Milk Run Logistics: Literature Review and Directions

Gurinder Singh Brar and Gagan Saini

***Abstract*— The purpose of this paper is to review the literature on Milk Run Logistics and to present an overview of its implementation practices adopted by the manufacturing organizations. The paper also discusses milk run logistics in the procurement system with a special emphasis on the automobile industry. Milk run system is all about logistics support for the supply chain. Milk run system results in reduction in cost of transportation, travelling path and fuel consumption. The effects of the direct shipment on the traffic conditions and on the environment have also been studied. By introducing the milk run logistics under heavily congested traffic conditions, the supplier can have full control on the procurement process. Also, the number of trucks on road can be reduced thus resulting in improvement in traffic conditions. The effect of the milk run logistics on the reduction of CO_2 is also discussed. The promotion of Milk-Run logistics can be highly evaluated from the viewpoint of environmental policy.**

***Index Terms*— Milk run logistics, supply chain, just in time, procurement system.**

I. Introduction

THE business environment is becoming increasingly competitive as supply-chain business customers expectations ratchet ever upwards and the capability of competing companies to deliver consistent quality at low prices continues to develop [1].

Today Automobile industry has an important place in the national economy. Automobile industry has a high rate of input and output, as a production tool and a durable consumer good. Whether in production stage, sales stage, or use stage, is an important source of revenue. The supply chain management of every organization is thinking every step's logistics cost of the supply chain from upstream to downstream, then grasp the elements of the supply chain links for maximum benefit throughout the supply chain optimal solution. The formation of a high efficiency with low-cost supply chain can be a competitive advantage, and success in the market [2].

Materials procurement system in a manufacturing plant is demanded to be very effective and efficient. If a system becomes more effective and efficient it will directly makes the line production and the following process smooth, so there will be no lack of materials, lateness, even line stop. It will also reduce the production base price then the company's profit will increase.

The competitions in the auto industry in around the world have become so fierce nowadays that auto manufacturers have to find better ways to manage and minimize its production cost. Supply chain and logistics management plays an important role as logistics costs are major cost components in the total production cost. The Just-in-Time system (also lean production system) implemented by many other auto manufacturers with different degrees of success as a means to reduce production costs.

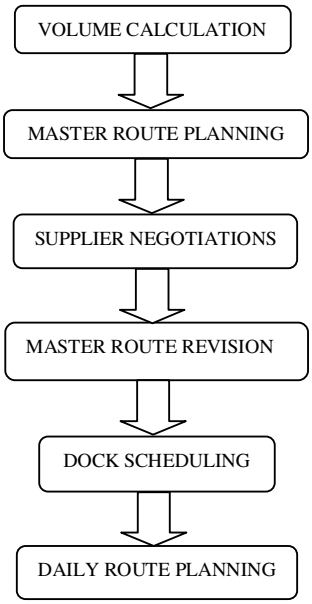

Fig. 1. Simplified steps of supply procurement planning process [3]

Figure 1 depicts a simplified lean production system. Its main concept is to reduce the wastes found throughout the systems, particularly those in warehouses — inbound supply inventory. By using the Just-in-Time system, planning and scheduling of every significant parts of the production have to be done effectively and efficiently. Supply procurement is one of the most important parts in the production system and has to be planned and scheduled to support the needs of the production line.

The supply procurement planning process of the case company begins with volume calculation corresponding to

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the production plan for the next period. This entails breakdown of parts and quantities required as well as identification of potential suppliers. Next, a master milk-run pickup route is created using information about supplier locations and pickup volume at each supplier location. This step is currently done manually. Planners begin from previous month's mater route plan and perform incremental changes to the plan according to changing volumes.

Next, the company informs its suppliers of the volumes and pickup schedule, and enters negotiations with each supplier. If modification to the master route is needed after the negotiation, it is done to finalize the period's master route. Once the master route is completed, it is then used to schedule receiving dock activities. This is necessary to avoid congestion and ensure high and uniform utilization of the facility. The master route is then used for the entire period as a template on which daily operation is based. The daily milk-run pickup route will deviate from master route slightly according to shifting daily volumes. This also is currently done manually [3].

It is also necessary to have a safe logistics system (against transportation damages, wrong item delivery and stock-outs) that put importance not just on speed but also on transportation quality. In order to make the procurement system very effective and efficient the industry will prepare the three logistics concept, namely:-

1. The first concept is 'flexible logistics' that can cope with demand fluctuation.

2. The second concept is logistics with a competitive edge as a result of 'minimum lead times (LT) and lower costs'. Ultimately, it includes reducing logistics costs by advancing localization of parts suppliers and preparing Milk- Run route. After performing a re-assessment of such issues on production and procurement, shortening of lead times and reduction of distribution costs are pursued.

3. The third concept is logistics with 'minimum environmental impacts'. The response to the environmental problem is a major issue not only in Japan but also on a global level. In the logistics field, the ultimate objective is to reduce the amount of CO_2 exhausts generated from the transportation activities and to decrease the amount of packaging and wrapping materials used.

And this three logistics concept can be achieved with the used of milk run logistics in the part procurement system. Milk-Run logistics is becoming one of the standard systems of an overseas version of JIT distribution. At overseas production bases, Milk-Run logistics in the local country and the above-mentioned international distribution system are combined, and a global procurement logistics system is formed [4].

II. Milk Run Logistics

Milk-Run logistics is a generic name of a logistics procurement method that uses routing to consolidate goods by the buyer. It is a method of goods collection in which the user (i.e. car assembly manufacturer) dispatches one truck at a specified time period to visit various suppliers (i.e. parts supplier) following a predefined route to collect parts or products, and deliver them to the factory [5].

In general, the reasons why Milk-Run logistics has been widely employed are:

1. Reduction in transportation costs due to consolidated transportation offsetting even the use of small lot transport.

2. Improvement of the assembly manufacturer's production line and greater accuracy of JIT goods delivery due to synchronization. Milk-Run logistics can provide consolidated collection of goods necessary to improve logistics procurement systems.

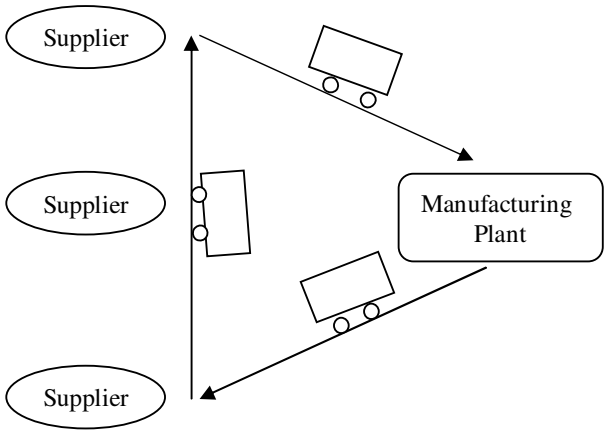

Fig. 2. Milk run operation [5]

3. Improvement of the vehicle loading rate, shorten the total distance traveled. It can achieve various suppliers and manufacturers of coordination, improve agility supplies and flexibility, but also improve the ability of the manufacturer's response and system efficiency.

4. It reduces the risk of product quality if problems. Manufacturers can quickly discover and inform the corresponding suppliers, to minimize the impact on sales.

5. It changes logistics strategies, using third-party logistics significantly reduce in-process inventory, increased capital flows, reduce investment risks.

III. Review of Literature

The concept of milk run logistics originates from the dairy industry. The notion covers a transportation network where all input and output (I/O) material requirements of several stations are covered by one vehicle that visits all these stations, and circulates according to a pre-defined schedule. This transportation concept is economical when the I/O volume of each single station is essentially smaller than a truckload. The milk run concept is frequently applied in internal plant logistics to transport raw materials, finished goods, and waste between manufacturing and assembly Stations and the warehouses of the plant [6].

Few studies on logistics system of automobile parts have been undertaken by researches with focus on the Milk Run logistics in general. For example, Mehmet et al. (2004) presents principles to design the procurement system [7], Bowersox et al. (2002) concluded that Milk Run is an

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important element for an integrated lean logistics strategy [8], and Nojiri (2005) indicated that the Milk Run logistics increases efficiency when the production scale of auto assembly factories is relatively small, in the range of several tens of thousands [9]. The Milk-run Vehicle Routing problem is an extended variation of the vehicle routing problem. The vehicle routing problem and its variations have been studied extensively by Cordeau et al. (2005) [10].

Xu (2003) introduced milk run and contracts with third party logistics enterprises, the third party designed the most rational distribution routes and plans in accordance with the daily needs of Shangahi GM to pick up from different suppliers timing and then directly transport to Shangahi GM. With the introduction of this logistics Shangahi GM inventory war reduced by 30%, storage space savings of 10 thousand square meters. The total transportation trips reduced by 20%, 30% integrated logistics cost reduction and resources utilization increase 10% [11].

Xu and Han (2010) analyzed the linkage mechanism between the manufacturing and logistics industry during the financial crisis in china. The financial crisis is the important historical period of China's economic structural adjustment and industrial restructuring, manufacturers and logistics companies need to focus on the overall situation and work together to overcome the current difficulties. They proposed new method of transportation using milk run. They analyzed that after implementing this method inventory costs reduced through control transportation time and also there was reduction in costs of package because loading and unloading only need one time. The reduction in costs of transportation has been proved to be as much as 67.5% [12].

Lin and Cha (2010) optimized the integration of the inventory and transportation in the distribution system. It is important research in logistics integration strategy. They analyzed the relationship between inventory and transportation, builds the ITIO issue optimization based on milk-run mode, and combining the character of Model. They also designed Genetic Algorithm of natural number coding to solve vehicle scheduling model of milk-run, then uses stepwise iterated algorithm to balance inventory cost and transportation cost, in order to make the total cost of milk-run logistics network system minimum [13]. Ricoh Express introduced the “milk run” method, by which one truck travels around to multiple suppliers to pick up cargo. To operate the milk run system effectively, the company developed a system to optimize vehicle routing, by checking shipment volumes with suppliers prior to collection, by telephone or dedicated network. This new initiative more than doubled loading efficiency, from 30% to 65%, and shortened total travel distances for transportation. In addition, for large cargo with a sufficiently high loading rate, these efforts led to an annual reduction of 310 tons, or 35%, in CO_2 emissions [14].

Webasto Company which is producing roofs for Volkswagen cabriolets in Portugal, in a first round of optimization optimized milk runs for the German supply industry, consolidation of tours and routing from Germany to Portugal, which saved about 25% of transport costs, and energy consumption in a similar range [15].

DHL (Dalsey, Hillblom and Lynn), a Deutsche company of Germany that provides international shipping, in August, 2008, successfully implemented milk run system for jaguar land rover. Results improved efficiency and reduces cost [16]. Rosini and Preti (2006) conducted a study on the Bologna metropolitan area. The Metropolitan area is the origin/destination point of regional, national and international supply chains for preparing the Policy guidelines for the rationalization of freight traffic. After implementation of the milk run logistics it was found that the number of incoming trucks reduced and waiting time of vehicles will be zero. The total transportation cost reduced to 37% and there was reduction in the lead time [17].

Valeo is an independent group fully focused mainly for the reduction of CO_2 emissions. In June 2009, a new process was deployed in Spain to improve the quality of service named “The Milk Run”, it involves Valeo Service collecting its orders directly from suppliers and delivering them to its warehouses. The milk runs speed up customer service while optimizing transport costs. In the second half of the year, they were extended to all of Valeo Service’s European divisions. It also improved its stock rotation by 10% through rigorous management [18]. Michael and Claudia (2009) studied how stock transports to individual production lines can be optimized through the milk run. They introduced routes to supply several production stations or cells within one transport. The clustered routes lead to more frequent trips to the production lines. A higher delivery frequency has a positive effect of a marked reduction of inventory volume at the production stations. The number of transports can consequently be reduced and the utilization of transport equipment optimized. This leads to a reduction of inventory and transport costs [19].

Chen and Shuaiying (2009) established a cost optimization model for adopting milk-run for the supply-hub under multiple suppliers and obtained an optimized replenishment policy to the supply-hub for each group of suppliers without considering the penalty cost condition [20]. Over the last 20 years, Toyota has also transformed it’s after –market parts distribution system using the principle of milk run system. Dealers pre-diagnose and pre-order parts they need each day, instead of carrying months of stock, and get two three deliveries a day on milk runs from local distribution centers [21].

Akiyamaa and Yano (2008) studied the current conditions pertaining to truck deliveries to large retail stores in Japan. The report covered a total of 750 stores with 5,384,545 square meters of retail floor space. On a single day, it was estimated that large-scale retail stores in Tokyo receive nearly 46,000 truck deliveries. In order to reduce the number of trucks, the association plans to introduce a designated delivery agent system, whereby a designated agent consolidates goods from many vendors and delivers them to a department store, rather than having each vendor make separate deliveries. The truck deliveries could be reduced by 2,700 per day. This would be a very

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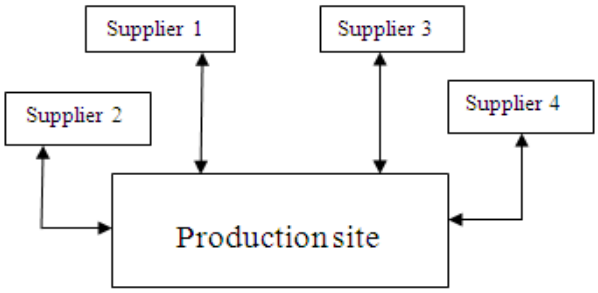
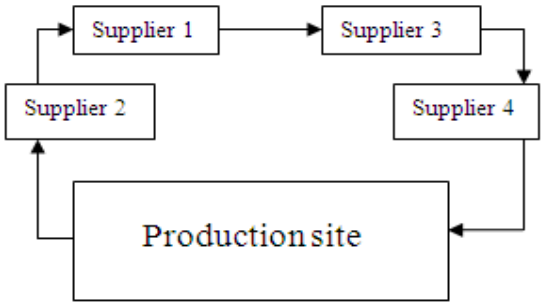
significant change, and it is equivalent to around 5.5% of the total number of truck deliveries to large retail stores in Tokyo [22].

Toyota uses milk runs from suppliers to support its JIT manufacturing system in both Japan and the United States. In Japan, Toyota has many assembly plants located close together and thus uses milk runs from a single supplier to many plants. In the United States, however, Toyota uses milk runs from many suppliers to each assembly plant. Gopaljee has its own milk –shed area allotted by the central and respective state governments, which in turn supports multiple groups of Village Level Center's (VLCs) covering over 4500 villages. About 1,25,000 farmers deliver fresh milk to Gopaljee twice a day at their 4,500 established milk societies. For collecting milk 50 milks routes were prepared, ensuring that milk is lifted within 3 hours of milking and brought to chilling centers. For this about 123 vehicles move around continually to collect milk from prepared route. A single vehicle covered around 25 villages [23].

Konica Minolta is using the milk run logistics in Wuxi City in Jiangsu, China. It contributes to reducing CO_2 emissions by shortening the total driving mileage of the trucks. Figure 3 shows the distribution system of Konica Minolta. Previous they used the direct shipment distribution system for all distribution system. In this system they used the separate vehicle for its all suppliers with separate route.



(a) Previous way



(b) Milk Run Logistics (New Way)

Fig. 3. Konica Minolta distribution system

Konica Minolta had a problem of CO_2 emission from its distribution activities. So they employed a milk run logistics for round collection of its cargoes as show in figure 3. Results contributed to reduced CO_2 emission by shortening the total driving mileage of the trucks [24].

Karagul and Albayrakoglu (2007) implemented milk run sytem in Turk Tractor Fabrikas (TTF) is located in Ankara in central Anatolia region of Turkey. It was found that TTF should simplify the material supply processes by implemented milk run system with the help of analytic hierarchy process in a manner to move over a total of four geographical regions for its 128 supplier companies grouped in 16 cities from which it conducts material supply. The costs for supply of materials can reduce approximately 0.2% of the total purchasing cost. This means a saving of 18,000-20,000 Euros per month. Also reduction in work-in-process (WIP) inventories of 25%. There is also reduction in the number of personnel and associated costs, communication and control costs will be decreased significantly. [25]

Rachman et al. (2009) solved the vehicle routing problems with milk run system to minimize cost. The study was undertaken in an automotive manufacture company which is one with the biggest production capacity in Indonesia. In the present research, milk run system was applied to all suppliers. This proposed system was compared to the current system to get the result of efficiency. The total truck's travelled distance between these two systems was also compared. The optimization was obtained using the implementation of Differential Evolution (DE) algorithm method. Route of milk run system proposed has a total mileage within a day of 6847.10 km. The route at this time the company has used is 8077.5 km. Reduction in distance that occurs is equal to 1230.4 km or 15.23%. The proposed route could increase the average utility of vehicles by 22.88%. The current truck's rent cost is Rp.41.450.000. It is higher comparing to the optimal truck's rent cost which is Rp.31.000.000. It can be concluded that milk run route can economize the truck's rent cost as Rp.10.450.000 per day or 25.21%. [26]

The Milk Run logistics utilizes the trucks efficiently, where the average loading factor in terms of truck space utilization becomes very high. It results in less environmental impacts, including CO_2 emission. High loading factor is realized partly because the trucks bring not only necessary auto parts but also the returnable containers to pack the parts. The empty containers get back to the original suppliers just before picking up new parts in the next run [27]. CO_2 emission from the trucks to pick up the parts is estimated by the equation (1) shown below:

$$CO_2 = TR \times FE \times (D+100) \times EF \quad \text{.....(1)}$$

where,
CO_2 = CO_2 emission (kg)
TR = Number of Trucks (vehicles)
FE = Fuel Efficiency or Average fuel use (litres/100km)
D = Distance travelled (km/vehicle)
EF = Emission Factor in CO_2-kg (kg/liter)
(EF is 2.951 kg/ liter in the case of diesel fuel)

IV. Features of Milk Run Logistics

In foreign countries where the density of parts suppliers is low, Milk-Run logistics has expanded, spreading all over the world. The automobile industry has been leading globalization efforts for a long time now. Moreover, Milk-Run logistics has spread not only in the automobile industry

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but also in the consumer electronic and electro-mechanical industries. Milk-Run, which puts the assembly plant at its core, is a frequent parts procurement system implemented in a comparatively small urban region, or a virtual expanded factory yard. The features of Milk- Run logistics are enumerated below:-

First, Milk-Run logistics has been planned to improve loading rates at possible levels and reduce the number of trucks and travel distances. As a result, it is an excellent transport method in which exhaust gases from trucks can be controlled. Therefore, the promotion of Milk-Run logistics can be highly evaluated from the viewpoint of environmental policy.

Second, because the Milk-Run logistics requires accurate management based on the operational plan, we could introduce an urban logistics policy to increase transportation reliability. For developing countries, a road infrastructure that can make scheduled operations possible and a road quality that does not cause damage to the transported goods are required. For developed countries, policies such as road-use control systems could be introduced to prioritize vehicles with high load factors.

Third, consolidation using standardized returnable boxes and containers are implemented to increase transport efficiency in Milk-Run logistics.

Fourth in the production system if milk run is used for supply the materials in the production line; the overall transportation cost is decrease and optimal utilization of the resources.

Finally, Milk-Run logistics is performed through close coordination and linkages between the automobile manufacturer, parts supplier, and logistics service provider, and its influence on regional transport becomes more significant if the scale of the Milk-Run logistics becomes larger. In other words, Milk-Run logistics is purely private efforts with financial motivation, but it has positive external effects for society as well. In this case, public involvement may be required for planning Milk-Run logistics which include the cooperation of related local governments and affected residents.

V. Conclusions

Milk-Run is a frequent parts procurement system implemented in comparatively small region, or a virtual expanded factory yard. Milk-Run logistics has been planned to improve loading rates at possible levels and reduce the number of trucks and travel distances. As a result, it is an excellent transport method in which exhaust gases from trucks can be controlled. Therefore, the promotion of Milk-Run logistics can be highly evaluated from the viewpoint of environmental policy. The Milk-Run logistics requires accurate management based on the operational plan, we could introduce a logistics policy to increase transportation reliability. The global warming problem in the environment due to the direct shipment can also be reduced by use of milk run logistics. The milk run system reduces the carbon dioxide emission from the distribution system by reducing the truck deliveries in transportation. The overall supply chain cost can be minimized by using milk run system in transportation instead of direct shipment.

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