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Production Planning and Aggregate Production Planning

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Abstract:

Competition has a direct impact on the growth of the economy. Manufacturing systems can be improved by a well-thought-out production strategy. Problems with aggregate production planning and sales forecasting are leading an Installation Elevator Company to be unable to deliver items on time and have an impact on customer satisfaction. Studying and comparing forecasting methodologies used by installation businesses, as well as studying aggregate production scheduling in order to analyze and identify the lowest aggregate production costs, were among the goals of this study Aggregate production planning (APP) addresses two critical issues, labor level and inventory utilization, so that the variable needs from downstream processes may be met in a cost-effective manner with the work breakdown structure of all projects and their building strategies. To satisfy the changing needs of aggregate products, aggregate production planning is a planning and control procedure for all production processes. Determine production and inventory levels so that a limited labor and equipment can reduce total production costs on the other side, the goal of maintenance planning is to increase equipment efficiency in order to meet production demands.

Keywords — ***APP, planning, Aggregate Production, Production Planning, organization, APP Model.***

INTRODUCTION

An organization's manufacturing unit must have an integrated production planning and control system to ensure efficient, effective and economical operation. Once a product design has been tweaked and a production method has been refined, the next step is to plan production and monitor its progress. Low productivity, inventory management, and resource usage are addressed by production planning and control. Scheduling, dispatch, inspection, quality control, inventory management, supply management, and equipment management are all aspects of production planning. [1] In order for a company to meet its production goals, it must have a well-managed production control system in place.

Manufacturing planning and management is the process through which the company's resources are directed and aligned in order to meet the predetermined goals. An understanding of the flow of materials at the right moment and the need for consistency can be gained by using this kind of analysis. Prior to beginning actual production, a series of steps must be completed. Production planning, batch size, target distribution, and operation sequence all fall under this category. [2] There is a difference between production planning and production administration, which is responsible for making sure that all production plans are carried out in a timely manner. Planned scheduling of work, workload distribution among machines and people, and an appropriate work flow are all possible with production planning and control. Processing, on the other hand, is a planned action that transforms raw materials into useable products. For a show to be a success, there are many things to do. Human capital, financial resources, machinery, materials, and time are all examples of natural resources that can be utilized effectively. [3]

This planning technique seeks to determine the most efficient mix of production and labor for each

period throughout the medium term. Production levels for each product line will be predetermined so that they can adjust to changing demand as it arises. In production planning systems, APP is a fundamental component. As a result of aggregate planning, a plant's output can be maintained without interruption. A three- to 18-month time frame is usual for aggregate production planning. Aggregate planning encompasses not only individual production runs or the fabrication of individual items, but also all production activities inside a facility (or across numerous facilities for major corporations). [4] Since demand for individual items may fluctuate significantly, aggregate production planning helps businesses maximize resource utilization even in the face of these fluctuations.

In aggregate planning, the goal is to reduce operational expenses by balancing the needs of the market with the available resources. Aggregate plans outline exactly what resources are needed and when they should be purchased to keep costs down. As a manufacturer, your ultimate goal should be to maximize productivity at the lowest feasible price, which is what aggregate planning is all about. [5]

The prime objective of Aggregate Production Planning is to judge company policies and management inputs linked to operations, distribution and marketing, materials, accounting and finance, engineering and human resources to reduce the price and increase revenue, enhance customer service, lessen inventory investment, decrease changes in production rates, reduce changes in work-force levels, boost utilization of plant and equipment.

AGGREGATE PLANNING BENEFITS:

- Stabilizes manufacturing efforts
- Facilitates lean manufacturing
- Optimizes space and resource utilization
- Lowers operating costs
- Improves on-time delivery
- Improves supply chain relationships
- Raises customer satisfaction

AGGREGATE PLANNING STRATEGIES:

Companies can select from three different approaches to aggregation planning. Listed here are the details.

- **LEVEL STRATEGY:**

Maintaining an even production rate and labor size is the goal of the level approach. A strong demand forecast is needed in this strategy so that output can be increased or decreased in anticipation of a fall or increase in demand. Stable labor is an advantage of a level strategy. One of the drawbacks of a level strategy is the resulting rise in inventory and backlogs.

- **CHASE STRATEGY:**

Chase strategy, as the name suggests, aims to constantly adjust production to meet demand. Low inventory and backlogs are advantages of the chase strategy. The disadvantages include decreased output and quality, as well as a diminished labor pool. [6]

- **HYBRID STRATEGY:**

As the name says, hybrid strategy tries to find a middle ground between level strategy and chasing strategy.

COSTS RELEVANT TO AGGREGATE PRODUCTION PLANNING:

Basic production costs: material costs, direct labour costs, and overhead costs. It is customary to divide these costs into variable and fixed costs.

Costs associated with changes in the production rate: Costs involved in hiring, training, and laying off personnel, as well as overtime compensations.

Inventory related costs. Aggregate production planning models may be supportive as decision support systems and to appraise proposals in union negotiations.[7]

TECHNIQUES OF AGGREGATE PLANNING

Various techniques are used to perform the task of aggregate planning. Usually, there are two

categories: Informal trial-and-error techniques and mathematical techniques. In practice, informal techniques are more commonly used. However, a substantial amount of research has been done to mathematical techniques, but still, they are not as extensively used, they often serve as a basis for comparing the effectiveness of alternative techniques for aggregate planning.

There are several steps in general procedure for aggregate planning:

1. Determine demand for each period.
2. Determine capacities (regular time, overtime, subcontracting) for each period.
3. Identify company or departmental policies that are pertinent (e.g., maintain a safety stock of 5 percent of demand, maintain a reasonably stable workforce).
4. Determine unit costs for regular time, overtime, subcontracting, holding inventories, back orders, layoffs, and other relevant costs.
5. Develop alternative plans and compute the cost for each activity.
6. If satisfactory plans emerge, select the one that best satisfies objectives. Otherwise, return to step 5.

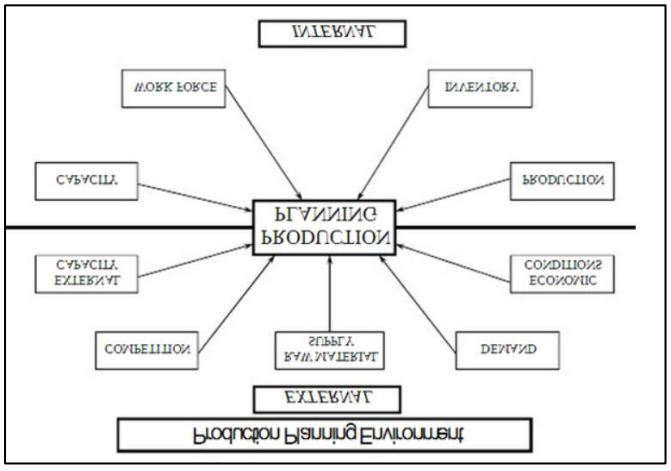


Fig. 1: Aggregate Planning Process

During the execution of the aggregate production plan, some parameters of the model may be altered such as demands, productivity rates, related costs, number of workers, and inventory levels. These parameters should be modernized regularly and the APP model is solved to resolve the revised aggregate production plan.[8]

STEPS INVOLVED IN PRODUCTION'S PLANNING AND CONTROLLING:

Having proper production planning and control operating systems in an organization makes it very easy to ensure a cost-effective manufacturing process, encourage timely delivery of goods, reduce overall time, satisfy customers, synchronize manufacturing with other department heads, and ensure that proper man is assigned the best tasks [6]. Production planning is at the heart of any industrial plant. Other tasks include material prediction, planned order processing, long-term management, infrastructure development, and other [9]. The PPC process begins with anticipating a product's demand and then creating a production plan to meet that require in order progressing the product advancing. Production planning is a method of organizing a series of actions so that producers are in the correct places at the correct time to maximize their resource. Production planning and control are divided into two categories: production's planning and controlling, and these two are further divided into stages

1. Planning:
   The planning department receives comprehensive information from managers regarding the amount to be produced and the dates when delivery to consumers has been guaranteed. This allows for detailed planning of productive activities. The engineering department also provides the planning department with the required engineering and drawing specifications.
2. Routing:
   Routing requires deciding on the work's direction and also the sequence in which particular tasks will be accomplished. Routing's purpose is to find the most efficient and cost-effective sequence of occurrences. When creating the route card, keep in mind that the plant's equipment are running at full capacity,

and people and other resources are being used to their full potential.[10]

3. Schedule:
   Scheduling is referred as the process of estimating the time of completion and operation, and the time needed to finish the entire series as intended, while taking into consideration all important factors. It entails the creation of a timetable that details the overall time required to create a product as well as the time spent at each equipment and procedure.
4. Loading:
   A load is an amount of work, and loading is the process of distributing that quantity of work to the processes required to create each item. Assigning jobs to work centres or equipment inside the work centers is referred to as loading.

Fig. 2: Phases Involved in Production's Planning and Controlling

5. Dispatching:
   Dispatching refers to the act of transmitting something to a certain location. It refers to completing all measures necessary to carry out the production schedule outlined in the routing and scheduling processes [8].
6. Follow-Up (or Checking the Progress)
   The control component of production planning and control is follow-up. It comprises analyzing if work is moving as planned and how far deviations from norms have occurred, along with taking corrective measures to restore law and order.
7. Inspections:
   Follow-up is a control component of production planning and control. It includes assessing whether or not work is proceeding according to plan, as well as evaluating how far deviations from norms have happened and taking corrective measures to restore order.[11]
8. Correction:
   Other phases in the production control process are evaluated, and changes are made as needed. Routings, job scheduling, and even talks with workers who are taking those extended breaks are all part of this

REVIEW OF LITERATURE:

Models for the optimization of pulp mill operations have been proposed by Santos, Almada-Lobo (2012) [12], and Figueira et al. (2013) [17] based on simulations.

Goals such as short lead times, low WIP levels, high capacity utilization, and high due date dependability are evaluated by Nyhuis & Wiendahl (2009) [13] in their analysis of the efficiency of the production system.

The goal of Hsu et al. [14]'s deteriorating inventory model is to discover the best ways to invest in replenishment and preservation technologies while maintaining a consistent deterioration rate and time-dependent partial backlog. Let's say that the preservation technology cost varies with replenishment cycle length and takes into account both time-varying degradation and reciprocal time-dependent partial backlogging rates; this model was expanded by Dye and Hsieh [15]. An ever-changing consumer choice model, based on the freshness and price of agricultural products, was established by Wang and Dan [16]. An order, pricing, and preservation technology investment decision problem for no instantaneously disintegrating commodities with generalized price sensitive

demand, time-varying degradation rates, and no shortage was studied by Li et al. [17]. [18]

Uncertainty, according to Galbraith (2007) [19], is the discrepancy between the amount of information needed to complete a task and the amount of information already in possession. Real-world production processes are hampered by a wide range of uncertainties. There are two types of uncertainty: environmental uncertainty and system uncertainty, according to Ho (1989) [20]. Data or factors like as demand, resources, costs, and objective function coefficients are all examples of imprecise input in real-world APP problems since they are based on inadequate or unavailable information (Wang & Liang, 2004). Uncertainty in production planning models, including APP models, was studied by Mula et al. (2006) [21]. Fuzzy set theory and stochastic programming were used to address uncertainty in APP models.

Using the meta-heuristic (Genetic Algorithm) and the Big-M linear programming methods, Hossain et al. (2016) [22] demonstrate a multi-period, multi-product aggregate production planning model to reduce the cost of waste in the manufacturing process and boost employee motivation.

Using the ILOG-CPLEX software, Attia et al. (2016)[23] created an aggregate production planning model to minimize production costs with multiple operating restrictions, such as demand and inventory as well as working hours, overtime, and the use of temporary workers. It was then compared to the company's previous method based on this research findings First year, 5.43 percent, 2.66 percent, and 1.86 percent, respectively, of production costs were reduced by the model.

OBJECTIVES:

- To study APP relationships with other types of production planning
- To study basic issues in APP models
- To study structural groups for APP models
- To study Aggregate Planning Strategies and its benefits

RESEARCH METHODOLOGY:

Data gathering, data evaluation, and study results based on study findings are all part of a research technique. A research technique is a method for performing a study. Research is the methodical collecting and study of facts and information for the advancement of knowledge in any field. The study's objective is to develop intellectual and practical solutions to difficulties via the application of systematic methodologies. The current research is descriptive in nature and is based on secondary data acquired from a number of sources, including books, education and development, journals, scholarly papers, government publications and printed and online reference materials.

RESULT AND DISCUSSION:

To account for the degree of uncertainty in an APP model, various structural groups can be formed. For APP models, the input data might range from deterministic to stochastic and even fuzzy collections. APP model structure is also influenced by the number of objective functions a model has. [24]

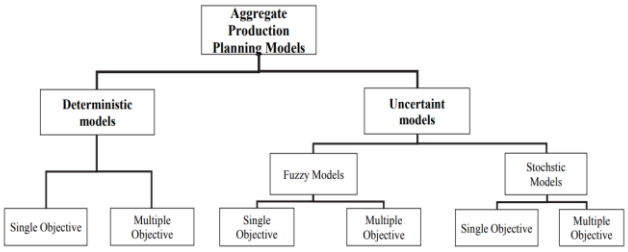


Fig. 3: Structural groups for APP models

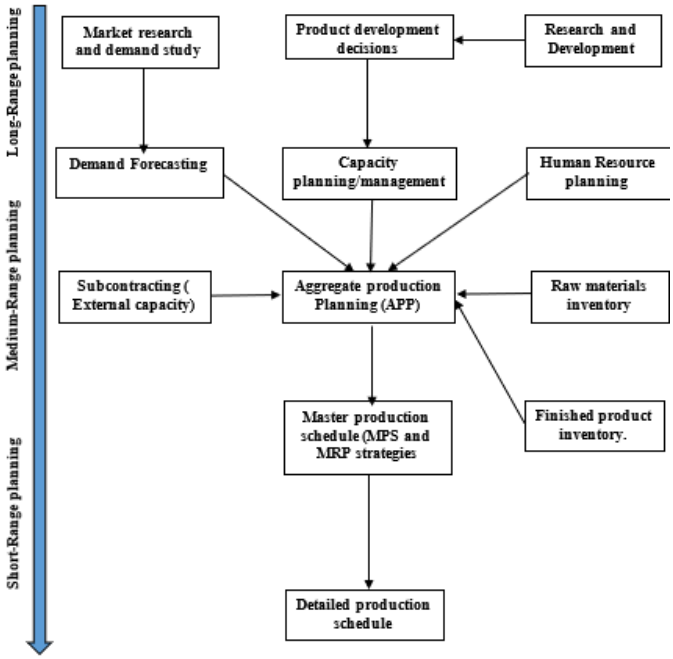
There are six major structural categories in the APP model based on these two criteria. Fig 3 depicts these groups in further detail.

Table 1. Basic issues in APP models

Basic Issue	Definition
Market demand	Demand for each period that must be satisfied by product, inventory or backorder
Inventory	Products that are held in stock in each period
Backorder	Part of demand that has not been satisfied in each period
Production capacity	Maximum amount of products that can be produced in each period by system (for machine and manpower)
Warehouse space	The capacity of the warehouse for the holding inventory
Costs of production	Costs of production consist of regular time and overtime production and costs of inventory carrying and backorders
Subcontracting	Hire the capacity of other firms temporarily to make the component parts or products
Labor level	Number of workers in each period includes regular and overtime workers
Hiring and Layoff cost	Additional workers need to be recruited to handle extra production loading and redundant workers to be laid-off to reduce overheads.
Product Price	Selling price of products

The complexity of aggregate planning is largely due to the necessity of coordinating interdependent factors in order for the firm to effectively respond to demand. An overview of the most common difficulties raised in each APP model may be seen in Table 2 [25].

Fig 4 depicts the APP's place in relation to other production planning and management systems from a holistic standpoint.



APP connections with other production planning and control tasks are depicted in Fig 4.

Fig 5 depicts the hierarchy of production planning activities, showing that APP falls between long-term strategic planning decisions, such as new product development, and short-term shop-floor scheduling procedures. APP [26]

Fig. 5: Profits of Production's Planning and Controlling

To accomplish throughput objectives, production control employs a variety of control approaches to obtain optimum performance from the production system. Fig 5 depicts the advantages of production's planning and controlling [27]

CONCLUSION:

It is critical to understand the aggregate production planning problem. In order to update plans more frequently, APP minimizes the quantity of data needed in the planning process. With a rising demand for more complete models that simultaneously consider various factors relevant to real-life difficulties, the aggregate production planning (APP) role is becoming increasingly crucial in operations management decisions.

REFERENCES:

1. *G. Li, Y. Duan, and J. Huo, "Ordering, pricing and preservation investment decision for non-instantaneously deteriorating items," System Engineering Theory and Practice, vol. 36, no. 6, pp. 1422–1434, 2016.*
2. *E. J. Lodree Jr. and B. M. Uzochukwu, "Production planning for a deteriorating item with stochastic demand and consumer choice," International Journal of Production Economics, vol. 116, no. 2, pp. 219–232, 2008.*

3. *X. Yu, "A stock model with jumps for uncertain markets," International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, vol. 20, no. 3, pp. 421–432, 2012.*
4. *Y. Ning, J. Liu, and L. Yan, "Uncertain aggregate production planning," Soft Computing, vol. 17, no. 4, pp. 617–624, 2013.*
5. *Baykasoglu, A. (2001). MOAPPS 1.0: aggregate production planning using the multiple-objective tabu search. International Journal of Production Research, 39(16), 3685-3702.*
6. *Baykasoğlu, A., & Göçken, T. (2006). A tabu search approach to fuzzy goal programs and an application to aggregate production planning. Engineering Optimization, 38(2), 155-177.*
7. *Chen, S. P., & Huang, W. L. (2010). A membership function approach for aggregate production planning problems in fuzzy environments. International Journal of Production Research, 48(23), 7003-7023.*
8. *Chen, S. P., & Huang, W. L. (2014). Solving fuzzy multiproduct aggregate production planning problems based on extension principle. International Journal of Mathematics and Mathematical Sciences.*
9. *Ganesh, K., & Punniyamoorthy, M. (2005). Optimization of continuous-time production planning using hybrid genetic algorithms-simulated annealing. The International Journal of Advanced Manufacturing Technology, 26(1-2), 148-154*
10. *Jamalnia, A., & Feili, A. (2013). A simulation testing and analysis of aggregate production planning strategies. Production Planning & Control, 24(6), 423-448*
11. *Leung*, S. C., & Wu, Y. (2004). A robust optimization model for stochastic aggregate production planning. Production Planning & Control, 15(5), 502-514.*
12. *Santos M and Almada-Lobo B. "Integrated pulp and paper mill planning and scheduling." Computers & Industrial Engineering 63(2012):1-12.*
13. *Figueira G, Santos M and Almada-Lobo B. "A hybrid VNS approach for the short-term production planning and scheduling: A case study in the pulp and paper industry." Computers & Operations Research 40 (2013):1804-1818.*
14. *Wallace J and Mark L. "To Pull or Not to Pull: What Is the Question." J Manufacturing and Service Operations Managementt 6(2004):133-148.*
15. *Peter Nyhuis and Hans-Peter Wiendahl. "Basic Principles of Modeling Logistic Operating Curves." Springer Book (2009):17-37.*
16. *P. H. Hsu, H. M. Wee, and H. M. Teng, "Preservation technology investment for deteriorating inventory," International Journal of Production Economics, vol. 124, no. 2, pp. 388–394, 2010.*
17. *C.-Y. Dye and T.-P. Hsieh, "An optimal replenishment policy for deteriorating items with effective investment in preservation technology," European Journal of Operational Research, vol. 218, no. 1, pp. 106–112, 2012.*
18. *L. Wang and B. Dan, "Fresh-keeping and pricing strategy for fresh agricultural product based on customer choice," Chinese Journal of management, vol. 11, no. 3, pp. 449–454, 2014.*
19. *Hossain, M. Md., Nahar, K., Reza, S., and Shaifullah, M.K., Multi-period Multi-product Aggregate Production Planning under demand uncertainty by considering Wastage Cost and Incentives, World Review of Business Research, Vol. 6, no. 2, pp. 170-185, 2016.*
20. *Attia, E.-A., Megahed, A., Baioumy, S., Elbetar, A., and Duquenne, P., Aggregate Production Planning Considering Performance Evolution: A Case Study, Proc. 17 th Int. AMME Conference, pp 25-40, 2016.*
21. *M. Bonney, "Reflections on production planning and control (PPC)," Gestão & Produção, 2000, doi: 10.1590/s0104-530x2000000300002.*
22. *C. Wang and X. B. Liu, "Integrated production planning and control: A multi-objective optimization model," J. Ind. Eng. Manag., 2013, doi: 10.3926/jiem.771.*
23. *S. M. Jeon and G. Kim, "A survey of simulation modeling techniques in production planning and control (PPC)," Production Planning and Control. 2016, doi: 10.1080/09537287.2015.1128010*

24. *Vocationa Business: Training, Developing and Motivating People by Richard Barrett - Business & Economics – 2003*
25. *M. Stevenson, L. C. Hendry, and B. G. Kingsman, "A review of production planning and control: The applicability of key concepts to the make-to-order industry," International Journal of Production Research. 2005, doi: 10.1080/0020754042000298520.*
26. *"Production Planning And Control Procedures In A Manufacturing Company," optal software. https://www.optelco.com/role-of-production-planning-and-control-manufacturing-industry/*
1. *V. Wickramasinghe, "Performance Management in Medium-Sized Enterprises," Perform. Improv. Q., 2016, doi: 10.1002/piq.21227.*