTURE

In the proposed collaboration scheme, whenever an SME Express Delivery company needs to deliver an item to another city, it will have more than one forwarding partner to choose from or it may leave the choice to the computer system. An essential requirement in such a collaborative network is the appropriate software platform to support the operations and functions. The structure of the proposed agent-based system is shown in Figure 3.

Figure 3: The system structure and involved agents.
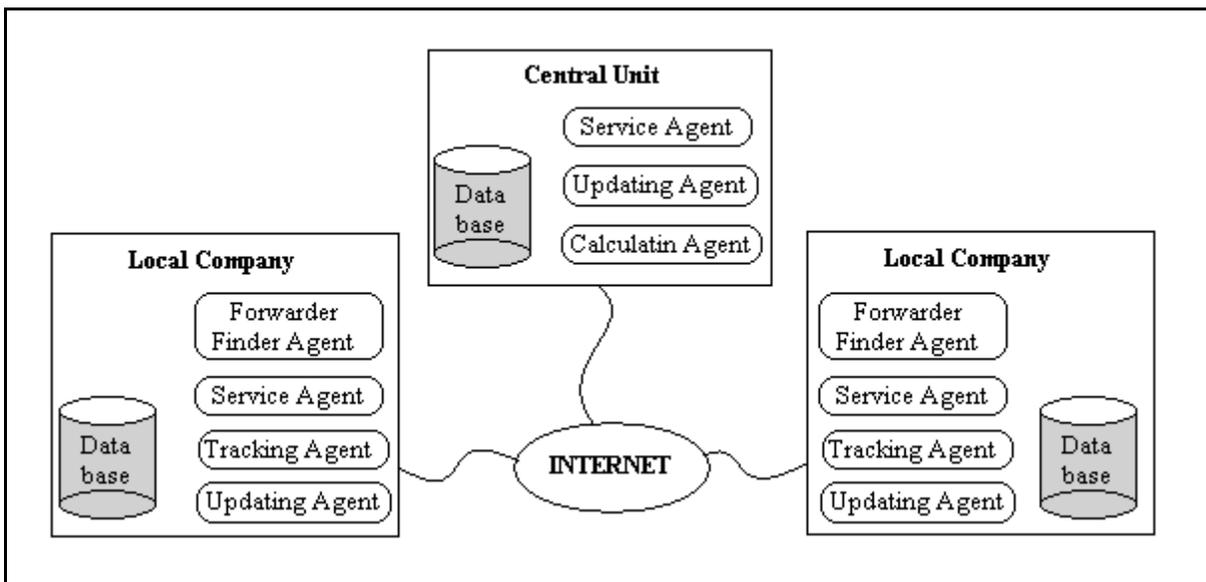
An agent platform is established at each alliance company's host, containing several agents that act independently, irrespective of whether user acts as a sender or forwarder in the context of the sender-forwarder relationship. A company's Logistics Information System database is accessible to some of the agents only. However, all of the agents (except the Calculating Agent) are able to interact with non-local agents over the internet, thus supporting users in the various system functional roles. The central unit is responsible for the provision of the rankings of all forwarders in different destination districts and for recording of all forwarding related data, while and at the same time providing the source information used in the generation of the company rankings.

Agents

The proposed system comprises several function agents: Forwarder Finder Agent, Service Agent, Tracking Agent, Updating Agent, and Calculating Agent. The functions of these five types of agents can be briefly described as follows.

- The Forwarder Finder Agent is available to all companies through the local host. It interacts with service agents in both the central unit and forwarding company to implement the forwarder selection function.

- The Service Agent covers both the alliance companies' systems and the central unit's system. It responds to Forwarder Finder Agent's requests for the forwarder selection process. The Service Agent has only limited access to local data in assisting the functions of the system.

- The Tracking Agent is in the system of all companies. Its main function is to spot changes in the forwarder's delivery records and inform the Updating Agent of the Sender Company and central unit of these changes. Such changes are sent through agent massages.

- The Updating Agent is available to both the central and to the individual company systems and saves the content of massages from the Tracking Agent into the local database.

- The Calculating Agent is available only to the Central Unit and updates the priority list by calculating ratings from the delivery completion records.

The existence of the Service Agent, Tracking Agent and Updating Agent also enhance the overall system security, as any kind of access to the database, including retrieving, saving and correcting, can only be made by agents from the home system via the pre-defined context; external agents do not have direct access to the local data.

Agent interactions

Figure 4 shows the interactions of agents incorporating most of the system functions; for simplicity only agents that are directly involved in each step are shown. The databases of local companies that some of the agents access are not shown. The Priority List and Completion Records play a central role in the system function.

Figure 4: Agent Interactions.
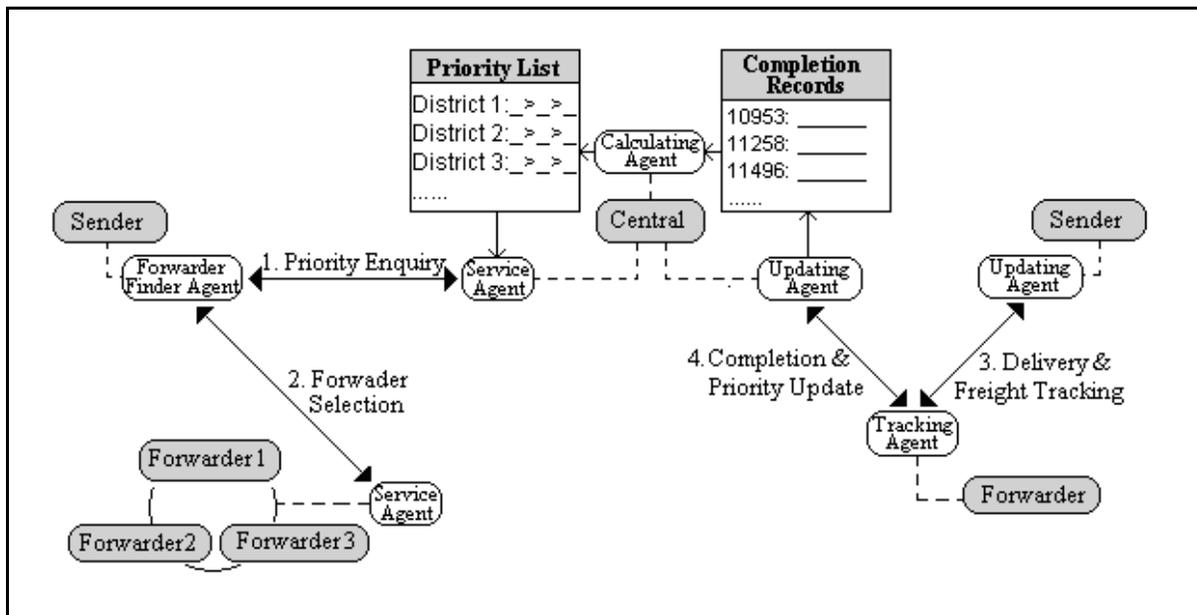
Priority Enquiry and Forwarder Selection is used to realize the function of forwarder selection and task assignment. This process starts when the sender company receives a service request from its customer, and is considered accomplished when the forwarder company name is finalized. The agents involved are the Forwarder Finder Agent of the sender company, the Service Agent in the central module, and the Service Agents of potential forwarder companies. After an order inquiry is received by the sender company, the operator inputs the destination area into the system and the following steps will then take place:

Step1: The Forwarder Finder Agent of the sender company requests the priority for the destination area from the Service Agent in the central unit.

Step2: The central Service Agent checks the Priority List and returns the priority ranking to the sender's Forwarder Finder Agent.

Step3: The sender's Forwarder Finder Agent visits possible forwarders' hosts and interacts with their Service Agents, which can access the local LISs/ databases containing service detailed information. The Forwarder Finder Agent shows the ranking on the Priority List, service availability and service details to the operator.

Step4: According to the information provided by the Forwarder Finder Agent (also considering of the customer's preferences), the operator makes the forwarder selection decision and asks the customer to confirm the order.

Delivery & Freight Tracking starts when a forwarding order is actually generated and the freight enters the forwarder's network, and finishes when delivery is complete. The agents involved are the Tracking Agent of the forwarder company and the Updating Agent of the sender company. The Tracking Agent in the forwarder company monitors the delivery records in the database, and whenever changes are made, it sends a message to the Updating Agent in the sender company.

The Updating Agent updates the sender's tracking records in the database when it has received any new massages.

Completion & Priority Update occurs when a delivery is completed: completion records are sent to the central unit, and important details of the completion process are recorded in the central database. This is followed by an updating of the priority list and an initiation of action relating to tasks such as payment. The involved agents are the Tracking Agent of the forwarder company and the Updating Agent & Calculating Agent of the central unit. The completion records are updated in the same way as tracking records. The Calculating Agent periodically updates the priority list using pre-defined rules as described in Section 3.3 and updates completion records.

Performance evaluation mechanism

The priority list is the result of an evaluation that ranks the companies on both short term and long term performance. The ranking is generated in accordance with the Performance Measurement (PM) of certain Key Performance Indicators (KPIs). The KPI is considered as an important logistics PM tool by both researchers (Zhao, 2009; Davidson, 2006; Ploos van Amstel and D'hert, 1996) and industry consultants (PriceWaterhouseCoopers, 2011; Procurement Group, 2011). It has also been widely implemented by many well-known logistics companies, such as UPS, TNT, CEVA Logistics, and a number of others. In supply chain management applications, the use of a PM system has contributed to the formation of an alliance relationship among 3PLs in a supply chain (Remko I. V. H., 2001). In the proposed system we also establish a PM-based service evaluation scheme to rank and prioritize collaborating companies in the alliance.

There are quite a number of reported research publications on PM for logistics services (Gunasekaran et al., 2004). As the PM mechanism itself is independent of the system structure, a variety of PM methods as well as KPIs can be used in the proposed system. Our preliminary studies suggested that a rather simple performance mark generated by adding various weighted KPIs fits our purpose quite well, and should be able to effectively support the practical needs of the Chinese SMEs express delivery companies.

In the specification of the KPIs, the findings of a full-scale industrial survey conducted by the China Association of Warehouses and Storage (2005) were used as the basis. Efficiency, security and proof of delivery (POD) were considered as major performance factors for logistics service in the survey. Small scale interviews involving groups of industry experts from 3 express delivery companies were also conducted to elicit the needs and problems of the SMEs express delivery companies, as well as the requirements of customers who frequently use their express delivery services. The expert opinions were in line with the survey findings and the following main points emerged.

First, efficiency and security are the top two concerns of both express delivery providers and users, and need to be emphasized in the relevant indicators. From their point of view, efficiency refers to the duration of the door-to-door delivery, while security refers to the possibility of a parcel being lost or damaged.

Second, in regards to the alliance relationship, behaviour such as cheating - deliberately recording incorrect freight completion dates and times, delay in financial settlement, etc. - should be exposed or minimised, as such practice is unfair on other members and will eventually destroy

relationships. We therefore included another indicator in the system called Credibility, which reflects a company's willingness to help protect the alliance relationship.

The above considerations led us to a PM-based evaluation scheme using 3 simple KPIs as follows:

The <u>Forwarding Leading Time (LT)</u>**.** The lead time of forwarding operations can almost be directly equated with efficiency, and thus forms an important indicator. Forwarding lead time is the average time required for a forwarder to deliver all parcels assigned to it during a short period of time, a day or a week.

The <u>Fright Lost Rate (LR)</u>**.** Fright loss rate is the proportion of freight that is lost or damaged for all forwarded items over a relatively longer period of time, perhaps a month. This indicator relates to the security concern. LR has a greater impact than CT**.** The reason being that freight damage or loss is considered to be much more serious than delay.

The <u>Credibility rating (C)</u>**.** A company's credibility is a simple measure that reflects a company's trustworthiness in the alliance relationship. It is initially set at 100 and whenever falsely recorded information is detected - cheating on freight completion records, delay in financial settlement, etc. - credibility points are deducted.

Scoring functions are next established to for the 3 performance indications. The overall performance single indicator (M) is a weighted average of three KPIs different weights and putting them into the following equation:

$$M = W_{lt}*V_{lt} + W_{lr}*V_{lr} + W_c*V_c \tag{1}$$

W_{lt}, W_{lr}, and W_c are the weights for forwarder lead time, freight lost rate and credibility respectively. The three weights are all positive and add to 1 for convenience. V_{lt}, V_{lr}, and V_c are the individual scoring functions of forwarder lead time, freight lost rate, and credibility respectively.

It should be noted that the real life operation can vary greatly from one alliance to another. The scoring functions and weights used for generating M can be set according to system users' own special features, preferences, and needs. It is also relatively easy to add more attributes into the above formula for computing M if they wish to do so.

## SYSTEM DEVELOPMENT AND CASE STUDY

The proposed agent-based system platform and the aforementioned agents were developed using the JADE (JAVA Agent Development Environment) platform and the necessary business information and data for the express SMEs is stored using MYSQL database server. The connection between JADE and MYSQL is realized via mysql-connector-java- JDBC driver.

A limited case study of is now presented to illustrate the mechanisms of the proposed collaboration scheme and the agent-based architecture. The mini case example was built based on the know delivery collaboration scenarios and the potential interactions between the alliance companies. Each of the companies may well own local service networks in several other districts, but in the case example only three districts are used. The table inserted in Figure 5 lists the ranking of the forwarders in serving each of the 3 districts. For example, to serve a

destination in SH_HK (Shanghai Hongkou) the priority is DFE, which indicates that company D is ranked first, following by F and then E.

In the limited case study, it is assumed that a customer in Beijing raises a service request to company A to send a parcel to SH_PD district in Shanghai. Company A first registers this order in the system, and then whole process begins, starting with the forwarder selection function. First, the Forwarder Finder Agent of company A obtains the ranking list from the Service Agent of the central unit. As shown in the list in Figure 5, the ranking gives the FDE for delivery to SH_PD, and shows that company F is has top priority followed by company D and company E. Service requests are then sent to these companies sequentially according to the rankings. In this case company F is ranked first, however, if it declines the order, the order will be offered in turn to the next two companies. When an acceptance is finally received together with the service price, say form company D, the Forwarder Finder Agent will then select company D as the forwarder.

Figure 5: Geographical structure of the limited case study.
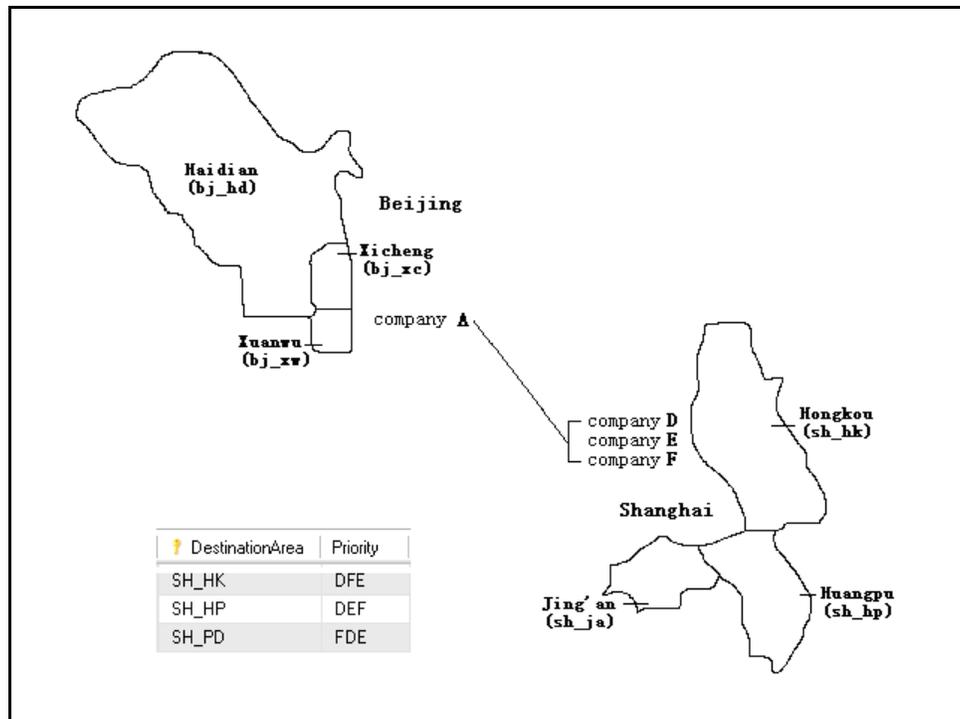
The second phase involves the tracking function. Since company D is now handling the parcel, and company A is the sender, the Tracking Agent of company D should monitor the parcel status and send information to the Updating Agent of company A.

The last phase is the performance recording and ranking function. After completion of the delivery of the parcel, the Tracking Agent of company D will send the updated record to both the central unit and sender company A. The completion record can then be updated in the relevant database. This in turn allows the KPIs of individual forwarder companies to be updated, and the updated KPIs are be used to establish the new rankings for future use.

CONCLUSION AND FUTURE RESEARCH SUGGESTIONS

Initial feedback on the proposed collaborative scheme, though still in its very early stages of implementation, suggests that the efficiency and effectiveness of the domestic freight forwarding alliances among SME express delivery companies in China can be improved. Faster and more reliable delivery services can be offered and a closer relationship can be established amongst the collaborating partners. The proposed agent-based technology is flexible and rather easy to use, and, most important, affordable to SME express companies with very limited IT budgets.

Future research may need to look at the dynamics of the system in terms of joining or leaving the system and how well the entities cooperate. A number of other considerations can be explored, as many variables were omitted or simplified in our limited case example. It is possible that such variables and considerations could become significant to the performance of the alliance in actual practice and in more complex situations.

A problem that may occur in large scale alliances relates to the maximum capacity of single forwarders. For example, one of the forwarders with a high ranking in certain city is likely to receive a large number of orders from senders in other cities in a single day. This situation results in relatively fewer parcels being assigned to other forwards in the same city, resulting in poor utilization of resources of the other forwarders. Even if the favoured forwarder has been very effective and efficient in the past in dealing with parcels sent from alliance companies, a large workload on a particular day may adversely affect processing speed and efficiency. Our proposed system in fact provides a solution to this problem, in that a forwarding company can reject incoming orders at any time if it feels that it is unable to meet the specific order delivery requirements. When responding to service requests, the Service Agent checks the availability before confirming the request, i.e., the operators of forwarder companies can reject all incoming orders if they are not able to cope with them. If a company takes on more orders than it can handle, causing delivery delays, its performance indicators will be adversely affected and will in turn receive less orders in the future. The system was therefore designed to allow a company to can turn the service off when capacity on any particular day has been reached. This action reduces the possibility of poor performance, which in turn lowers the forwarder's KPIs and reduces future business.

The overall management and control of all companies in the alliance can become more complex. Such an interlocking relationship amongst the companies may well raise more problems in delayed payments, in settling conflicts, and in managerial trust and confidence. When dealing with such problems, companies need to refer to the priority ratings generated by the system, and the ratings may well be subject to argument as not being entirely fair from this or that point of view of companies in the alliance. The use of a priority list is essential to the operation of such an alliance, and is a central feature of our proposed system. Priority determines the number of orders assigned to a company, and is partly based on delivery quality, which may not be easy to ensure and to measure accurately. In trying to establish rules specifying the reduction/increase in ranking resulting from delivery performance, it is important that every company in the alliance agrees to the rules, and not tries to circumvent rules through inaccurate or even false reporting.

Freight batching is another interesting problem that nearly every sender faces, i.e., parcels may be sent individually or in small batches. However, inter-city transportation may not be available continuously, and thus it could become both practical and economical to try and batch parcels before transportation. While our system allows a batch of parcels heading for the same destination city to be assigned to different companies in the destination city, this feature can force parcels to be grouped into much smaller batches or even sent individually, which in turn may increase cost and processing time at the sending point. A possible solution is to finalize the forward selection after batches are formed and assign the entire batch to one company in the destination city, but this will lead to some inflexibility and possibly a reduction in overall efficiency when the company in the destination city has to reject the entire batch, when in fact it would have been quite possible to accept part of the batch.

SMEs account for the vast majority of the express delivery companies in China, and many of them have chosen to collaborate in domestic freight forwarding in order to gain a competitive edge and expand operations. However, many problems have emerged, mainly as a result of an insufficient reliable collaborative relationship between members in the SMEs alliance. The proposed platform is aimed at providing an IT tool to support and improve collaborative operations.

This rather novel approach in establishing "m" to "n" collaboration amongst SME express delivery will also introduce flexibility in the initial formation of an alliance for inter-city delivery services, with each city having several participating companies. In such a system, inter-city delivery involves a decision on selecting one from a group of forwarding partners in the destination city to complete the last stage of a delivery order. This in turn introduces a new form of competition which was previously absent in the pair-wise (1 to 1) structure. This competition, to win the final leg of a delivery order, must be resolved by assessing the performance of the companies involved using some single measure of performance which evaluated from other key performance indicators.

Implementation first requires the necessary databases to be established, so as to provide the necessary information for operating in such an interactive business arrangement. The structure of an agent-based software tool for supporting the proposed collaboration scheme is also proposed. Software agents are deployed to represent different tasks for different collaborative parts of the system. Agents interact to allocate delivery orders based on performance, which in turn requires other agents to be established for keeping track of the past performance of companies in the alliance. The proposed performance measure is rather simple, and further research could prove useful in improving the measure.

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