International Business Management 8 (6): 353-356, 2014
ISSN: 1993-5250

Aggregate Planning for Minimizing Costs: A Case Study of PT XYZ in Indonesia

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Abstract: The rapid growth of educational toy industry has lead to a fierce competition. PT XYZ is one of the major players in educational toy industry Indonesia currently trying to win the industry. The company needs to develop a good strategy for competitive advantage in winning the competition. The objectives of this study are to calculate the seasonal forecasted demand and develop aggregate production planning for PT XYZ to meet seasonal demand with the lowest cost. The data is gathered through literature review and secondary data directly from the company. The demand data from past 3 years is used to forecast the seasonal demand using multiplicative seasonal model. All of data is analyzed and used to design aggregate planning by using 3 strategies which are chase, level and mixed strategy. The calculation of the cost of each strategy is using manual computation and application POM for Windows. The results of this study show that the mixed strategy is the optimal strategy to meet demand with the lowest cost for PT XYZ.

Key words: Aggregate planning, seasonal demand, forecast demand, educational toy industry, optimai strategy

INTRODUCTION

The demand for educational toys has been steadily increasing, as the income per capita increasing in Indonesia. Parents naturally prefer educational toys, as opposed to common toys. The educational toy industry is growing rapidly with sales of educational toy during the 1st semester in 2012 has reached about USD 60 million. It was increased about 15% from previous year. This leads to the growth of educational toys industry and at the same time increases the competition among them. In 2012, there are 84 toy companies that registered in Indonesia and the number keeps growing. In addition to big companies, many small firms also start to join the business. There are, also some foreign competitors like China that sells toys with very cheap has already entered the market in Indonesia.

PT XYZ is one of major local companies that engaged in educational toys industry in Indonesia. Their most popular product is Fun Doh Modelling Compound which is wax similar toys that can be formed and modified as desired. The strength of the products is designed to be safe and non-toxic for children. PT XYZ sells its products through distributors, wholesalers and retailers. PT XYZ is facing difficulty in fulfilling uncertain demand of its main product which is Fun Doh Modelling Compound (hence, forward will be referred as Fun Doh). The variation of demand pattern make it difficult for the company to set production strategy that will meet all demands while minimized costs.

So far PT XYZ manufactures the products, according to customers demand without much of the analysis. This is most of the traditionally family owned company operated in Indonesia. Many complaints are already received by the company due to the lateness of Fun Doh product arrival. If this problem continue, customers will lose their trust and essentially will go to the companies that possibly are the competitors of PT XYZ. This research is to analyze previous demand data and to forecast future demand and develop optimal production strategy for meeting all demand while maintain minimum cost, so as to gain a more sustainable profitable business of PT XYZ.

Literature review: Operations management is one of the 3 major functions of any organization and it is integrally related to all the other business functions. All organizations market (sell), finance (account) and produce (operate) and it is important to know how the operations management activity functions (Heizer and Render, 2011). To achieve competitive advantage, operations managers must have good plan for production. Competitiveness is how effectively an organization meets the want and needs of customers relative to others that offer similar goods and services (Stevenson, 2009). It's hard for organization to meet demand because demand keeps changing. So, organization can do demand forecasting for next production.

Forecasting demand can address short-range, medium-range and long-range problems. Long-range

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forecast help managers deal with capacity and strategic issues and are the responsibility of top management. Top management formulates policy-related questions, such as facility location and expansion, new product development, research funding and investment over a period of several years. Medium-range planning begins once long-term capacity decisions are made. This is the job of operations managers. Scheduling decisions address the problem of matching productivity to fluctuating demands. Medium (or intermediate) range planning is accomplished by building an aggregate production planning. Short-range planning may extend up to a year but is usually <3 months. This plan is also the responsibility of operations personnel who work with supervisors foremen to disaggregate the intermediate plan into weekly, daily and hourly schedules. Tactics for dealing with short-term planning involve loading, sequencing, expediting and dispatching.

Forecasting: Forecasting is necessary because all organizations operate in an atmosphere of uncertainty but decision must be made today that affect the future of organization (Hanke and Wichern, 2009). Forecasting is an estimation of future level from the past data that is used to make decision within company in uncertainty condition.

There are some approaches forecasting. There are 2 general approaches for forecasting, such as qualitative and quantitative approach. In this research, the researcher is not using qualitative methods. There are 2 categories in quantitative which are:

- Time series model predict on the assumption that the future is a function of the past. These models use past data to forecast the future data
- Associative models incorporate the variables or factors that might influence the quantity being forecast

In understanding seasonal variations, it is important for capacity planning in organizations that handle peak loads. Seasonality is expressed in terms of the amount that actual values differ from average values in the time series. Analyzing data in monthly or quarterly terms usually makes it easy to spot seasonal patterns, seasonal indices was developed by using a multiplicative seasonal model (Krajewski *et al*., 2007). The steps of multiplicative seasonal method are (Heizer and Render, 2011):

- Find the average historical demand each month by summing the demand for that month in each year and dividing by the number of years of data available
- Compute the average demand over all months by dividing the total average annual demand by the number of seasons
- Compute a seasonal index for each season by dividing that month's actual historical demand (from step 1) by the average demand over all months (from step 2)
- Estimate next year's total annual demand
- Divide this estimate of total annual demand by the number of months and then multiply it by the seasonal index for that month. This provides the seasonal forecast

Aggregate planning: In an open operational system, the organization must adopt operational practices which are consistent with the open system orientation (Lisboa *et al*., 2012). The open system organization must be able to read the competitive environment in order to determine the demand which reflects the customers timely requirements. Once the demand is determined, the organization must arrange operational plans to meet the demand. Aggregate Production Planning (APP) is the process which generates and evaluates these plans.

Aggregate Production Planning (APP) has received much interest from both the industrial and academic fields and aims to identify production (Liu *et al*., 2011). Inventory and work force levels to meet fluctuating demand requirements over an intermediate-range planning horizon (Jacobs and Chase, 2011). Various approaches have been developed to formulate and resolve the corresponding problems within the manufacturing context. In manufacturing industries, Aggregate Production Planning (APP) is used to best utilize human and equipment resources to meet fluctuating customer demand.

Most aggregate planning methods determine a plan that minimizes cost. These methods assume that demand is fixed; therefore strategies for modifying demand are less considered (Schroeder, 2008). When demand is considered given, the following cost should be included:

Hiring and layoff costs: The hiring cost consists of the recruiting, screening and training cost required to bring new employee up to full productive skill. The layoff cost includes employee benefits, severance pay and other costs associated with layoff.

Overtime and under time costs: The overtime costs often consist of regular wages plus a 50-100% premium. The cost of under time is often reflected by the use of employees at less than full productivity.

Inventory-carrying cost: Inventory-carrying costs are associated with maintaining the product in inventory; they include the cost of capital, variable cost of storage, obsolescence and deterioration.

Subcontracting costs: The cost of subcontracting is the price that is paid to a subcontractor to produce the units. Subcontracting costs can be either more or less than the cost of producing units in-house.

Part-time labor costs: Because of differences in benefits and hourly rates, the cost of part-time or temporary labor will probably be less than that of regular labor.

Cost of stock out or back order: The cost of taking a back order or the cost of a stock out should reflect the effect of reduced customer service. This cost is extremely difficult to estimate but it can be related to the loss of customer good will and the possible loss of future sales.

Planning strategy: There are 2 strategies which are chase and level strategy. When just one of these strategy is used to absorb demand fluctuations, it is termed a pure strategy; 2 or more strategy used in combination called a mixed strategy (Jacobs and Chase, 2011).

Chase strategy is a strategy to achieve output rates of each period that match the demand forecast for that period. The chase strategy that is also called just-in-time, tries to adjust production to meet demand. A chase strategy adjust the labor inputs in order to track the expected monthly demands (Radwan and Aarabi, 2011). Common tactics for varying capacity are overtime or under time, hiring or firing and subcontracting some work out (Buxey, 2005). This strategy can be accomplished by changing workforce level, varying work hours or subcontracting. The main purpose of this strategy is to meet demand in each period with any possible ways. The inventory cost in this strategy is low. However, it results in high training cost, overhead cost and high hiring and firing cost.

A level strategy is an aggregate plan in which the company produce the same amount of product from period to period. A level strategy maintains a constant daily (aggregate) production rate and draws upon stockpiles of finished goods whenever monthly outputs dip below their matching sales marks. In addition, a level strategy prefer to produce same level of output that can be saved to cover the shortfall in other periods which means using constant workforce in constant work hours. It results in high inventory cost but the cost of employee is constant. The strategy also called just-in-case, it basically moderates the fluctuations, holding inventory or placing backorders as needed levels.

Mixed strategy is the combination of 2 or more alternatives. Normally, a certain combination of level and chase strategy (a mixed strategy) minimizes the total marginal (labor-inventory) cost summed over a 12 months horizon. Mixed strategy can incorporate management policies imposed by PT XYZ, like no >5% can be laid off (Russell and Taylor, 2011).

MATERIALS AND METHODS

This research is applied research conducted at PT XYZ in operations area. This research used secondary data from the company and data from literature review. The researcher uses multiplicative seasonal model to forecast the seasonal demand. In determining the aggregate planning strategy, the researcher uses 3 planning strategies, such as chase, level and mixed strategy to evaluate which is the optimal strategy. The planning strategies is calculated using manual calculation and POM for Windows application software.

Based on the data collected, the researcher calculated the seasonal forecasted demand. This is the result of seasonal forecasted demand using multiplicative seasonal method (Table 1).

After obtaining the seasonal forecasted demand for 2014 which is then followed by the development of production strategies and its associated costs. There are 3 strategies that researcher consider on this stduy are: chase, level and mixed strategy.

Chase strategy: Chase strategy is strategy to produce the amount of products of each month that match the demand forecast for that month. In this strategy, there is no inventory cost. The company must produce the exact amount of product that match demand through regular production, overtime production and also subcontracting.

Level strategy: The 2nd strategy is to produce the same amount of products each month during 1 year. The total demand in 2014 is 498.384 units, so every month PT XYZ must produce 41.532 units. There will be high inventory

Table 1: Seasonal forecasted demand

Months	Seasonal index	Average demand of 2014	Seasonal forecasted demand
January	0.947235	41532	39,341
February	1.286029	41532	53,411
March	0.827944	41532	34,386
April	0.582196	41532	24,180
May	1.156805	41532	48,044
June	1.349606	41532	56,052
July	0.979234	41532	40,670
August	0.739607	41532	30,717
September	0.885271	41532	36,767
October	1.023292	41532	42,500
November	0.963436	41532	40,013
December	1.259345	41532	52,303

Result of data processing

Table 2: Summary production planning strategies and associated costs

Strategies	Regular production	Overtime production	Sub-contract	Shortage	Inventory	Time in meeting demand	Total cost (Rp)
Chase	✓	✓	✓			On time	436.195,210,00
Level	✓	✓		✓	✓	Not always on time	443.817,313,00
Mixed	✓	✓			✓	On time	427.202,916,00

and shortage cost. When the company produce more than the demand, there will be many inventories. When the company produce less than the demand, there will be shortage cost because customer cannot get the products.

Mixed strategy: The mixed strategy is mixing chase and level strategy, taking into account the advantages and disadvantages of chase and level strategy with the aim to reduce the negative effects of alternative pure strategy previously offered. The point is to produce suit to production capacity of regular time, overtime and subcontract and still fulfill the demand every month with minimum costs. In this study, the researcher uses the transportation method to search for optimal solution.

RESULTS AND DISCUSSION

It can be seen that from all 3 strategies, mixed strategy aggregate planning is the most optimal strategy of aggregate planning for PT XYZ problem with total costs of Rp 427.202,916,00 (Table 2).

CONCLUSION

Based on the analysis that has been discussed earlier, it can be concluded as follows:

- Fun Doh's seasonal demand in 2014 is forecasted using multiplicative seasonal method by determining the seasonal index each month from the past 3 years data. The highest demand of the year is in June where the holiday starts. The lowest demand of the year is in April
- There are 3 strategies that are being considered in this study. They are chase, level and mixed strategy options. The mixed strategy is the best option for the company with the lowest cost of Rp 427.202,916,00

RECOMMENDATIONS

From the result of this study that have been described earlier, the researcher is up on some recommendations as after:

- PT XYZ should always forecast the demand rigorously because educational toy is a very seasonal demand product. A good forecasted demand will enable the company to set a better strategy of production planning
- For 2014 and the year after, the best solution is the mixed strategy that consequently the company should consider to change the policy to impose overtime working policy as needed
- This study is limited to one product which is the major or biggest product at PT XYZ. For future study, the researcher suggests to do aggregate planning for all products in the company to see overall optimal production strategy

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