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On Optimization of Requirements Forecasting and Material Flow on the Basis of Grey System Theory

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Abstract: Between suppliers and manufacturers, there exists a market demand which is subject to market fluctuation and can not be precisely forecasted. Under this background, the study aims at the research on the adoption of scientific methods to reduce the impact of market fluctuation upon both sides of supply and demand. In this article, the author solves the problem from two aspects. Firstly, the Grey System Model is applied to precisely predict the market demand. Secondly, a third party warehouse between suppliers and manufacturers is established to adjust the contradiction between supply and demand. Furthermore, through case verification, it is found that the time of material supply will be decreased from 100 days to about 38 days and the stock value is correspondingly reduced. Therefore, the author suggests that the Grey System Theory should be utilized by suppliers to optimize their approaches of forecasting the market trends and manufacturers' requiring quantities.

Key words: Third party warehouse (3 PW), logistics management, grey theory, JIT

INTRODUCTION

Centralization and decentralization are two decisive elements for the rationality of material flow. Irrational material flow will add order cycle time and logistics cost to suppliers and manufacturers. Various solutions have been raised to decrease the unfavorable factors, of which the most advanced solution is the synchronized logistics system which demands stable or at least predictable material flows. In this article, the author holds that outsourcing is not applicable to lowering logistics cost, shortening circulation time and sharing risk in China's rapidly growing market and hence the feasible approach is to adopt the Grey System Model to increase the precision of requirements forecasting and to establish third party warehouse to maintain clear control on the material flow.

APPLICATION OF GREY SYSTEM MODEL TO REQUIREMENTS FORECASTING

In cybernetics, color shades are used to describe the distinctness degree of information. Ashby names the unknown objects of the internal information Black Box and this name is generally accepted. "Black" is used to stand for information indistinctness, "white" for complete information distinctness and "grey" for partial distinctness or partial indistinctness. Accordingly, the information systems of distinctness, indistinctness and partial distinctness or partial indistinctness are called "white", "black" and "grey" systems, respectively. Deng (2002) established the Grey System Theory, a new theory of studying minor data, poor information and indistinctness of partially known or partially unknown information. The Grey System Theory aims at the systems of minor samples, poor information and indistinctness and more importantly it extracts valuable information through generating and developing the partially known information to realize proper description and effective monitor of the system's operational behavior and evolutionary law.

In enterprise supply chain management, it is critical to design a flawless Pull system from downstream to up stream of the supply chain (Olhager and Ostlund, 1990). The effective implementation of this system requires guaranteed stability of material flow and precise requirements forecasting (Cachon and Lariviere, 2001). But it is difficult to make a precise forecasting in a developing and unreliable competitive environment. Therefore, one workable way is to predict the logistics requirements between suppliers and manufacturers by considering the supply chain as a whole. The Grey Model (GM) forecasting process is illustrated in Fig. 1.

A Grey System Model can be then helpful to forecast future required quantities to supply. The factor of time is considered and each parameter of the forecasting model varies with time.

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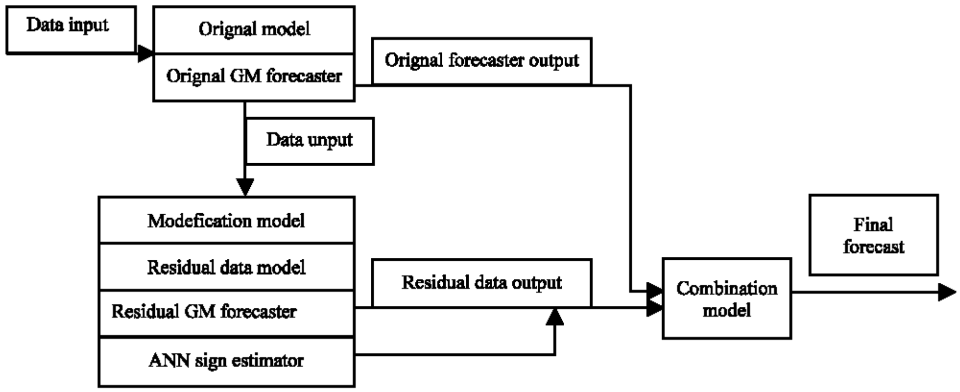


Fig. 1: Logistics requirements forecasting process

$$f(t)=\sum_{i=1}^{m}\left[\omega_i(t)f_i(t)+\varepsilon_i\right]\sum_{i=1}^{m}\omega_i(t)=1$$

Where:

F (t) = Total quantities of supply within the time t
I = Types of material, i = 1, 2, ..., m
ω_i (t) = i = 1, 2, 3,......., m: corresponding weights of f (t)
ε_i = Random perturbation variables

APPLICATION OF THIRD PARTY WAREHOUSE TO OPTIMIZING LOGISTICS PROCESS

The third party warehouse is a buffer of safety stock for the unpredictable volume of goods. It is set up for the supplier to deliver products to the manufacturer at a higher speed, thus, helping the supplier diminish responsibility and cut back cost in the material circulation. This logistics mode means that there are no direct logistics activities but information communication between suppliers and manufacturers and that the third party warehouse is a buffering storehouse for the latter. The relation between supplier, manufacturer and third party warehouse is shown in Fig. 2:

- Supplier's finished goods are transferred to the 3PW on a Forecast Report basis and fixed orders (Material flow+information flow)
- When goods are needed, the 3PW by means of e-kanban delivers them to the Manufacturer (Material flow+information flow)
- The Manufacturer emits his Forecast Report to notice the Supplier (Information flow)

The third party warehouse benefits those unstable manufacturers because it can timely provide the quantities of goods demanded by them. On the other hand, it doesn't matter to the stable and reliable manufacturers because they can accurately predict the quantities of future demands and so the Pull System is applicable to them.

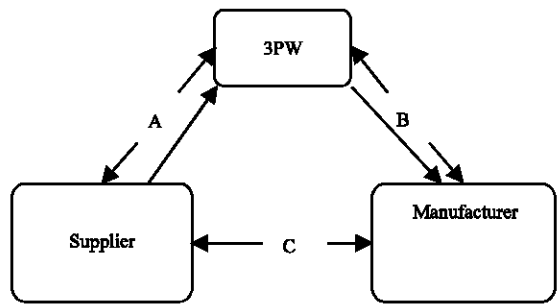


Fig. 2: Relation between supplier, manufacturer and third party warehouse

CASE STUDY

A certain corporation was the worldly largest supplier of automotive components and parts with a sale of 25.3 billion Euros in 2004. Its Suzhou branch company (hereinafter called the "Company") was founded in 1999 and currently it has 1100 employees and consists of 5 production divisions, namely Automotive Electronics, Car Multimedia, Chassis System Brakes, Chassis System Control, PA-ATMO (Assembly Systems and Special Machinery).

Plant logistic activities:

- **Product logistics:** IN and OUT logistics, storage, packaging; logistics planning
- **Manufacturer order processing:** Working out production plan on the basis of inventory and sending order to the supplier according to the Pull Principle of supply chain
- **Internal material flow:** Design of Milkrun, implementation of Milkrun, Kanban management, staff training and ramping up support team
- **Manufacturer logistics' crucial points:** Material demand planning (supplier side), manufacturer requirement planning and logistics information system (SAP)

Third party warehouse logistics: Take the car parts logistics activities of the Company in Suzhou to Chang'an-Suzuki in Chongqing as an example:

- **Location:** The automotive components and parts are shipped by boat from Suzhou to the port of Chongqing and then transferred to the third warehouse, waiting for the manufacturer's order, 16 days in total
- **Organization:** There is a small office with two employees, one supervisor and six workers, one truck, one electric and two manual levers
- **Layout:** There is an up-to-level ramp to pick up the packages, three main rows of goods, poor conditions, old and cheap storing structures. The warehouse has two gates and next to the south gate is an area for the goods to be shipped soon
- **Information system:** It takes 30 min from the time Suzuki emits the e-kanban order to the time it gets shipped to the Line

Company's logistics principles

Company's Value Stream Planning (VSP) and Lineback Planning as part of its Production System): VSP is applied to yearly target deployment in the plants. It is aligning logistics activities along the value stream to provide effective and long-term improvement on logistics. Instead, "Lineback planning" means that the optimum must be found by an integrated process to increase the value of the whole supply chain rather than that of the suppliers.

Reverse engineering implementation: Reverse engineering can help directly implement JIT, since if the Company has a stable forecasted data at the downstream of the chain, it can calculate a roughly stable production (supply amount of the upstream) on the basis of the data. It is indeed a bottom-up Pull approach, since concerning bottlenecks, the forecasted demand at the end of the chain would significantly get larger and larger going backwards to other tiers of the Supply Chain, i.e. Suppliers and Suppliers of Suppliers. The suppliers will also consider the bearing capability of other parties, because internal "Production Logistics" also has a strong influence on the overall performance of the chain.

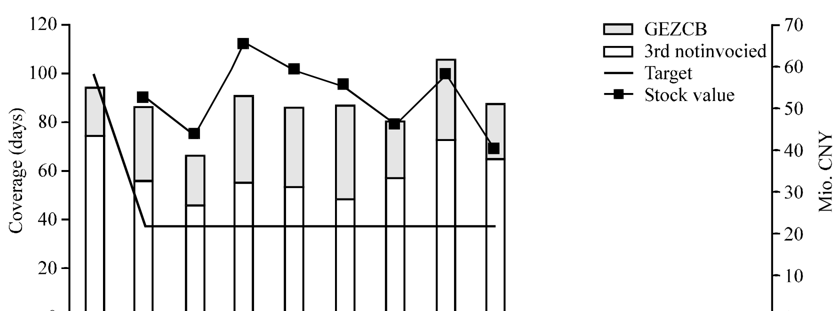
Application of Grey System Theory to forecasting requirements: Since in most of the cases, Logistics system may be rather complicated to analyze with standard means, it will be useful to employ GST method to forecast future markets and manufacturer demand.

Lean design to a buffering less material flow-PULL system: The PULL system requires the material flow to be flawless. It is desirable to adopt such a system for every constituent in the supply chain, but it is hard to make an overall implementation due to instable required quantities on both IN and OUT interfaces of the plant. It would then demand big efforts from both Suppliers and Manufacturers to level their quantities requirement (Cachon and Lariviere, 2005). The best way to obtain these performances would be to introduce e-kanban systems.

GEZ and WIP systems

WIP, pipeline, storage: GEZ is an audit system designed by the Company to analyze its current material flow, which is exactly like a monthly-based chart of the following quantities.

In Fig. 3, the Y axis on the left represents that the current material flow can meet the manufacturer's normal usage time (day); and the Y axis on the right stands for



2011	2012	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
75	57	46	56	54	49	58	73	66					
19	29	20	34	32	37	23	32	22					
100	38	38	38	38	38	38	38	38					
	52,....	43,....	65	59,....	55,....	45,....	57,....	40,....					

Fig. 3: Effect brought by the third party warehouse

stock value, of which: 3rd not invoiced = 3rd in SAP-3rd Actual, Stock Value = 3rd in SAP+RBAC Stock Total. The X axis stands for time.

CSWH to supply in Outbound, CSW to supply in Inbound: The Company is transforming actual CSWH to direct supply in Outbound, while it's switching to CSW in Inbound. Its policies are driven by lowering costs and improving service quality. Following these principles, it is found that the Pull systems are used on outbound side and PUSH for the inbound, mainly depending on manufacturer's requirements (Slack and Correa, 2001). Milkruns in Company are both out and in plant. In plant, production Milkruns and supplying Milkruns are often combined with Kanban system to optimize JIT deliveries; and out of it Milkruns can be either implemented by a Third Party Logistics or by Company itself in delivering the goods.

CONCLUSION

In present China, it is difficult to utilize the Pull system on-line in the material flow between suppliers and manufacturers, especially the small-and medium-sized manufacturers, since this system requires that the manufacturers can provide timely, precise and continuous information of demand and that the suppliers need to precisely forecast the manufacturers' demand. The precise forecasting is not easy to obtain in an unstable market and the Pull system hence can not give full play to its strong points. Up till now, it has been observed that only suppliers of Toyota Motor can make precise and reliable forecasting and this lets it be able to directly use the synchronized Pull system. Therefore, most of China's suppliers should apply the Grey System Theory to optimize their approaches of forecasting the market trends and manufacturers' requiring quantities.

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