UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN APPLICATION OF LINEAR PROGRAMMING IN AGGREGATE PLANNING: A CASE STUDY AT ELECTRONIC COMPANY

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) with Honours.

by

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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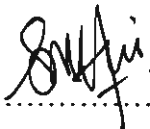Karung Berkunci 1200, Ayer Keroh
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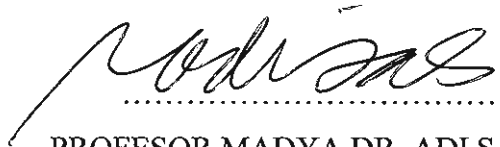
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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) with Honors. The member of the supervisory committee is as follow:

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ABSTRACT

The project discuss about Aggregate Planning in one of a communication manufacturing company in Melaka. The company produces communication device, among the products is a pager. The company under study needs to improve their customer demand to meet the delivery schedule in an expected period at the same time minimize the production cost. One of the approaches to improve this problem is through applying linear programming method. The objective of this research is to optimize utilization of plant capacity, reduce overall inventory, and balance the use of workers and production cost. Linear Programming was used in this research to optimize production cost of the aggregate planning of the pager with considering of constraints: plant capacity, demand, inventory and workers. Some alternative scenario of production plan were developed; the best alternative is selected by finding an optimal solution which provides minimizing cost, maximizing capacity, minimizing inventory and maintaining a stable work force.

ABSTRAK

Projeck ini membincangkan tentang perancangan dan kawalan pengeluran di salah satu syarikat pembuatan komunikasi di Malaka. Syarikat tersebut menghasilkan alat-alat komunikasi dan salah satu daripadanya ialah pager. Syarikat yang dikaji ingin memperbaiki kepuasan pelanggan dengan mengikut jadual penghantaran dan hantar pada masa yang dijangkakan. Salah satu pendekatan untuk memperbaiki masalah ini adalah melalui kaedah linear programming. Objektif-objektif dalam kajian ini ialah mengoptimumkan penggunaan kapacity kilang, mengurangkan inventori secara keseluruhan, mengimbangkan penggunaan pekerja, dan kos pengeluaran. Linear programming telah digunakan dalam kajian ini dan bertujuan untuk mengoptimumkan kos pengeluaran dalam perancangaan pengeluaran pager dengan mempertimbangkan kendala seperti kapasiti kilang, permintaan pelanggan, inventori dan pekerja. Beberapa alternatif senario dalam rancangan pengeluaran telah dicadangkan dan alternatif yang terbaik telah dipilih dengan mencari penyelesaian yang optimum dengan meminimumkan kos, memaksimumkan kapasiti, meminimumkan inventori dan mengekalkan tenaga kerja yang stabil.

DEDICATION

I dedicate this report to my parents. Without their patience, understanding, support and most of all love, the completion of this work would not have been possible. Their gentle but firm direction has been most appreciated. So, I would like to thanks for my father and mother. Their guidance, understanding and love have always been an inspiration. Thank you.

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LIST OF ABBREVIATIONS

APP	-	Aggregate Production Planning
DM	-	Decision Maker
DSS	-	Decision Support System
ETA	-	Estimated Time of Arrival
ETD	-	Estimated Time of Delivery
JIT	-	Just-In-Time
LDR	-	Linear Decision Rule
LP	-	Linear Programming
MCMILP	-	Multiple Criteria Mixed Integer Linear Programming
MILP	-	Mix Integer Linear Programming
MPMP	-	Multi Period Multi Product
MRP	-	Material Requirements Planning
MS	-	Microsoft Office
OT	-	Overtime
PLP	-	Possibilistic Linear Programming
PPLICS	-	Limited Inventory Capacity and Allowed Stockout
PSH	-	Production Switching Heuristic
PSM	-	Projek Sarjana Muda
PVC	-	Polyvinyl Chloride
RHS	-	Right-hand Side
UK	-	United Kingdom
UTeM	-	Universiti Teknikal Malaysia Melaka
WIP	-	Work in Progress

CHAPTER 1

INTRODUCTION

This research is focus on the production planning at a communication manufacturing company, ABC Sdn. Bhd. Currently, the communication manufacturing company faces a production planning problem which did not meet customer demand. In this chapter, it commences with the background which introduces to reader the concepts of production planning and thereafter associated problems are highlighted. The objectives and scope are outlined and then lead the way for the purpose of this project report. This chapter ends with organization report which will briefly explain the flow of this report.

1.1 Background

Production planning is use to determine the quantity and timing of the production for intermediate future. The planning time horizon is from three to eighteen months ahead. Operations managers responsible to plan for the production by adjusting production rates, labour level, overtime work, inventory level, subcontracting rates and other controllable variables to get the best way to meet forecasted customer demand. Aggregate is a part of production planning implies that an aggregate plan, which is a combination of appropriate resources into general, or overall terms. The planner needed to select the rate of output for a facility over the next three to eighteen months by using the related input; for example, a given forecasted customer demand, inventory levels, workforce size and facility capacity (Heizer, J. and Render, B., 2008).

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The key choice of production planning is what planning decisions that need to be included in the model. According to the definition of production planning, production planning models include the decisions on production and also the inventory quantities. The identification of the relevant costs is also and crucial issue in the production planning. The costs involve in the production planning is important and it needs to determine the variable production costs, including inventory holding costs, setup-related costs, and any relevant resource acquisition costs. Other than those costs, there might also the cost that associated with imperfect customer service, such as when the demand of customer is backorder. There is a backordered cost that the company should pay. (Kok, A.G. and Graves, S.C., 2003).

Aggregate planning stats with a forecast of aggregate demand for the intermediate range and follow by a general plan. The plan is use to meet demand requirements by setting output, employment, and finished-goods inventory levels or service capacities. Operation managers might general a number of plants and each of the plans must be examined in light feasibility and low cost. A plan that is reasonably good but has minor difficulties, it may be reworked; while a poor plan should be discarded. The alternative plans will be considered until an acceptable one is achieved. The output of aggregate planning is normally a production plan. The aggregate plans are periodically updated. It always does account updated forecasts and other changes monthly. Thus, this result in a rolling horizon that is the aggregate plan always covers the next 12-18 months (Stevenson, W.J., 2007).

There will be a production problem when there are limited production resources that cannot be stored from period to period. Hence, choices must be made. The options that we need to consider are, resources to include and how to model their capacity and behavior, and their costs. Other than that, there may be uncertainty associated with the production function that we need t consider. The example of uncertainty is the uncertain yields or lead times. Once might only include the most critical or limiting resource in the planning problem, that is a bottleneck. Alternatively, when there is not a dominant resource, then one must model the resources that could limit production (Kok, A.G. and Graves, S.C., 2003).

The intention of aggregate plan is to satisfy customer demand in terms of maximizes profit for the firm. Aggregate planning is done for a given supply chain design. This means that capacity of the various facilities in the supply chain is constraints now. However demands are predictable or predicted variability for period to period in the planning time horizon. Furthermore, there is a demand variation which cannot be predicted. Aggregate plan is made to obtain a minimum cost plan from the estimated demand and given supply chain constraints. The meaning of aggregate planning problem is forecast the customer demand for each period in the planning horizon, determine the production level, capacity level, inventory level and the workforce level for each period that maximize the firm's profit over the planning horizon. In addition, to extent variation is possible like number of shift and overtime (Chopra, S. and Meindl, P., 2007).

Usually, aggregate planning is aim to minimize costs over the planning time horizon. However, other strategic issues may be more important than cost. These strategies may be to smooth employment levels, to drive down inventory levels, or to meet a high level of service. When generating an aggregate plan, the operations manger must think of the answer from several questions. The manager needs to think of that should inventories be used to absorb changes in demand during the planning period? Should changes be made by varying the workforce size? Should overtime and idle time given to absorb fluctuation or part-timers be used? Should subcontractors be used on fluctuating orders so that a stable workforce can be maintained? Should prices or other factors be changed to influence demand? (Heizer, J. and Render, B., 2008).

1.2   Problem Statement

Production planning and control is one of the manufacturing strategies that represent the beating heart of manufacturing. An industry, that lack of proper production planning and control is just like a bank without bank manager. Most of the manufacturing industry ignore and lack of sufficient knowledge, study and proper skill about the production planning and control. Thus, it always bring a lot if problem to the organization, such as low productivity, low efficiency, problem about

movement of material, poor inventory control, and did not meet the customer demand. Currently, ABC Sdn. Bhd., a communication manufacturing company wants to improve their customer demand and customer satisfaction by providing products delivery on the right time and right quantity. One of the possible method or technique may help the company to improve their performance is through proper production planning and control.

1.3   Objective

- To understand the aggregate planning in an electronic company.
- To formulate aggregate planning into linear programming method.
- To optimize the production cost based on production constraints.
- Select the best alternatives based on different production scenarios.

1.4   Scope of Study

This research mainly focuses on a communication manufacturing company which produces communication devices. The study include using a forecasted customer demand and orders for each period in the planning horizon to determine the production level, inventory level and the capacity level for each period that maximizes the firm's profit over the planning horizon. Production rate decision, process planning and capacity decisions, workforce decisions, and inventory scheduling decision will be made. Thus, this project will make a proper plan using linear programming base on the forecasted demand, develop alternatives and select the best alternative plan to obtain an optimal production planning. The capacities are match with demand requirements and minimize costs. This project only discusses on the production planning of pager and does not discuss on the production planning of other product.

1.5   Organization Structure

Chapter 1 is the introduction of the report, which shows the background of the project and states the problem statement, objectives, and scope of the project. Other than that, it briefly explains the whole organization of the report.

Chapter 2 is the literature review which describes the concepts, tools and techniques that related to this project. Previous case study and theories from different resources such as journals, website and books are included in this chapter. The information in this chapter included definition of production planning, strategies of aggregate planning and methods for aggregate planning.

Chapter 3 is the methodology of how this project is conducted; it describes the project planning in a flow chart. Moreover, the resources that involved in the methodology that is going to use in this project are pointed out. Lastly, a Gantt chart shows the project schedule.

Chapter 4 shows the current production planning of the company. The company background is represented in this chapter. Then, the procedure to collect the data, type of data collected and procedure to conduct production planning is explain in this chapter. The result which included data collection, data verification, and data analysis is presented in this chapter.

Chapter 5 is discussion which comment on the "Current state" production planning and "new" production planning implemented. The difference and effectiveness of new planning is then discussed.

Chapter 6 is the conclusion and recommendations; the report is summarized in this chapter and recommendations are proposed in order to improve the project in future.

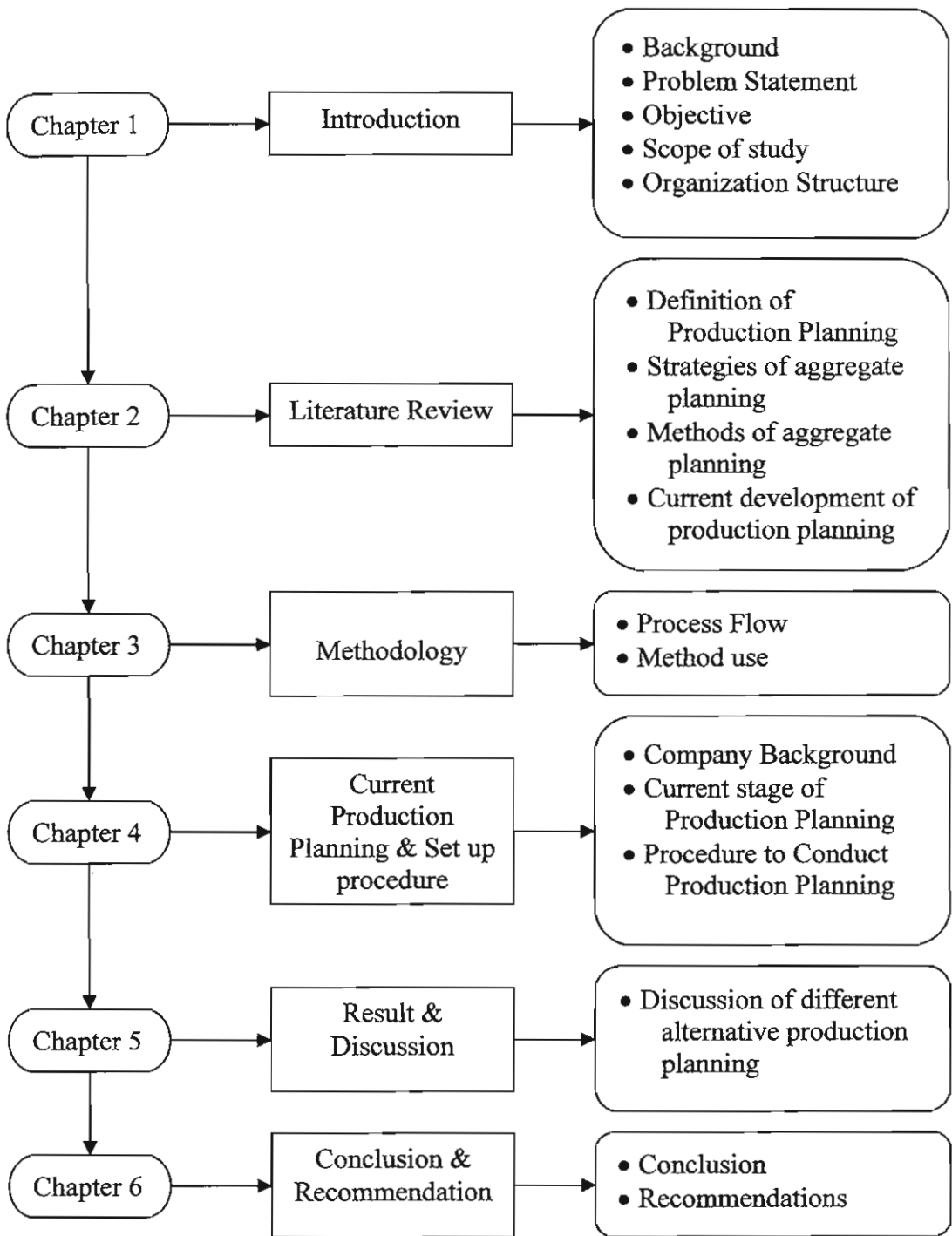All the organization structure of this report is shown in the Figure1.1 below.

Figure 1.1: Organization structure of report

CHAPTER 2

LITERATURE REVIEW

This chapter presents all the findings that are related to this project. Fully-referenced review from the relevant literature including the definition of aggregate production planning, production planning strategies, production planning methodologies and current development of production planning method are covered.

2.1   Definition of Aggregate Production Planning

Aggregate production planning (APP) gives the best way to meet the forecast demand in the intermediate future by adjusting regular and overtime production rates, inventory levels, labor levels, subcontracting rates, and other controllable variables. The planning is often from 3 to 18 months (Wang, R.C. and Liang, T.F, 2005). The target of aggregate plan is to optimize the production rate, the workforce level, and inventory in hand. Production rates relevant to the number of workers that needed for production. Inventory on hand defined as the balance of the unused inventory that leftover from the previous period (Chase, R.B. *et al.*, 2002).

Aggregate planning is a medium-range capacity planning that use to achieve a production plan which will effectively make use of the organization's resources to satisfy expected demand. The aggregate production planning not only determines the output levels planned but also the suitable or proper resource input mix to be used. Those decisions on output rates, employment level and changes, inventory levels and changes, back orders, and subcontracting must be made by the planners (Lin Pan. and Kleiner, B.H., 1995).

Aggregate planning might aim to influence demand as well as supply. Variables such as price, advertising, and product mix might be used to achieve it. Marketing, along with operations, will be intimately involved in aggregate planning if changes in demand are considered. Basically, aggregate planning is a big-picture approach to planning. Instead of focusing on individual products or service, they focus on overall, or aggregate, capacity. There are other corporate decision that closely related with aggregate planning; for example, budgeting, personnel, and marketing. There is strongest relationship to budgeting. Most budgets are based on suppositions about aggregate output, inventory levels, personnel levels, purchasing levels, etc. Thus, an aggregate plan should be the basis for initial budget development and for budget revisions as conditions warrant (Lin Pan. and Kleiner, B.H., 1995).

There are four things that needed for aggregate planning (Heizer, J. and Render, B., 2008):

- An overall unit for measuring sale and output that is logical.
- A forecasted demand for a reasonable intermediate planning period.
- A method that suitable to determine the costs.
- A model that involves the combination of forecasts and costs to make the scheduling decisions for the planning period.

2.1.1 Operations Planning Overview

Generally, demand forecasting can refer to short, medium and long range problems. Long-range planning is usually done annually, focusing on a horizon which is greater than one year. Intermediate-range planning typically accompanied with time increments that are monthly or sometimes quarterly in a period from 6 to 18 months, while a short range planning covers a period from one day or less to six months, with the weekly time increment (Chase, R.B. *et al.*, 2002).

Figure 2.1 below shows the positions aggregate panning relative to other major operations planning. Process planning and strategic planning are generally involved

in the long-range planning. Process planning generally determining the specific technologies and procedures required to produce a product or services while strategic capacity determining the long-term capabilities of the production system. The aggregate planning just place after strategic planning, and it is the medium-range planning (Chase, R.B. *et al.*, 2002).
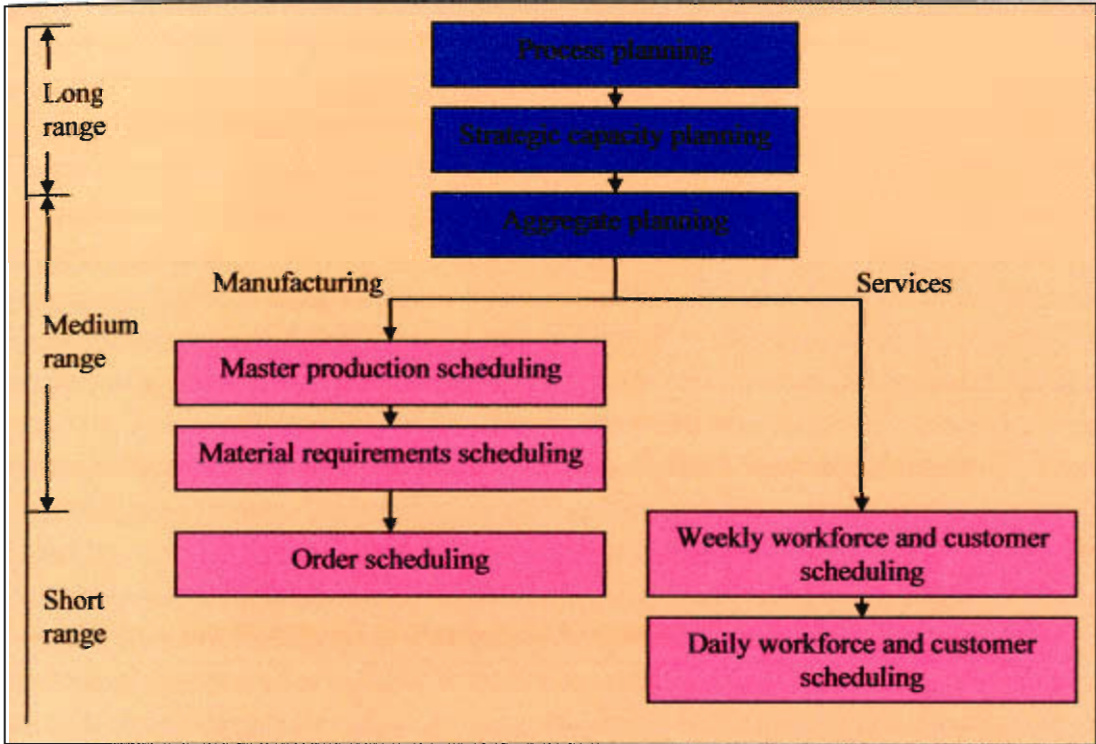

Figure 2.1: Overview of major operations planning activities (Chase, R.B. *et al.*, 2002)

Capacity and strategic issues are the responsibility of top management. With long-range forecast, it helps managers deal with it. Medium-range planning is the job of the operations managers which begins once long-term capacity decisions are made. Scheduling decisions refer to the problem of matching the productivity to fluctuating demands. All of those intermediate-range plans need to be consistent with the long-range strategy which come from the top executive and work within the resources allocated by the earlier strategic decisions. Medium-range planning is building an aggregate plan and short-range planning may extend up to a year but is mostly less than 3months. The short-range plans are the responsibility of operations personnel, supervisors and foreman to dispatching or disaggregate the intermediate plan into weekly, daily and hourly schedules. Figure 2.2 shows the planning sequence (Heizer, J. and Render, B., 2008).
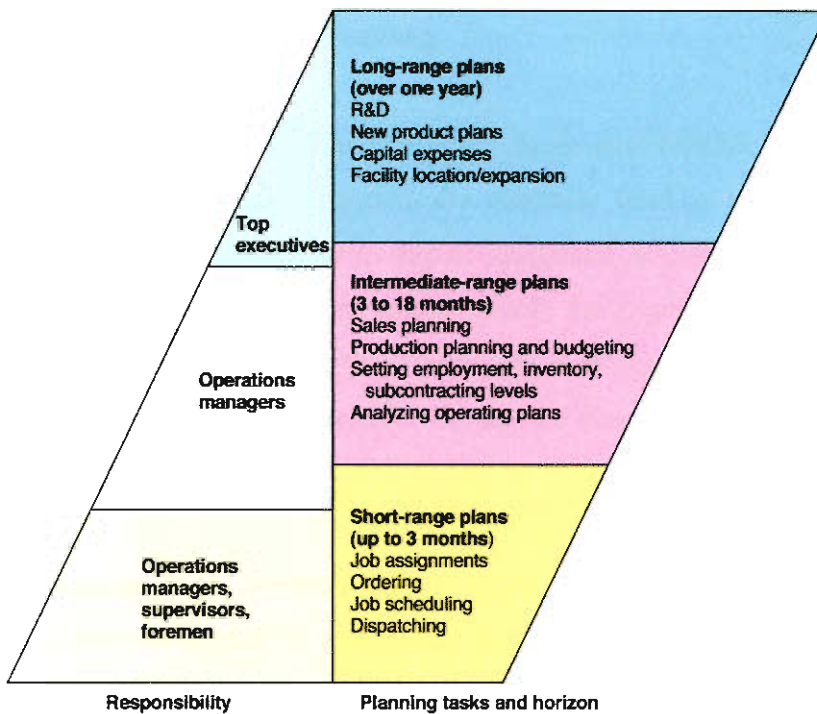
Figure 2.2: Planning tasks and responsibilities (Heizer, J. and Render, B., 2008)

2.1.2 The Characteristics of Aggregate Planning

To understand more about the aggregate planning, the characteristics of aggregate planning are shows below (Schroeder, R.G., 2000):

- About 12 months of time horizon, with periodically updating of the plan (perhaps monthly);

- An aggregate level of product demand consists of one or more categories of product and the product demand is assumed to be fluctuating, uncertain, or seasonal

- There is possibility of changing the supply and demand variables;

- A variety of management objectives which include low costs, low inventories, flexibility to increase future output levels, good labor relations, and good customer service

- Consists of facilities that cannot be expanded and consider fixed.

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