International Journal of Advanced Research in Engineering Technology & Science
ISSN: 2349-2819
Email: editor@ijarets.org Volume-9, Issue-6 June – 2022 www.ijarets.org

A study on Contribution of Inventory Model

Dipendra Mani

M.Phil, Roll No: 141445

Session: 2014-15

University Department of Mathematics

B.R.A Bihar University, Muzzaffarpur

Abstract

Due to a lack of qualified people and technological resources, inventory management is one of the main issues facing industrial companies in the present supply chain management. The degree, quantity, quality, and cost of strategic outsourcing decisions are influenced by far too many factors. Although outsourcing lessens the need for capital expenditure, it nevertheless raises serious issues with inventory management and production planning by adding additional stocks. Due to a lack of resources, the semi-finished items are outsourced for a few processes before being returned to the manufacturer for completing procedures. The essay is based on mathematical modeling and process outsourcing optimization that takes into account variable quantity and faulty manufacturing for efficient supply chain management. Based on data collected from the industry, a numerical experiment was conducted to test the suggested outsourcing-based SCM paradigm. The findings are important for determining the best production and outsourcing quantity at the lowest possible total SCM cost. To determine how relevant the impact of input parameters on the overall cost is, a sensitivity analysis was carried out. The study makes a significant mathematical contribution to the development of a process outsourcing model for SCM. The research study helps managers determine whether process outsourcing is economically feasible for handling inventory and the supply chain between a manufacturer and an outsourced partner.

Keywords: process outsourcing; inventory management; imperfect production; mathematical modeling; supply chain management

Introduction

In the current socioeconomic environment, outsourcing is a production method that is widely used all over the world. The market is saturated in terms of product diversity and product life cycle, making it difficult to compete in this technologically advanced era. Additionally, an organization must concentrate on specialized procedures and outsource other tasks in order to exploit the rival. Today, it is challenging to satisfy all client expectations; as a result, the primary goal of outsourcing should be to increase flexibility and free up the company to concentrate on its core competencies. Initially, businesses would typically outsource non-specialized tasks, but with changing times, it is now possible to outsource any task, regardless of whether it is specialized or not. Due to a number of benefits, including a minimal initial investment, cost savings, and improved customer services, outsourcing has gained the focus of enterprises. The basic production order quantity model makes the assumption that every single lot of products produced is defect-free, although in actual productions, some defective items do exist. To assure high-quality products, some of these damaged products are eliminated while others are reconditioned. A corporation in Japan that designs anime figures and outsources its production tasks to its CM is an example of outsourcing. They hire someone else to do the coloring, which is a challenging task and normally takes longer to finish the copied figure. This corporation outsources its operations to a CM, who brings down the expected cost by around 25%. The epitome of economic globalization is outsourcing in the supply chain (SC), which decentralizes the SC and presents the OPM with unpredictability. A Deloitte poll from a few years ago showed that about 71% of 600 executives from international companies believe that SC risk has a substantial impact on the company's strategic decisions. Because of the technological edge in industrialized nations, the original product manufacturer (OPM) in particular designs a new product.

Later, it contracts with a manufacturer from a developing nation to handle its manufacturing. The benefits are clear, including the release of capital, the decrease in labour costs, and the increase in worker productivity. Many academics have tried to cope with yield uncertainty, and they often represent it in a multiplicative way. These researchers, however, made an unrealistic assumption that is physically impossible: that the number of goods produced will always be exactly equal to the quantity ordered. The Requisite items might not be available in a production setting that uses a make-to-order situation. However, in other study projects, the researchers have chosen their own manufacturing and order amount. In these circumstances, optimizing the production and order quantity are both crucial. There is a lot of research on product outsourcing, but very little on process outsourcing

and the creation of its mathematical model. The project's goal takes into account the outsourcing process in a problematic setting in order to optimize and save costs. Outsourcing is necessary for businesses with limited resources to meet client demands. The mathematical models for the supply chain are also created and evaluated using the data in the proposed research, giving the decision-makers a platform to reduce total cost by optimizing the lot size and outsourced quantity.

Using mathematical models

To handle the inventory and production control by modeling process outsourcing operations, a supply chain management model was designed, taking manufacturer and multi-vendor into consideration. Mathematical modeling includes the assumptions, notations, and model formulation.

Assumptions The following presumptions are taken into account before moving forward with the modeling: Due to a lack of internal resources, the manufacturer outsources some operations; the customer demand is only satisfied in phase 3; the demand and production rates are known and constant; only one type of item is taken into account in the model; the raw material holding cost per unit item is lower than the unit holding cost of work in progress; and there are no shortages because phase A has a higher production rate than phases 2 and 3, which are both higher than phase 3. (P1 > Pvi> P3 > D);

- The inspection is carried out during the production and rework phases;
- The scrape is zero in both the production and rework phases;
- The rate of reworking is the same as the production rate;
- Inventory holding costs are based on the average inventory;
- The screening cost is regarded as insignificant in this model.

$$TC = TC_m + \sum TC_{vi}$$

In addition,

$$\sum TC_{vi} = TC_{v1} + TC_{v2} + TC_{v2} + \ldots TC_{vn}$$

The cost of manufacturer is given as

$$TC_m = S_m + PC_m + H_m + CE_m + IC_m$$

Similarly, the cost of the ith vendor will be

$$TC_{vi} = S_{vi} + M_{2i} + H_{vi} + CE_{vi} + IC_{vi}$$

where $i = 1, 2, 3, \ldots, n$.

Cost of the Outsourcer and the Manufacturer

Phases 1 and 3 comprise the two divisions of the manufacturing process. Each phase has its own set of expenses. The manufacturing cost includes the setup cost, production cost, holding cost, carbon emission cost, inspection cost, and rework cost.

Setup Fees

There is no relationship between quantity or time and this fixed cost. This cost covers expenses for things like tool setup, switchovers, and other things. It is the price of initially setting up the production system. Costs of setup for manufacturers are determined by:

$$S_m = \frac{s_m \times D}{Q}$$

Similar to this, vendors' setup fees can be displayed as

$$S_{vi} = \frac{s_{vi} \times D}{Q}$$

Cost of Manufacturing and Rework

The demand for manufactured items is the main factor affecting this cost. This cost includes all processing, machine, labour, and material costs. The manufacturing cost per unit item and the reworks cost per unit item are taken to be equal for the same phase. The production and rework expenses for stages A and C are consequently given.

Cost of Phase A manufacturing

$$M_1 = m_1 \times D \times (1 + \alpha_1)$$

Phase C Manufacturing Cost

$$M_3 = m_3 \times D \times (1 + \alpha_3)$$

Manufacturing and rework cost for outsourcer is given

$$M_{2i} = m_{2i} \times D(1 + \alpha_{2i})$$

Holding Charge

The expense associated with maintaining an inventory of raw materials, semi-finished goods, and finished goods is known as the holding cost. The price of transporting semifinished items between the manufacturer and the supplier is also included in this cost.

$$H_m = \frac{Q}{2}(h_m X + h_{r1} + h_{r3})$$

where

$$\zeta = \left\{D\frac{(1-\alpha_1)}{P_1}\right\}(1+2\alpha_1) + \frac{\alpha_1^2 D}{P_1} + \left(1 - \frac{D}{P_1} - \frac{\alpha_1 D}{P_1}\right) + \frac{D}{P_3}\left(1 - \frac{D}{P_3} - \alpha_3\right)(1+2\alpha_3) + \frac{\alpha_3^2 D}{P_3}\left(1 - \frac{D}{P_3}\right) + \left(1 - \frac{D}{P_3} - \frac{\alpha_3 D}{P_3}\right)^2$$

For each of the three phases, the holding cost's derivation is provided in Appendix B. The holding cost of outsourcers is also provided.

$$H_{vi} = \frac{Q}{2}(h_{vi} Y_i + h_{r2i})$$

where $i = (1, 2, 3)$, and

$$Y_i = \frac{Q_{2i}}{2}\left\{\frac{D(1+\alpha_{2i})}{P_{2i}}(1+2\alpha_{2i}) + \frac{\alpha_{2i}^2 D}{P_{2i}} + \left(1 - \frac{D}{P_{2i}} - \frac{\alpha_{2i} D}{P_{2i}}\right)\right\}$$

Cost of Carbon Emissions Carbon emissions take place during the production process. Not only the government and businesses are very concerned about reduced carbon emissions, but consumers increasingly want eco-friendly goods. For managerial considerations, this production model adds costs related to carbon emissions. The cost of carbon emissions per unit of output might be represented for the manufacturer.

$$CE_m = e_m \times f_m \times D$$

For outsourcers, it is shown by

$$CE_{vi} = e_{vi} \times f_{vi} \times D$$

Conclusion

Mathematical models have been developed to successfully coordinate supply and inventory between a manufacturer and many vendors. The optimization of production volume and outsourcing volume reduces the supply chain's overall cost. The vendor is contracted to provide the parts, which are then returned to the manufacturer for further processing. For efficient SCM, the process has been modeled and optimized. One of the key contributions of the proposed research is the process outsourcing model, which is crucial for the comprehension of managers and decision-makers about managing the optimal production quantity and optimal outsourcing quantity among various vendors. At the bottom end of the manufacturer, additional inventory is produced, which well managed and regulated using mathematical is modeling for the orderly flow of goods in SCM. The suggested manufacturer and vendor-based SCM model the defect. All production and outsourced amounts are inspected, and any defective goods are then redone. The vendor's marginal rate is also very important for managing the outsourcing operation in SCM, and the cost of carbon emissions has an intermediate impact on the total cost, while other factors all have a very low impact on the total cost of SCM, according to the sensitivity analysis, which demonstrates a significant relationship. The managers must understand the important cost parameters for SCM outsourced management.

References

1. Jaber, M.Y.; Zanoni, S.; Zavanella, L.E. Economic order quantity models for imperfect items with buy and repair options. Int. J. Prod. Econ. 2014, 155, 126–131.
2. Shaban, A.; Costantino, F.; Di Gravio, G.; Tronci, M. A new efficient collaboration model for multi-echelon supply chains. Expert Syst. Appl. 2019, 128, 54–66.
3. Tang, S.; Wang, W.; Zhou, G. Remanufacturing in a competitive market: A closed-loop supply chain in a Stackelberg game framework. Expert Syst. Appl. 2020, 161, 113655.
4. Hilletofth, P.; Hilmola, O.P. Role of logistics outsourcing on supply chain strategy and management: Survey findings from Northern Europe. Strateg. Outsourcing Int. J. 2010, 3, 46–61.
5. Kumar, M.; Vrat, P.; Shankar, R. A fuzzy goal programming approach for vendor selection problem in a supply chain. Comput. Ind. Eng. 2004, 46, 69–85.

6. Amid, A.; Ghodsypour, S.; O'Brien, C. A weighted additive fuzzy multiobjective model for the supplier selection problem under price breaks in a supply chain. Int. J. Prod. Econ. 2009, 121, 323–332.
7. Rezaei, J.; Davoodi, M. A deterministic, multi-item inventory model with supplier selection and imperfect quality. Appl. Math. Model. 2008, 32, 2106–2116
8. Karpak, B.; Kumcu, E.; Kasuganti, R.R. Purchasing materials in the supply chain: Managing a multi-objective task. Eur. J. Purch. Supply Manag. 2001, 7, 209–216.
9. Scott, C.; Lundgren, H.; Thompson, P. Guide to Outsourcing in Supply Chain Management. Guide Supply Chain Manag. 2018, 2, 189–202. 18. Shy, O.; Stenbacka, R. Strategic outsourcing. J. Econ. Behav. Organ. 2003, 50, 203–224
10. Behara, R.S.; Gundersen, D.E.; Capozzoli, E.A. Trends in information systems outsourcing. Int. J. Purch. Mater. Manag. 1995, 31, 45–51.
11. Chiu, S.W.; Liu, C.J.; Li, Y.Y.; Chou, C.L. Manufacturing lot size and product distribution problem with rework, outsourcing and discontinuous inventory distribution policy. Int. J. Eng. Model. 2017, 30, 49–61.
12. Jamal, A.M.M.; Sarker, B.R.; Mondal, S. Optimal manufacturing batch size with rework process at a single-stage production system. Comput. Ind. Eng. 2004, 47, 77–89.
13. Sarkar, B.; Cárdenas-Barrón, L.E.; Sarkar, M.; Singgih, M.L. An economic production quantity model with random defective rate, rework process and backorders for a single stage production system. J. Manuf. Syst. 2014, 33, 423–435.
14. Cárdenas-Barrón, L.E. Economic production quantity with rework process at a single-stage manufacturing system with planned backorders. Comput. Ind. Eng. 2009, 57, 1105–1113.
15. Widyadana, G.A.; Wee, H.M. An economic production quantity model for deteriorating items with multiple production setups and rework. Int. J. Prod. Econ. 2012, 138, 62–67.
16. Sarkar, B.; Sana, S.S.; Chaudhuri, K. An imperfect production process for time varying demand with inflation and time value of money—An EMQ model. Expert Syst. Appl. 2011, 38, 13543–13548.
17. Taleizadeh, A.A.; Sari-Khanbaglo, M.P.; Cárdenas-Barrón, L.E. Outsourcing rework of imperfect items in the economic production quantity (EPQ) inventory model with backordered demand. IEEE Trans. Syst. Man Cybern. Syst. 2017, 49, 2688–2699.
18. Alvarez, L.H.; Stenbacka, R. Partial outsourcing: A real options perspective. Int. J. Ind. Organ. 2007, 25, 91–102.
19. Benaroch, M.; Webster, S.; Kazaz, B. Impact of sourcing flexibility on the outsourcing of services under demand uncertainty. Eur, J. Oper. Res. 2012, 219, 272–283.

20. Inderfurth, K.; Kelle, P. Capacity reservation under spot market price uncertainty. Int. J. Prod. Econ. 2011, 133, 272–279