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WORLD MARITIME UNIVERSITY

Shanghai, China

RESEARCH ON INBOUND LOGISTICS STRATEGY FOR SHANGHAI GENERAL MOTORS

With the application of milk run and distribution center integration

BY

ZOU ZHE

China

A research paper submitted to the World Maritime University in partial fulfillments of the requirements for the award the degree of

MASTER OF SCIENCE

INTERNATIONAL TRANSPORTATION AND LOGISTICS

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DECLARCTION

I certify that all the material in this research paper that is not my own work has been identified, and that no materials are included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

ZOU Zhe

Supervised by

Professor XU Dazheng
World Maritime University

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ABSTRACTS

Title of Research paper:	**Research On Inbound Logistics Strategy For Shanghai General Motors With The Application Of Milk Run And Distribution Center Integration**
Degree:	**MSC**

With the development of the world economy and globalization, the manufacturing industry is developing so fast especially automotive vehicle manufacturing industry which brings a large challenge to logistics and makes logistics system more and more complex. To eliminate the wastes and unreasonable activities in logistics system, more and more manufacturers are focusing on the Lean Logistics Management.

In this research paper, Shanghai General Motors is taken as an example and a new inbound logistics system is put forward to replace the current inbound logistics system to achieve an effective and low-cost logistics performance according to Lean Logistics Management.

Based on the analysis on SGM current inbound logistics, lots of problems will be defined and a new inbound logistics will be put forward. To quantitative analyze the improvement brought by new system to SGM, one simulation software called Extendsim will be used to simulate the situation of new system applied in SGM and a simulation analysis will be given based on the data recorded by Extendsim.

The supporting system of new system and expected result of the application of new system will be given in the last part.

KEYWORDS: Lean logistics management, Inbound logistics, Milk run, Distribution center, Simulation, Supporting system.

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LIST OF ABBREVIATIONS

CC	Consolidation Center
DD	Direct Delivery
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FMS	Fleet Management System
LLM	Lean Logistics Management
MRDCIS	Milk Run and Distribution Center Integration System
OTD	Order TO Delivery
RDC	Regional Distribution Center
RFID	Radio-Frequency Identification
SGM	Shanghai General Motors
TMS	Transportation Management System
VDC	Vehicle Distribution Center
VSC	Vehicle Storage Center
3PL	3rd Part Logistics

Chapter 1 Introduction

1.1. Background

With the development of the world economy and globalization, the manufacturing industry is developing so fast and the companies involved in manufacturing industry are becoming more and more competitive. Many successful companies become international manufacturers and sell their products all around world. With the theory of supply chain management well established, more and more manufacturers are focusing on the cooperation and communication with their global partners involved in the supply chain, and lean production has become the competitive advantage of the manufacturers.

As a result, many manufacturers locate their factories all round the world especially in China, India, and other developing countries in which human resources and raw materials are cheaper. Cheaper raw material and manpower could benefit the manufacturers by achieving cost-effectiveness in manufacturing and procurement.

Automotive vehicle manufacturing industry is one of the most important manufacturing industries because the demand of the automobiles is getting larger and larger which leads to the fast development of automotive vehicle market. Many international automotive vehicle manufacturers such as GM, Ford, and Toyota have made production and procurement all around world for many years, benefiting from the cost-effectiveness in manufacturing and procurement.

However, this kind of geographical change brings a large challenge to logistics which makes logistics system more and more complex. Nowadays, to eliminate the wastes and unreasonable activities in logistics system, more and more manufacturers are

focusing on the Lean Logistics Management, including the automotive vehicle manufacturers. As we all know, thousands of spare parts are needed when an automotive vehicle are made, which leads to the difficulty in inbound logistics management. Because the high cost of transportation and warehousing for the spare parts of automotive vehicle brings a large challenge on the automotive vehicle manufacturers, LLM is more paid attention to in the whole logistics system of automotive vehicle manufacturers especially in inbound logistics.

LLM comes from the concept of Lean production given by Toyota Production System (Michael, 2000, pp.959-978), and its core principles such as flow, value, pull, minimizing waste, etc have become the paradigm for many automotive vehicle manufacturers. What is the most important in lean thinking is the minimizing the waste such are waiting, overproduction, over processing, unused creativity, excess inventory, unnecessary transport, defects and unnecessary movement (Lumsden, 2006, p.3).

Minimizing waste and the elimination of unnecessary logistics activities will result in a large reduction in logistics cost and more efficient logistics activities. With the successful case of Toyota Production System (Michael, 2000, pp.959-978), LLM is more paid attention to in logistics system of manufacturers. Inbound logistics system is an extremely complex system with thousands of spare parts, the application of LLM in inbound logistics contributes to the manufacturers by achieving efficiency and cost-effectiveness in logistics.

1.2. Research Purpose

As the large demand in automotive vehicles requires a larger capacity of automotive vehicle manufacturers, the logistics activity is becoming more and more complex especially inbound logistics. With thousands of spare parts needed to be transported,

stored, packed and delivered, the traditional inbound logistics is getting ineffective and inefficient and it also keeps a high logistics cost which consist of the larger part of the total cost. On the other hand, the pool communication between suppliers and manufacturers leads to the inflexibility in logistics and many problems in transportation, warehousing and delivery.

In this research paper, Shanghai General Motors is taken as an example and a new inbound logistics system is put forward to replace the SGM's current inbound logistics system to achieve an effective and low-cost logistics performance according to LLM.

So the objectives of the research are:

- Find the main problems in inbound logistics system of SGM;
- Try to solve the problems by using new strategy for Shanghai GM inbound logistics system according to LLM;
- The application of information system and technology will be found to support the new inbound logistics system;
- The general suggestion of improving the inbound logistics system of automotive vehicle manufacturers will be given through the example of SGM.

1.3. Methodology

In this research, to quantitative analyze the improvement brought by new system to SGM, the software of Extendsim is used in chapter 4 and the simulation model will be estimated before using Extendsim.

Simulation model is a kind of mode in which all the parts of the real situation will be involved and lots of indexes of the real situation will be figured out by the model solution. In this research paper, the simulation model of new inbound logistics system will be given before the simulation based on the data given by SGM logistics

department.

Extendsim is a kind of simulation software which could simulate the real situation base on the result given by simulation model and it will be used in chapter 4 to simulate the current situation and the new inbound logistics system respectively to quantitative analyze the improvement brought by new inbound logistics system to SGM.

1.4. Structure

There are six sections involved in this research paper:
In chapter 1, introduction including background, research purpose, methodology and outline will be given. In background, global manufacturing industry analysis and LLM applied in logistics system will be introduced and in researc0h purpose, the objectives of the research paper will be given. Moreover, the methodology used in this research paper and the outline are also given in this part.

In chapter 2, the literature review are made based on three aspects of inbound logistics which consists of elements of inbound logistics, factors influencing inbound logistics, and inbound logistics mode.

In chapter 3, analysis on SGM current inbound logistics will be given including the introduction of the current system and problem definition of SGM current inbound logistics system.

In chapter 4, introduction of MRDCIS and the advantages of MRDICS will be given in the first part and in the following part, the simulation of MRDCIS will be made to quantitative analyze the improvement brought by MRDICS to SGM. Finally, the feasibility of MRDCIS will be given according to the current situation of SGM

inbound logistics.

In chapter 5, the supporting system of MRDCIS including information system and information technology will be discussed in this section, and expected result of the application of MRDCIS will be given in the last part. Lastly a summary of the whole research paper will be given in chapter 6 as well as the suggestions for the implementation of MRDCIS in SGM.

In the next chapter, the literature review are made based on three aspects of inbound logistics which consists of elements of inbound logistics, factors influencing inbound logistics, and inbound logistics mode.

Chapter 2 Literature review

2.1. Overview

As the manufacturing industry develops so fast, more and more companies are focusing on the inbound logistics which is an important part of the supply chain. At the same time, many scholars and professors are working on the research of companies' inbound logistics system, especially the automotive vehicle manufacturers'. So far, the discussions and researches about automotive vehicle manufacturers' inbound logistics system can be concluded in three aspects: factors influencing inbound logistics, elements of inbound logistics, inbound logistics mode,

In the next part, the literature review will be made based on the three aspects of inbound logistics which consists of the papers, researches and methodology that are helpful to this research paper.

2.2. Factors influencing inbound logistics

Richardson thinks there are three key elements of inbound logistics which are network designing, mixed JIT, and event management (Richardson, 2003, pp.30-34). All the three factors will play an extremely important role in inbound logistics.

In Holmstroem and Aavikko's research, by analyzing the inbound logistics of Saab-Vulmet, an automotive vehicle manufacturer in Finland, he concludes that frequency of replenishment, quantity of replenishment, and the safe stock are the three key elements of inbound logistics, and he also points out the Decision Support System should has the function of providing the information of frequency of replenishment, coordinating with multiple suppliers, and evaluating the suppliers' service level

(Holmstroem & Aavikko, 1994, pp.1-8).

Chatur thinks the 3PL providers' management is also a factor that influences the inbound logistics. What he believes is the good communication and collaboration between the 3PL providers and the manufacturers will bring the benefits of cost reduction in inbound logistics to manufacturers (Chatur, 2005).

From what has been discussed above, in Richardson' research, network designing and mixed JIT belongs to the facilities (Richardson, 2003, pp.30-34), and Holmstroem emphasizes the importance of information system (Holmstroem & Aavikko, 1994, pp.1-8), while Chatur thinks 3PL providers are also important part of inbound logistics (Chatur, 2005). In conclusion, facilities, information system, and the 3PL providers are the key factors influencing inbound logistics.

2.3. Elements of inbound logistics

2.3.1. Milk run

As the inbound logistics consists of two main parts which are transportation and warehousing, transportation mode plays a very important role in inbound logistics. One new transportation mode which has been well developed in recent years is milk run system.

> "The name of this system comes from the traditional system for selling milk in the West, in which the milkman used to walk to the doors of the customers' houses with his dray in a specified route and deliver the milk containing bottles to his customers and finally take back the empty bottles. This system has been performed in miscellaneous industries and the auto manufacturing companies of the world have been (and are) the most important clients of this system" (Du et al, 2007, pp.565-577).

> "Milk Run System determines the route, the time schedule, the type and the number of parts that different trucks must choose in order to receive the orders from various suppliers with the primary assumption that all trucks must return the empty pallets to the demand center" (Eskandari et al, 2009, pp.1076-1081).

In the milk run system, the spare parts of the suppliers in the same region will be consolidated and delivered to the customers' warehouse by trucks, In Wang jinlian's opinion, milk run carried by manufacturer has lots of advantages: high loading rate and low transportation cost, on time delivery, easy to manage the suppliers, less packaging, high turnover rate and low inventory level (Wang, 2009, p. 21).

Milk run, as a new mode of transportation, has been applied in inbound logistics of automotive vehicle industry for many years with characteristics of high delivery frequency, small delivery volume (Zhou & Zhang, 2008, pp.111-112), and reliable service. With the development of milk run system, the advantages of milk run system, such as high loading rate, low transportation cost and on time delivery, attract more and more automotive vehicle manufacturers to adopt it in inbound logistics.

Taking what has been discussed above into account, milk run system contributes to the efficiency and cost-effectiveness of the inbound logistics and provides a better service when compared with the traditional transportation mode.

2.3.2. Supply-hub

In automotive vehicle industry, warehouse plays an extremely important role in its logistics system because thousands of spare parts that needed to be transported, stored, packed, and delivered are involved in inbound logistics.

A supply-hub is a warehouse which is located close to the manufacturer's plant where its supplies will be packed, stored, picked up and delivered and the materials will be paid for only after consumed (Barnes, 2000). Barnes firstly proposed the concept of

supply-hub, discussing the advantages and disadvantages of supply hub and the necessity of establishing the supply hub in logistics system. Supply-hub is an effective strategy to achieve the goal of cost reduction and quick response.

Supply-hub model is totally different from the traditional warehouse in term of the service it provides and the role it plays in the logistics system.

> "The Supply Hub not only provides traditional vendor-managed inventory or third-party logistics services, but can be a supply chain integrator, which can enhance information sharing, and provide overall supply chain solutions efficiency." (Wang et al, 2010, pp.93-97)

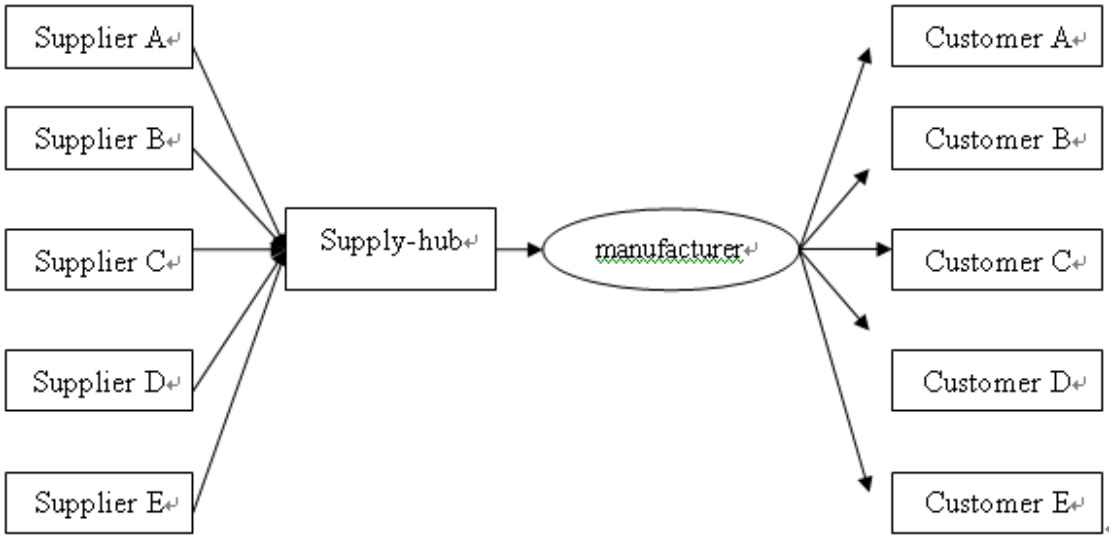

Figure 1-Supply-hub mode

Source: Wang, Z. G. & Zhu, B. F. & Yang, Y. (2010). Replenishment policy for supply hub based on Third-party logistics. *International Conference on Computer Application and System Modeling: Vol*. 4 (pp.193-197). Taiyuan: North University of China.

2.3.3. Replenishment

Where planning the replenishment of the warehouse, the decision-makers always take milk run system into consideration. Wang Zhengguo, Zhu Benfei, and Yang ying think "Replenishment mode of supply-hub based on 3PL can generally be divided into the traditional replenishment mode and Milk-run Replenishment" (Wang et al, 2010,

pp.193-197). In the milk-run replenishment mode of supply-hub, it will implement the cycle transportation among suppliers which are divided into different groups and information system is also used in milk-run replenishment mode of supply-hub, in which production information, inventory information, and logistics requirements planning are involved.

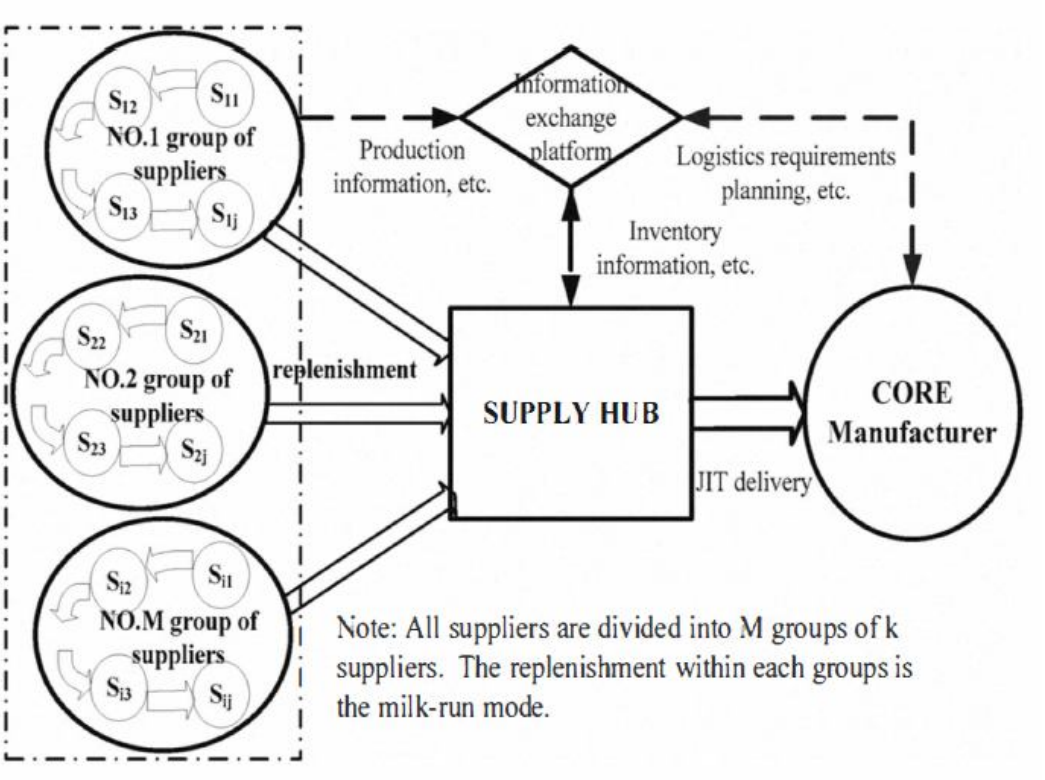

Figure 2-Replenishment of supply-hub

Source: Wang, Z. G. & Zhu, B. F. & Yang, Y. (2010). Replenishment policy for supply hub based on Third-party logistics. *International Conference on Computer Application and System Modeling: Vol*. 4 (pp.193-197). Taiyuan: North University of China.

2.4. Inbound logistics mode

With the high development of automotive vehicle manufacturer, variety of inbound logistics mode has been put forward based on the traditional inbound logistics mode in the past few years. Chopra and Meindl classified the inbound logistics system into four main types: DD, milk run, crossing docking and tailored network (Chopra & Meindl, 2001, pp. 32-36).

As to the situation in China, there are three main inbound logistics mode according to Jiang shuman**:** Direct delivery, manufacturer milk run and 3PL milk run (Jiang, 2010, pp. 6-8).

In DD, suppliers delivery their cargo to the manufacturers by themselves under this mode and Jiang shuman thinks there are several disadvantages in DD: no benefits for whole supply chain, low loading rate and high transportation cost, difficulty to management, bad information share, and poor risk control (Jiang, 2010, pp. 12-13)

As automotive vehicle industry is developing, a new type of delivery called "milk run" (Ferrin, 1994, pp.53-69) was put forward to improve the traditional inbound logistics mode. In Wang jinlian's opinion, milk run carried by manufacturer with high delivery frequency and low delivery volume has lots of advantages: high loading rate and low transportation cost, on time delivery, easy to manage the suppliers, less packaging, high turnover rate and low inventory level (Wang, 2009, p. 21).

With the highly-development of 3rd Party Logistics, milk run has been outsourced to the 3PL providers, and now the inbound logistics mode of 3PL milk run is applied in automotive vehicle industry. According Jiang Xiaobing, 3PL milk run has more advantages over DD and manufacturer milk run: more focus on core business, better control of logistics cost, integration between warehousing and milk run, good communication between manufacturers and suppliers, etc (Jiang, 2001, pp. 88-91).

As we can see, the 3PL milk run has more advantages when compared with other inbound logistics modes and could contributes a lot to the whole supply chain.

2.5. Summary

From what has been discussed above, we can draw a conclusion that there are lots of researches and discussions focusing on the inbound logistics of manufacturers, especially the automotive vehicle manufacturers which mainly includes factors influencing inbound logistics, elements of inbound logistics, and inbound logistics mode. As we can see, the most efficient and cost-effective inbound logistics is 3PL milk run & supply-hub mode. Other scholars and professors elaborate the important roles milk run and supply-hub play in transportation and warehousing and their advantages when compared with the traditional ones.

In the next chapter, analysis on SGM current inbound logistics system will be given including the introduction and problem definition of SGM current inbound logistics system.

Chapter 3 Analysis on SGM current inbound logistics system

3.1. SGM logistics system

Since SGM was found based on the cooperation between General Motors and Shanghai Automobile Industry Company, the logistics system of SGM develops so fast especially inbound logistics. Nowadays, the logistics system of SGM has an impressively competitive advantage in logistics industry, with its advanced logistics mode and technology including logistics planning, packaging, transportation and warehousing, etc.

The logistics system of SGM is a combination of various logistics activities. The automobile parts will be delivered from the suppliers to SGM through Regional Distribution Center and Consolidation Center, the finished product will be transported to Vehicle Distribution Center or Vehicle Storage Center and then distributed to retailers all round the country by sea and trucks and finally bought by customer in the exhibition hall (Chen, 2010, p. 5). Nowadays, nearly 1 million vehicles will be transported and warehoused each year through this logistics system.

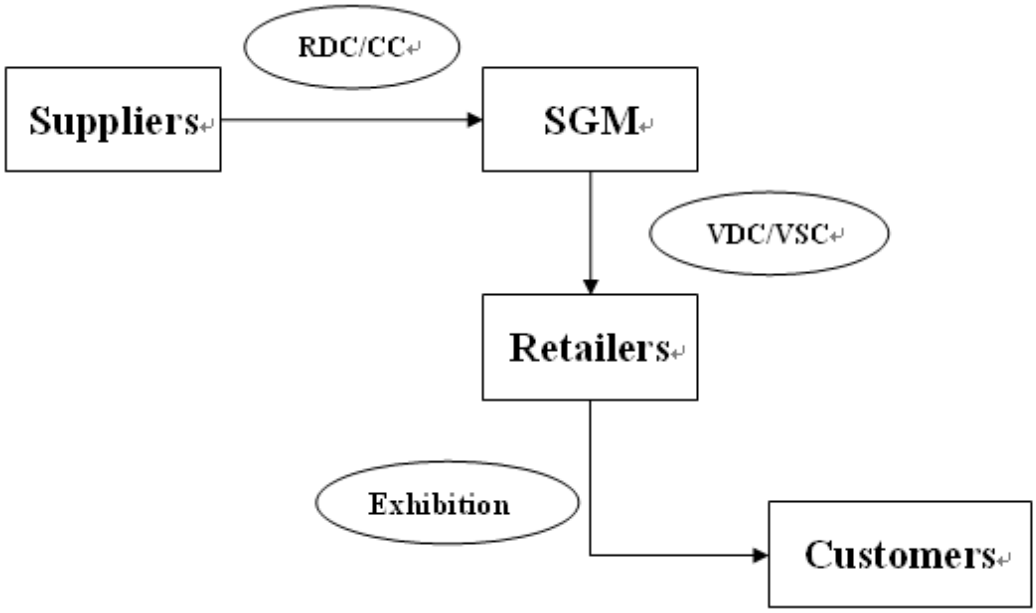

Figure 3-SGM logistics system

Source: Ye, C. (2010). Analysis on inbound logistics system of SGM, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

3.2. Analysis on SGM current inbound logistics system

The inbound logistics system of SGM is a complex and important logistics section of the whole logistics system because thousands of automobile parts should be categorized and transported and even a small mistake will lead to the shortage of materials. So the inbound logistics mode becomes the key factor to manage the inbound logistics in terms of improving efficiency and cost-effectiveness.

From figure 4 we can see there are three main inbound logistics modes in SGM: DD, Suppliers to RDC, and Milk run to RDC, and the introduction of each inbound logistics mode will be given below including participants, characters, advantages and disadvantages.

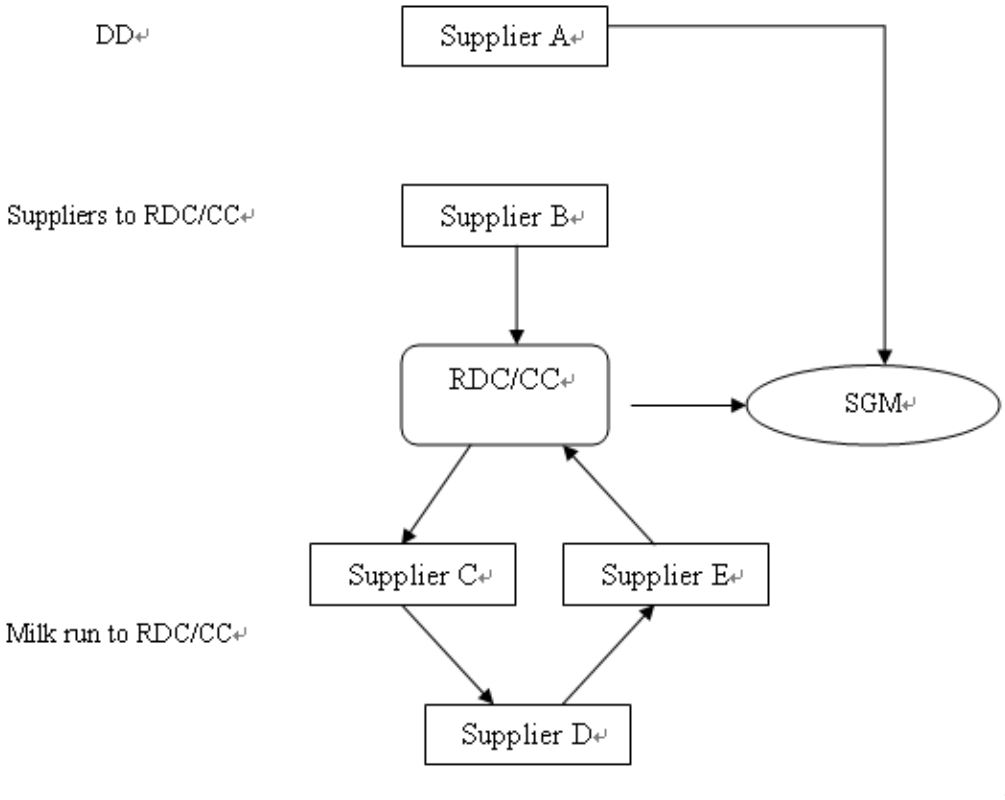

Figure 4- SGM current inbound logistics system

Source: Ye, C. (2010). Analysis on inbound logistics system of SGM, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

3.2.1. Direct delivery

First of all, some materials will be delivered by DD. In this situation, materials are delivered to SGM plant directly from the factory or warehouse of suppliers with unreturnable packaging of the materials like carton. The participants of DD only consist of SGM plant and suppliers, so DD is very efficient and effective.

Table 1-Transportation Service of Supplier A,B and C

Suppliers	Mode	Volume	Loading distribution rate	Transportation cost(RMB)	Delay rate
A	DD	40	40%	352	5.8%
B	suppliers to RDC/CC	50	60%	192	6.7%

C	milk run to RDC/CC	90	75%	150	1.2%

Source: Chen, J.（2010）SGM inbound logistics management, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

However, DD is far more expandable than the other inbound logistics modes in most situations. In Table 1, the logistics costs of three suppliers of SGM, which are Supplier A, B and C, are shown and we can see the transportation cost of Supplier A which uses DD is 352 RMB and extremely higher than those of Supplier B and C which apply other inbound logistics modes.

The high cost of DD is mainly caused by the low loading distribution rate. For DD, one truck usually carries only one kind of material which leads to the low loading distribution rate. As we can see from Table 1, the loading distribution rate of DD is usually 40%-50% while the loading distribution rate of milk run is usually above 75%.

Another problem of DD is the delay delivery. Due to the DD is carried by suppliers' fleet which is out of control of SGM, the delay delivery happens at high frequency. The delay delivery usually takes 5.8% of the total deliveries which influences the efficiency of whole inbound logistics system.

3.2.2. Suppliers to RDC

Some other materials are carried by the mode of "Suppliers to RDC". Materials are delivered to RDC by suppliers and then delivered to SGM plant after stored for several days in this mode. Materials will be stored, picked and checked in RDC and some of them will be repacked before delivered to SGM plant. In this inbound logistics mode, RDC can be regarded as supply-hub of SGM plant and the shortage of

materials in SGM plant will be avoided because inventory of the automotive parts are kept in RDC as replenishment.

Table 2-Inventory level of Supplier A, B and C

Suppliers	Mode	Lead time(days)	Volume	Frequency	Inventory level (days)
A	DD	5	40	1	0
B	Suppliers to RDC	7	50	1	7
C	Milk run to RDC	6	90	2	4.5

Source: Chen, J.（2010）SGM inbound logistics management, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

However, the inventory of the materials is kept at very high level in RDC. Based on the data given by SGM logistics department in Table 2, Supplier B which uses the mode of "Suppliers to RDC" has a high inventory level of seven while Supplier A and C's inventory level is respectively 0 and 4.5.

Several seasons are involved and one of the most important one is the long lead time. As we can see from Table 2, the lead time of Supplier B is 7 days which is the longest among the three suppliers. This is because in this mode transportation is undertaken by suppliers and some of the suppliers offer bad transportation service, leading to the long lead time. So out of control on transportation mainly keeps the high inventory level of RDC. In addition, the poor communication and coordination between RDC and suppliers makes it worse and even leads to some mistakes and loss.

There is also a problem in RDC and CC in this mode. According to SGM, RDC is used for warehousing and CC has the function of consolidation and distribution. In some situation, the materials need both warehousing and consolidating and they should be transported from RDC to CC. As a result, the transportation between RDC and CC becomes a kind of waste. Additionally, the poor communication and

coordination among RDC, CC and other department result in low working efficiency and poor resource utilization.

3.2.3. Milk run to RDC

The rest of the materials go through the mode of "Milk run to RDC". In this mode, the schedule and path of milk run has been made before the transportation is carried out. Materials are transported to RDC by milk run and then delivered to SGM plant after stored for one or two days. The function of RDC is similar to the second logistics mode's, but the transportation cost is decreased to large extend due to the application of milk run in this mode.

Table 3-Logistics cost of Supplier A, B and C

Suppliers	Mode	Volume	Transportation cost(RMB)	Inventory level (days)	Warehousing cost(RMB)
A	DD	40	352	0	0
B	suppliers to RDC	50	192	7	148
C	milk run to RDC	60	150	4.5	220

Source: Chen, J.（2010）SGM inbound logistics management, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

However, the inventory of the material is still kept at high level in this mode although the transportation cost is decreased to large extend due to the application of milk run. In Table 3, the inventory level of Supplier C is 4.5 days but the inventory cost is 220RMB which is more than that of Supplier B with inventory level of 7 days. That is because the volume of Supplier C is more than 60 in real situation because of the push system applied in the inbound logistics system of SGM. The schedule of milk run fleet is made based on the production plan which is made by forecasting in long term.

As we all know, based on the forecast in long term, push system has little flexibility on adjusting to the production by and certainly results in the increased inventory of materials in RDC.

3.3. Problem definition of SGM current inbound logistics system

Based on what has discussed above, the main problems of SGM current inbound logistics system will be defined as followed:

- The current transportation mode keeps high transportation cost.
- Delay delivery with high frequency reduces the efficiency of whole inbound logistics system.
- The inventory of RDC in current system is kept at high level leading to high inventory cost.
- The function of distribution, consolidation and warehousing is carried out respectively by two warehouses —— RDC and CC, sometimes leading to the increased cost and low utilization rate of the resources.
- Push system is used partially between SGM and its' suppliers which results in an increase in inventory and low flexibility of production.

3.4. Summary

In this chapter, introduction of SGM logistics system is given in the first part, and then analysis on SGM current inbound logistics system is given based on which the main problems of SGM current inbound logistics system are defined lastly. In the next chapter, a new system will be introduced to replace the current inbound logistics system of SGM to solve the current main problems and improve the inbound logistics' performance.

Chapter 4 Milk Run and Distribution Center Integration System

4.1. Milk Run and Distribution Center Integration System

Based on what has been discussed in chapter 3, there are so many problems in SGM current inbound logistics system that a new strategy should be made to improve the current situation of SGM inbound logistics.

Milk Run and Distribution Center Integration System is such a new system which is made based on the milk run and distribution center integration strategy for SGM current inbound logistics. The characteristics of MRDCIS can be concluded as followed:

4.1.1. A combination of milk run system and distribution center.

MRDCIS is a combination of milk run system and distribution center, in which the transportation system is milk run, and distribution center is used in the warehousing system. In MRDCIS, all the materials will be transported by milk run trucks to the distribution center where stored for some time and then delivered to SGM plant.

4.1.2. Milk run replaces the current transportation system

According to Wang jinlian, milk run has lots of advantages compared with other transportation modes: high loading rate and low transportation cost, easy to manage the suppliers, less packaging, high turnover rate and low inventory level (Wang, 2009, p. 21). So milk run should be used in MRDCIS to replace the current transportation system according to LLM.

4.1.3. Distribution center has the function of the distribution, consolidation, and

warehousing.

Distribution center in MRDCIS is totally different from the traditional distribution center, warehouse or supply-hub. In fact, distribution center in MRDCIS is a combination of supply-hub, RDC and CC which has the function of the distribution, consolidation, and warehousing. As a result, the RDC and CC in current inbound logistics system will be integrated into the new distribution center in MRDCIS if it is applied in SGM. Lots of wastes and unnecessary logistics activities which are talked about in chapter 3 will be avoided by the integration of RDC and CC.

4.1.4. Pull system is used in MRDCIS

Pull system (David et al, 2000, p.117) is used in MRDCIS to keep low inventory level and high flexibility of the production. The order of the materials will be given according to the order of automotive vehicles that comes from customers. By using the pull system in MRDCIS, the extra inventory both of materials and vehicles will be cut down and flexibility of the production will be improved when the vehicle market is fluctuant.

4.1.5. An integration system of all the logistics activities involved in the whole inbound logistics.

MRDCIS is an integration system of all the logistics activities involved in the whole inbound logistics including transportation, warehousing, packaging, repacking, etc. As a result, an integrated information system of milk run, distribution center and SGM plant is necessary when MRDCIS is applied in SGM. All the information interchange and communication will be carried by the integrated information system which contributes a lot to the integration and performance improvement of MRDCIS.

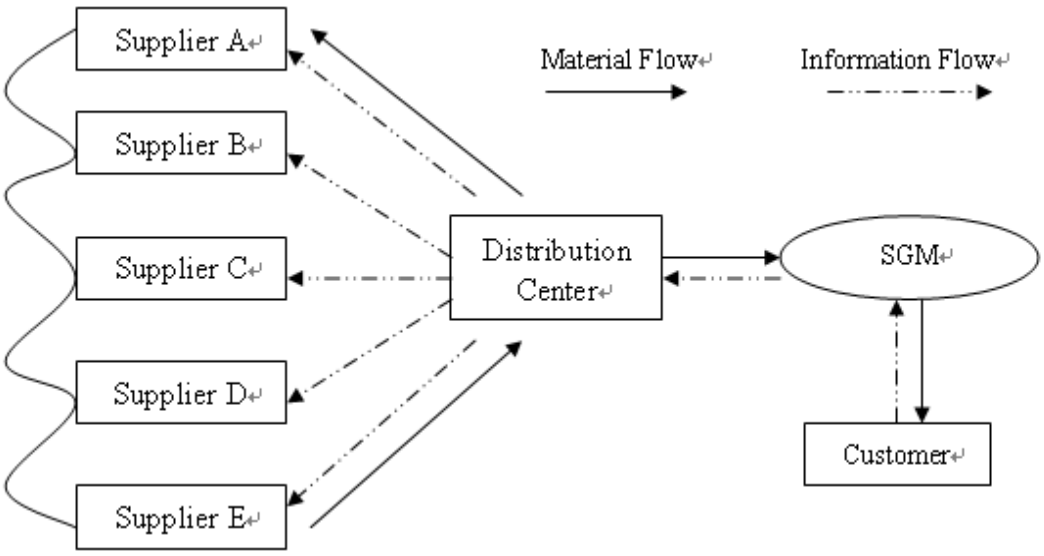

Figure 5-Milk Run and Distribution Center Integration System

Source: Own presentation based on 4.1. Milk Run and Distribution Center Integration System

4.2. Comparison between SGM current inbound logistics system and MRDCIS

4.2.1. Advantages of MRDCIS

Based on the introduction of MRDCIS, advantages of MRDCIS will be concluded as followed:

Milk run replaces the current transportation system, solving the problems of high transportation cost and delay delivery. By applying milk run to MRDCIS, the transportation cost could be cut down and the suppliers are all under control of SGM and on time delivery and lower inventory level will be more easily achieved.

RDC and CC will be integrated into a new distribution center which has the function of the distribution, consolidation, and warehousing, more multifunctional than the supply-hub, traditional distribution center and warehouse.

It is an integration system of all the logistics activities involved in the whole inbound logistics with an integrated information system of milk run, distribution center and SGM plant. The integration of the systems of which is involved in MRDCIS overcomes the variety of problems in communication and coordination between the internal departments of SGM as well as SGM and its suppliers.

Pull system is used in MRDCIS to keep low inventory level and high flexibility of the production, which is more reasonable and lean according to LLM

4.2.2. Comparison between current inbound logistics system and MRDCIS

The comparison between MRDCIS and SGM inbound logistics system will be made based on what has been discussed above.

Table 4-Comparison between MRDCIS and SGM current inbound logistics system

MRDCIS	SGM inbound logistics system
Milk run replaces the current transportation system, solving the problems of high transportation cost and delay delivery.	The current transportation mode keeps high transportation cost. Delay delivery with high frequency reduces the efficiency of whole inbound logistics system.
With milk run, the suppliers are all under control of SGM so that lower inventory level will be more easily achieved. RDC and CC will be integrated into a new distribution center which has the function of the distribution, consolidation, and warehousing.	The inventory of RDC in current system is kept at high level leading to high inventory cost. The function of distribution, consolidation and warehousing is carried out respectively by two warehouses —— RDC and CC, sometimes leading to the increased cost and low utilization rate of the resources.
Pull system is used in MRDCIS to keep low inventory level and high flexibility of the production, which is more reasonable and lean according to LLM	Push system is used partially between SGM and its' suppliers which results in an increase in inventory and low flexibility of production.

It is an integration system of all the logistics activities involved in the whole inbound logistics.	There are variety of problems in communication and coordination between the internal departments of SGM as well as SGM and its suppliers.

Source: Own presentation based on 3.3. Problem definition of SGM current inbound logistics system and 4.2.1. Advantages of MRDCIS

4.3. Simulation of MRDCIS

In this section, the real situation of MRDCIS applied in SGM will be simulated to evaluate the performance of MRDCIS based on the index of cost and efficiency which will be gained from the statistics of the simulation software. In addition, to quantity analyze the benefit and performance improvement of MRDCIS, a comparison of delay delivery, inventory level and logistics cost between MRDCIS and current inbound logistics system will be made through the simulation.

Before the simulation, hypothesis should be made to illustrate the precondition and a simulation mode of MRDCIS will be given in the following part based on which the simulation could be carried out. At last, a simulation analysis will be made according to the result of simulation. So this section consists of four parts which are hypothesis, simulation model of MRDCIS, simulation illustration and simulation analysis.

4.3.1. Hypothesis

Before estimating the simulation model of MRDCIS, lots of model hypothesis have to be put forward to illustrate the precondition of the model of MRDCIS. Specifically, the real situation is so complicated that some issues could not be simulated by software, so a variety of consumptions should be made for the simplicity of simulation mode:

- There are thousands of automotive suppliers which use different inbound logistics modes in real situation. To simplify the simulation mode, several suppliers with different inbound logistics modes will be chosen as the object of study including Supplier A, B and C.
- Considering the different package size of the material make the problem more complex, the package of the materials we choose is the same as a standard packaging unit in this simulation mode.
- Assume the daily demand of all the materials involved in the milk run route we choose are the same in this simulation mode.
- One issue should be assumed that the materials carried by one milk run truck will be handled in distribution center and delivered to SGM plant after stored for several days in this simulation mode.
- Special materials which have special requirement of loading and laying, leading to loading distributing rate will not taken into consideration in this simulation mode.
- The delay delivery caused by mistakes or unreasonable operations will not be considered in this simulation mode as well as extra inventory in distribution center caused by the shortage of areas.
- As the loss and damage caused by loading, dispatching, and handling happen in low frequency in real situation, the lost and damaged materials caused by loading, dispatching, and handling will be ignored in this simulation mode.

4.3.2. Simulation model of MRDCIS

The simulation model of MRDCIS is based on the trade-off between the transportation cost and inventory cost. The optimal situation with lowest inbound logistics cost will be found in the following part and several indexes will be figured out by Excel including delivery frequency and delivery volume by using the latest data of transportation and warehousing given by SGM logistics department.

As the transportation cost of milk run trucks from suppliers' factories to SGM plant for once can not be influenced by the quality of materials, the total transportation cost

only depends on delivery frequency. So low delivery frequency means low transportation cost. However, the milk run trucks with low delivery frequency must carry more materials compared with the situation of high delivery frequency because the total quantity of the materials in an order is unchangeable. As a result, the inventory cost will increase correspondingly when the quality of materials for once transportation increase. Obviously, there is a certain delivery frequency with corresponding delivery volume with which the total inbound logistics cost will be the lowest and that's the trade-off between the transportation cost and inventory cost.

4.3.2.1. Model construction

As we can see from the hypothesis, the total inbound logistics cost mainly consists of transportation cost of milk run fleet and inventory cost of distribution center in this case. The transportation cost of milk run fleet includes fixed cost which is the purchasing cost of milk run trucks, and variable costs which are fuel cost, maintenance cost, packaging cost, management cost, etc. The inventory cost of distribution center consists of material handling cost, storage cost, maintenance cost, management cost etc

Before model construction, some variables should be defined: take the total inbound logistics cost as C, purchasing cost of milk run trucks as C_p, transportation cost as C_t, inventory cost as C_i. For each batch of materials in each transportation, variable cost as C_v, fuel cost as C_f, maintenance cost as C_m, management cost of milk run fleet as C_{mag}. For each material in standard packaging unit, material handling cost as C_{mh}, storage cost per day in distribution center as C_s, management cost of distribution center as C'_{mag}.

As we can see

$$C = C_t + C_i , \quad (1)$$

In which,

$$C_t = C_p + C_v , \; C_v = C_f + C_m + C_{mag} , \; C_i = C_{mh} + C_s * T_i + C'_{mag} \quad (2)$$

Take an order of materials of Supplier A as an example, and take Supplier A's inbound logistics cost as C_A, delivery frequency as F, delivery volume as V, lifetime of milk run fleet as Y， storage time of each piece of materials is T_i, the lead time of each material as t, the quantity of materials required in the order as D.

For each order of materials of Supplier A

$$C_t = C_p/Y*t + C_v*F, \; C_v = (C_f + C_m + C_{mag}), \; C_i = (C_{mh} + C_s * T_i + C'_{mag})*V, \; V=D/F \quad (3)$$

According to the formulas above, for Supplier A, we can get,

$$C_A = C_p/Y*t + (C_f + C_m + C_{mag})*F + \sum_{i=1}^{F} (C_{mh} + C_s * T_i + C'_{mag})*D/F \quad (4)$$

Considering all the suppliers in the milk run route,

$$C = \Sigma (C_p/Y*t + (C_f + C_m + C_{mag})*F + \sum_{i=1}^{F} (C_{mh} + C_s * T_i + C'_{mag})*D/F) \quad (5)$$

4.3.2.2. Model solution

As the simulation model has been constructed, Excel will be used in the following part to figure out the lowest inbound logistics cost based on the latest data of transportation and warehousing given by SGM logistics department.

According to the simulation model for MRDICS, all the variables will be listed in Excel including consist variables which are t, C_p, C_f, C_m, C_{mag}, C_{mh}, C_s, C'_{mag},

D, dependent variables which are C_t, C_v, C_A, T_i, and decision variables are F and V.

Figure 6-Model solution

Source: Own calculation based on 4.3.2.1. Model construction.

According to the latest data of transportation and warehousing provided by SGM logistics department, for supplier A, the whole inbound logistics time for an order is 5 days on average, the quantity of materials required in the order is usually 40 standard packaging units, the initial investment of milk run truck is around 100000 RMB and its life time is 20 years.

As to transportation cost, for one delivery of milk run trucks, the costs segmentation of Supplier A's materials which consists of the purchasing cost, fuel cost, maintenance cost and management cost.

Table 5-Transportation cost of Supplier A in current inbound logistics system

Costs(RMB)	C_p	C_f	C_m	C_{mag}
Data	100000	18	12	5.8

Source: Dong, J. (2010). Optimization of transportation and warehousing in SGM, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

As to inventory cost, for each material in standard packaging unit, the costs segmentation is given in Table 6:

Table 6-Inventory cost of Supplier A in current inbound logistics system

Costs(RMB)	C_{mh}	C_s	C'_{mag}
Data	0.3	0.6	0.1

Source: Dong, J. (2010). Optimization of transportation and warehousing in SGM, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

After taking all the data into the Excel, the constraints will be made:

- V must be smaller than the capacity of milk run trucks;
- F must be integer and larger than 1;
- D must be smaller than the capacity of distribution center for Supplier A.

By using the function of "solver" of Excel, we can figure out the lowest inbound logistics cost in Figure 7: When F equals 2 and V equals 20, C_A gets lowest which is 238 RMB. It means the milk run trucks should carry the materials for twice, and every time the delivery volume is 20 standard packaging units. Due to the whole inbound logistics time for this order is 5 days, the milk run truck should delivery the materials in the first day and the afternoon of the third day. In such situation, the total inbound logistics of this order of material is the lowest and the transportation cost and warehousing cost is respectively 140 RMB and 98 RMB.

Figure 7-Model solution with data

Source：Own calculation based on Table 5 and Table 6, see APPENDIX I

4.3.3. Simulation illustration

In this section, a kind of simulation software called Extendsim is used to simulate the current inbound logistics system of SGM and real situation of MRDCIS if applied in SGM based on current situation of SGM and the simulation model of MRDCIS respectively.

4.3.3.1. Simulation of current inbound logistics system

According to the hypothesis, Supplier A, B and C will be chosen to take as an example in simulation and based on the current inbound logistics system, the Supplier A takes DD, Supplier B takes the mode of suppliers to RDC, and “milk run to RDC” is applied for Supplier C.

The transportation and warehousing data for Supplier A, B and C is given in Table 7:

Table 7-Transportation and warehousing data for Supplier A, B and C in current inbound logistics system

Suppliers	Mode	t	D	F	V	C_t （RMB）	C_i （RMB）	C（RMB）
A	DD	5	40	1	40	352	0	352
B	Suppliers to RDC	7	50	1	50	192	148	340
C	Milk run to RDC	6	90	2	45	150	220	370

Source: Chen, J.（2010）SGM inbound logistics management, unpublished presentation. Shanghai GM Limited, Shanghai, 2010.

According to the data of current situation of the three suppliers, simulation for the current inbound logistics system is carried out:

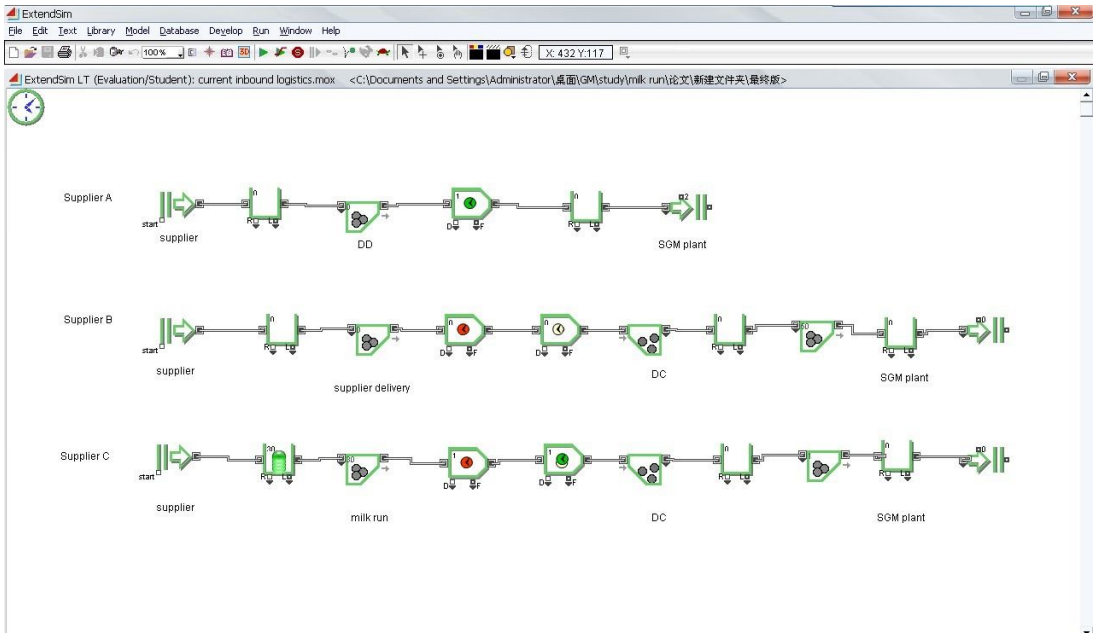

Figure 8-Simulation for the current inbound logistics system

Source：Own presentation based on 4.3.3.1. Simulation of current inbound logistics system by Extendsim

In this simulation, some variables should be setup at first,: the simulation time is define as a year (365 days), the transportation time is defined as 3 to 6 hours, and the

inventory in SGM plant is made 0. Moreover, several indexes are recorded by Extendsim including inventory level in RDC, transportation cost, warehousing cost and total inbound logistics cost after running the simulation.

4.3.3.2. Simulation of MRDCIS

Supplier A, B and C will use MRDCIS if MRDCIS is applied in SGM and according to simulation mode which is discussed in last section, the indexes of Supplier A has been figured out with which the lowest logistics cost could be achieved. With the same way, the transportation and warehousing data of the four suppliers could be gained based on the simulation mode:

Table 8-Transportation and warehousing data for Supplier A, B and C in MRDCIS

Suppliers	Mode	t	D	F	V	C_t (RMB)	C_i (RMB)	C(RMB)
A	MRDCIS	5	40	2	20	140	98	238
B	MRDCIS	5	50	2	25	162	122	284
C	MRDCIS	5	90	3	30	146	192	338

Source：Own calculation based on 4.3.2.1. Model construction, see APPENDIX I

According to the data of the three suppliers in Table 8, simulation for the current inbound logistics system is carried out:

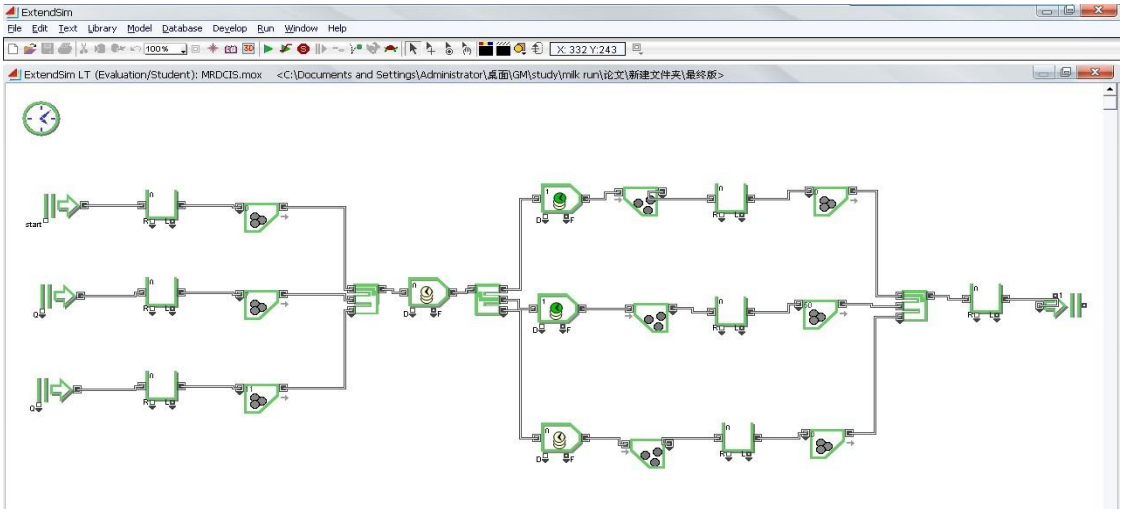

Figure 9-Simulation for MRDCIS

Source：Own calculation based on 4.3.3.2. Simulation of MRDCIS by Extendsim

In this simulation, some variables should be setup as same as the last simulation including simulation time, transportation time and inventory in SGM plant. Moreover, several indexes are also recorded by Extendsim including inventory level in RDC, transportation cost, warehousing cost and total inbound logistics cost after running the simulation.

4.3.4. Simulation analysis

After simulating for a time unit, Extendsim records the average data of the three suppliers in MRDCIS based on which some analysis about the current inbound logistics system and MRDCIS will be given in this part including delay time, inventory level, and cost.

4.3.4.1. Delay Time

Due to communication and coordination between SGM and its suppliers are getting better in MRDCIS than in original system and the transportation mode of milk run improve the OTD (Dong, 2010, p. 4), the delay time in MRDCIS is obviously smaller

the current inbound logistics.

4.3.4.2. Inventory Level

The inventory level of MRDCIS is also lower when compared with current inbound logistics system. Seen form Table 9, the total inventory of the three suppliers' materials 10.8 is less than that of current inbound logistics system which is 11.5. In addition, Supplier B's inventory is cut down for 7 to 3.75 while Supplier C's inventory is cut down from 4.5 to 3.3. In real situation, DD serves for about 10% of the total suppliers of SGM, the rest of which is taken by the other two modes, so the inventory level will be cut down to a large extend if MRDCIS is applied in SGM.

Table 9-Inventory Level of current inbound logistics system and MRDCIS

Suppliers	Inventory level (days)	
	Current system	MRDCIS
A	0	3.75
B	7	3.75
C	4.5	3.33
Total	11.5	10.8

Source：Own calculation based on Table 2 and Table 8, see APPENDIX II

From the data we can see, the efficiency is getting better in terms of delay time and inventory level in MRDCIS due to advantages of MRDCIS and the decrease of inventory level not only improves the efficiency of the system but also cuts down the inventory cost.

4.3.4.3. Cost analysis

Based on the data recorded by Extendsim in Table 10, a cost advantage of MRDICS will be found by comparing the cost of the two systems: the total costs of the three

suppliers are respectively decreased in MRDICS from 352, 340, and 370 RMB to 240, 287 and 344 RMB. Obviously SGM will keep lower inbound logistics cost if MRDCIS is applied in SGM.

For Supplier A, due to DD is used for it in current inbound logistics system, the transportation cost for DD is so high that it is actually higher than the total inbound logistics cost of Supplier A in MRDCIS. As a result, the total logistics cost for Supplier A has been cut down in MRDCIS.

For Supplier B, the transportation cost and inventory cost of MRDCIS are higher than that of current inbound logistics system, which means MRDCIS has cost advantages both in transportation and warehousing when compared with the mode of "Suppliers to RDC"

For Supplier C, the inventory cost is cut down form 220 to 195 while transportation cost keeps the same, but the total cost is lower than that of current situation. See from the data we can conclude the low inventory cost of MRDCIS contributes a lot to the decrease of its total inbound logistics cost. The transportation cost is not cut down because milk run is also used in current logistics system for Supplier C.

Table 10-Logistics costs of current inbound logistics system and MRDCIS

Suppliers	Current inbound logistics system			MRDCIS		
	C_t	C_i	C	C_t	C_i	C
A	352	0	352	148	92	240
B	192	148	340	170	117	287
C	150	220	370	149	195	344

Source：Own calculation based on Table 7 and 4.3.3.2. Simulation of MRDCIS by Extendsim

4.4. Feasibility of MRDCIS in SGM

Before MRDCIS is applied in SGM, weather it could be implemented in SGM should be considered. According to what has been discussed above, the current inbound logistics system should be changed if MRDCIS applied in SGM, and weather this kind of interchange could be achieved is the key to make MRDCIS into application in SGM and the priority factor to consider when the decision-makers think about the application of MRDCIS in SGM.

4.4.1. Milk run

Milk run is a section that should be considered during the application of MRDCIS in SGM. As all the automotive parts are carried by milk run trucks, it is necessary to expand the milk run fleet and make a complex and flexible schedule of thousands of milk run routings. Outsourcing the business of milk run to the 3PL could solve the problem of the management of milk run fleet such as fleet expansion, planning and scheduling. In addition, outsourcing could also cut down the cost of milk run by the professional service of 3PL.

4.4.2. Distribution Center

There are also some problems of distribution center that should be taken into consideration if MRDCIS is applied in SGM. The most important problem is the communication and coordination between distribution center and milk run. Based on the factor milk run has applied in SGM for a few years, the communication and coordination between the two departments could be improved by optimizing the current system of “Milk run to RDC” since the two modes are similar to some extend.

4.4.3. Supporting system

Information system and technology is needed in MRDCIS, which brings a large

challenge to the current management system of SGM. However, by continuous improvement of ten years, SGM has built a very powerful and integrated internal communication and tracking system and SGM's suppliers and 3PL providers also have multi-functional information system. So the information system required in MRDCIS could be achieved by integrating the information system of SGM, suppliers and 3PL providers. One the other hand, as 3PL providers have professional logistics facilities and service, the information technology such as RFID and EDI could be gained by outsourcing the business to 3PL providers.

4.5. Summary

In this chapter, MRDCIS is introduced including its mode, advantages, comparison between it and current inbound logistics and the feasibility of MRDCIS. Based on the introduction of MRDCIS, it is obvious that all the problems defined in chapter 3 could be solved in MRDCIS effectively. To prove the advantage of MRDCIS in solving these problems such as delay time, inventory level and cost, the simulation of MRDCIS is carried and from the analysis on the data recorded in the simulation we can draw a conclusion that the inbound logistics will keep lower delay rate, lower inventory level and lower cost if MRDCIS is applied in SGM to replace the current inbound logistics system.

In the next chapter, the supporting system of MRDCIS will be discussed and the expected results for implementation of MRDCIS will be given at last part.

Chapter 5 Perspective on the application of MRDCIS in SGM

When discussing the application of MRDCIS in SGM, one issue that should be taken into consideration is the supporting system of MRDCIS. In this chapter, supporting system of MRDCIS will be discussed including information system and information technology. Moreover, the expected result of applicaiton of MRDCIS will be given based on what has been discussed so far about MRDCIS.

5.1. Supporting system of MRDCIS

In this section, supporting system of MRDCIS will be introduced including information system which provides the system integration, business management, operation planning, etc. and information technology which provides technology service support in terms of hardware.

The current information system of SGM inbound logistics has not been advanced and integrated, and can not meet the demand of the business for communication and management. In addition, information technology SGM now use is not advanced which makes logistics activities inefficiency. As a result, the application of advanced information system and technology is quite necessary.

5.1.1. Information system

As to the current information system of SGM inbound logistics has not been integrated, an integrated management system is required among suppliers, milk run department, distribution center, and SGM plant to offer better communication and coordination and Enterprise Resource Planning (Wylie, 1990, pp.300-339) is such a kind of integrated management system. In addition, some other management systems

such as Fleet Management System, and Transportation Management System should be used in MRDCIS for logistics planning, implementation, and operation to improve the efficiency and effectiveness of MRDCIS.

5.1.1.1. Enterprise Resource Planning

Enterprise resource planning integrates internal and external management information across an entire organization, embracing finance, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application (Hossein, 2004, p. 707).

Obviously, ERP system is an integrative and powerful system which should be used in MRDCIS. If applied in MRDCIS, ERP should be used to integrate the systems of suppliers, milk run, distribution center and SGM plant. All the information of suppliers, milk run, distribution center and SGM plant should be shared in this system such as the inventory level of suppliers and distribution center, JPH (Dong, 2010, p. 7) of SGM plant, schedule of milk run, etc. so that any party involved in MRDCIS could communicate and coordinate with each other efficiently.

The application of ERP in system integration will improve the coordination and communications between the parties involved in MRDCIS and also avoid lots of mistakes made in current management system.

5.1.1.2. Transportation Management System

A Transportation Management System is a software system designed to manage transportation operations and TMS could manage three key processes of transportation management of milk run (Wikipedia, 2011):

- Routing planning

There are various suggested routing solutions offered to solve the transportation problems and the TMS will analysis them from the aspects of transport cost, shorter lead-time, fewer stops, etc. and finally give the most efficient transport schemes of milk run.

- Transport follow-up

TMS will also follow up the transport and take charge of the activities such as editing of reception, custom clearance, invoicing and booking documents, sending of transport alerts when milk run comes to delay.

- Performance improvement

TMS also has the function of performance improvement by putting forward some KPIs of transportation, according to which decision makers could take some measure to improve the efficiency and quality of transportation of milk run fleet.

Based on what is discussed above, TMS has the function of routing planning, transport follow-up, and performance improvement which will result in the most efficient transportation with lower running cost and better delivery performance.

5.1.1.3. Fleet Management System

Fleet Management System assists the company in accomplishing a series of tasks about the management relating to a company's fleet of vehicles which is referred to milk run trucks in this case.

The function of FMS includes vehicle financing, vehicle maintenance, vehicle telematics, driver management, speed management, fuel management and health and safety management (Wikipedia, 2011). In addition, the office could contract with the milk run fleet and do some activities such as remote control and related information

obtainment about the fleet by using the hardware installed in the trucks.

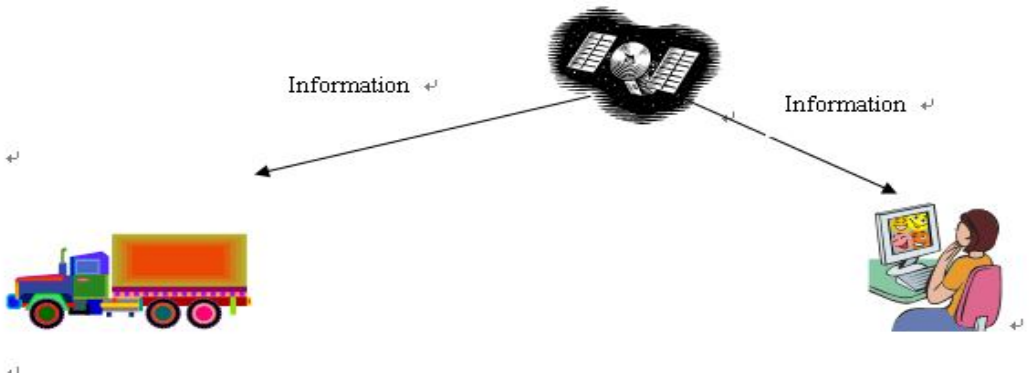

Figure 10-Fleet Management System

Source: Own presentation based on 5.1.1.3 fleet management system

The FMS provides the function of driver profiling, dispatch, and vehicle efficiency, so that the fleet can be maintained well and kept as the most efficient fleet that will contribute to the better performance of the fleet.

5.1.2. Information technology

Except for the information systems that are discussed above, some advanced information technology is also necessary to be adopted to improve the efficiency of MRDCIS by providing technology and operation support for the information system. The most popular and advanced information technology is Radio-Frequency Identification and Electronic Data Interchange which will be introduced as follows:

5.1.2.1. RFID

RFID is a technology that uses communication through the use of radio waves to exchange data between a reader and an electronic tag attached to an object, for the purpose of identification and tracking (Wikipedia, 2011).

As an advanced identification technology, RFID could be used for tracking and

tracing such as tracking of materials, milk run trucks, and even containers and racks which are used for packaging. On the other hand, RFID is also powerful in inventory management including materials receiving, shipment and inventory verification. In addition, RFID provides better service of identification with fewer mistakes in operation.

By applying RFID into MRDCIS, the visibility of supply chain of SGM will be implemented more easily. The materials will be tracked at anytime and the work efficiency of distribution center will be improved.

5.1.2.2. EDI

EDI is the structured transmission of data between organizations by electronic means. It is used to transfer electronic documents or business data from one computer system to another computer system (National Institute of Standards and Technology, 1996).

Due to some of the partners of SGM are oversea suppliers, the communication and data exchange between SGM and oversea suppliers are often inefficiency and full of mistakes because of the different cultures of companies. As EDI is an advanced data exchange tool, it could provide a more efficient and effect platform of communication and data exchange between SGM and its suppliers by making uniform format of data exchanging. Additionally EDI guarantees the security of the internal data of SGM. The protection of the internal data is very important especially for SGM because the data exchange among the parties involved in MRDCIS is quite frequent.

Due to the fact that most suppliers of SGM are large companies and most of them have possibilities to do Electronic Data Interchange, and compared with the benefit that brought by EDI, the cost of investment is relatively lower.

5.2. Expected result of the application of MRDCIS

With the MRDCIS applied in SGM, the whole inbound logistics system has been changed both in its mode and operation, which will have an impact on SGM logistics system even the whole supply chain. In general, the application of MRDICS in SGM will influence SGM in both short term and long term.

5.2.1. Short term

In short term, the applicaiton of MRDICS will have a positive impact on SGM logistics and production system: on one hand, MRDCIS contributes a lot to the efficiency and cost-effectiveness of SGM logistics system by keeping lower delay rate, lower inventory level and lower logistics cost which has been discussed in chapter 3 and 4; one the other hand, the advanced supporting system of MRDCIS improves the efficiency of the logistics system on operation level and offers an excellent platform of communication and coordination between the parties involved in MRDCIS. Generally, the implementation of MRDICS will make SGM logistics system more competitive in terms of efficiency and cost-effectiveness in short term.

5.2.2. Long term

As low logistics cost is included in the total cost of the finished automotive vehicles, and it makes the production more competitive in price, we can infer that SGM will become more competitive and get a large market share in long term with the improved customer service and competitive price. What is more important is the concept of if MRDICS is applied in SGM, LLM will be integrated into the culture of SGM which is beneficial to the competitive advantage of SGM.

5.3. Summary

By applying the supporting system of MRDCIS, efficiency and visibility of logistics system of SGM could be improved as well as the communication and coordination of the partners involved in MRDCIS. The expected result of application of MRDICS can be concluded based on the discussion so far: MRDCIS will contributes a lot to the efficiency and cost-effectiveness of SGM logistics system in shot term and eventually improve the competitive advantage of SGM in long term.

Chapter 6 Conclusion

6.1 Summary of this research paper

SGM is an international automotive vehicle manufacturer which is a famous and leading company in logistics, however, its inbound logistics mode is not lean according to LLM, and variety of problems are involved in the current inbound logistics system of SGM such as delay delivery, poor inventory level, and high transportation cost, etc.

Based on the problems of current inbound logistics system of SGM, milk run and distribution center integration strategy is put forward to solve the problems and improve the performance of inbound logistics system of SGM. The new system based on milk run and distribution center integration strategy has lots of advantages over current inbound logistics system by combining milk run with distribution center such as the advanced transportation and warehousing mode, the application of pull system, good platform for communication and coordination.

By replacing the current inbound logistics system with milk run and distribution center integration system, the problems of the current inbound logistics will be solved: the rate of delay delivery will be cut down, inventory will be kept at a very low level, and the logistics cost will also be decreased to a large extend. Based on what is discussed above, materials will be transported, stored, handled and delivered efficiently and effectively with lower logistics cost.

After analyzing on the feasibility of MRDCIS in SGM, one conclusion could be given: MRDICS could be applied in SGM according to the current situation by using and integrating the resource of current inbound logistics system including system,

facilities and manpower. In addition, supporting system of MRDCIS should be made with the implementation of MRDCIS to improve the logistics activities in terms of operation level such as ERP, FMS, TMS, RFID, EDI, etc.

In conclusion, with the MRDCIS implemented in SGM, the performance of SGM inbound logistics system will be improved in terms of efficiency and cost-effectiveness and finally SGM will become more competitive with its lean logistics system.

6.2 Suggestions for the implementation of MRDCIS

Apart from what is discussed in this research paper, more factors and issues should be evaluated before the implementation of MRDCIS in SGM such as the perpetration for implementation of MRDCIS, flexibility of MRDCIS, supplier management, etc.

When considering the implementation of MRDCIS in SGM, lots of preparations should be made: more manpower is needed including drivers, handlers, managers, etc; budget should be made based on the forecasting of investment of MRDCIS before implementation; the processes of MRDCIS applied in SGM should be detailed made as well as the standardized operation sheets for all the operators in MRDCIS.

As the production line of SGM changes in high frequency based on the demand of automotive vehicle market, the suppliers will be changed at the same time which influences the running of MRDCIS to large extend. For example, the milk run routings should be redesigned as well as the package of the automotive parts if a new type of vehicle comes into production. So MRDICS must be built flexibly enough to adapt to the situation and it is the main problem that should be figured out when considering the improvement of the performance of MRDCIS.

What can be concluded from this research paper is that all the suppliers of SGM should cooperate with SGM if MRDCIS is applied in SGM. When milk run is used as the mode of transportation in inbound logistics system, it brings a large challenge to the suppliers of SGM in terms of following the schedule of milk run, the way of loading and the package used in the transportation of milk run, which means an increase in operation cost for suppliers. As a result, making the suppliers accept the change and the increased logistics cost becomes the key point.

More researches and studies will be made after MRDCIS is implemented in SGM such as the improvement of performance of MRDCIS, problem solving of MRDCIS, the application of new technology in MRDCIS, etc.

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Appendix I -Model Solution for Supplier A/B/C

Supplier A

For Supplier A										
			t	=	5					
			D	=	40					
Capacity			Milk Run Truck		40					
			Distribution Center		100					
C_t		C_f	C_m	C_{mag}	C_p	Y				
		18	12	5.8	100000	7300				
		C_p	=	100000						
		C_v	=	(C_f	+ C_m	+ C_{mag}	) *F=	71.6		
		C_t	=	C_p	C_v	=	140.1			
C_i		C_{mh}	C_s	C'_{mag}	T_i					

		0.3	0.6	0.1	7.5					
		C_i	=	(C_{mh}	+ C'_{mag}	+ C_s	+ T_i	)*V	=	98
Decision Variable										
		F	=	2						
		V	=	30						
Subject										
		C_A	=	287.1						

Supplier B

For Supplier B										
			t	=	5					
			D	=	50					
Capacity			Milk Run Truck		45					
			Distribution Center		100					
C_t		C_f	C_m	C_{mag}	C_p	Y				
		24	15.5	7.2	100000	7300				
		C_p	=	100000						
		C_v	=	(C_f	+ C_m	+ C_{mag}	) *F=	93.4		
		C_t	=	C_p	C_v	=	161.9			
C_i		C_{mh}	C_s	C'_{mag}	T_i					
		0.3	0.6	0.1	7.5					

		C_i	=	(C_{mh}	+ C'_{mag}	+ C_s	+ T_i	)*V	=	122.5
Decision Variable										
		F	=	2						
		V	=	25						
Subject										
		C_A	=	284.4						

Supplier C

For Supplier C										
			t	=	5					
			D	=	90					
Capacity			Milk Run Truck		60					
			Distribution Center		180					
C_t		C_f	C_m	C_{mag}	C_p	Y				
		10	12	3.8	100000	7300				
		C_p	=	100000						
		C_v	=	(C_f	+ C_m	+ C_{mag}	) *F=	77.4		
		C_t	=	C_p	C_v	=	145.9			
C_i		C_{mh}	C_s	C'_{mag}	T_i					
		0.3	0.6	0.1	7.5					

		C_i	=	(C_{mh}	+ C'_{mag}	+ C_s	+ T_i	)*V	=	192
Decision Variable										
		F	=	3						
		V	=	30						
Subject										
		C_A	=	337.9						

Appendix II - Inventory Level of current inbound logistics system and MRDCIS

Suppliers	Mode	Lead time(days)	Frequency	Inventory level (days)
A	DD	5	1	0
B	Suppliers to RDC	7	1	7
C	Milk run to RDC	6	2	4.5

Suppliers	Mode	Lead time(days)	Frequency	Inventory level (days)
A	MRDCIS	5	2	3.75
B	MRDCIS	5	2	3.75
C	MRDCIS	5	3	3.33