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Case Report

Balancing Production Capacity and Demand through Aggregate Production Planning (app): A Case study in Baghdad Company for soft Drinks, Baghdad, Iraq

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Abstract

Based on the data witch researcher collected it from Production processes department in Baghdad Company for soft drinks, there were six kinds of soft drink products (Pepsi, Miranda, 7up, green apple, shani, and lemon). There were still shortages of production capacity in three products only (green apple, shani, lemon) in 2017. A company produced zero units at several times from the year 2017 for these limit products (3 only). To overcome this problem, the purpose of this research was to make Production planning & control consisting of: Aggregate production planning and forecasting demand by weighted moving average method in 2018. The tested values show how Baghdad Company for soft drinks can balancing between production capacity and demand of customers in the year 2018 through (first quarter only).

Keywords: Aggregate production planning; Production; Demand

Introduction

Capacity of production is the maximum rate of output of a process or a production system, managers are responsible for ensuring that the firm has the capacity to meet current and future demand .otherwise the organization will miss out on opportunities for growth and profits. Making adjustments to decrease capacity or to increase it. Capacity decisions related to process need to be made in light of the role the process plays within the organization and the supply chain as a whole, because changing the capacity of process will have an impact on other processes within the firm and across the chain.

Literature Review

Introduction: Capacity is the maximum rate of output of a process or a system. Managers are responsible for ensuring that the firm has the capacity to meet current and future demand. Otherwise, the organization will miss out on opportunities for growth and profits. Making adjustments to decrease capacity, or to increase it to facilitate the launch of an expanded product line as Tesla Motors did when planning a lower priced car model, is therefore an important part of the job. Acquisition of new capacity requires extensive planning and often involves significant expenditure of resources and time. Bringing new capacity online can take several years, for instance, in the semiconductor industry or in the construction of new nuclear power plants.

Production capacity and customers demand

The first capacity – related decision faced by any operation is (how much capacity should we have), but is in fact influenced by several factors particular to each operation and its competitive position (slack and Lewis, 2015:119). capacity planning and control is the task of setting the effective capacity of the operation so that it can respond to the demands placed upon it, this usually means deciding how the operation should react to fluctuations in demand (Slack et.al, 2010: 300). A four steps procedure generally can help managers making sound capacity decisions: (krajewski et.al, 2016 : 162)

1. Estimate future capacity requirements.
2. Identify gaps by comparing requirements with available capacity.
3. Develop alternative plans for reducing the gaps.
4. Evaluate each alternative, both qualitatively and quantitatively, and make final choice.

The important characteristic of capacity planning and control, as we are treating it here. is that it is concerned with setting capacity levels over the medium and short terms in aggregated terms. Some factors influencing the overall level of capacity can illustrates in (figure 1)

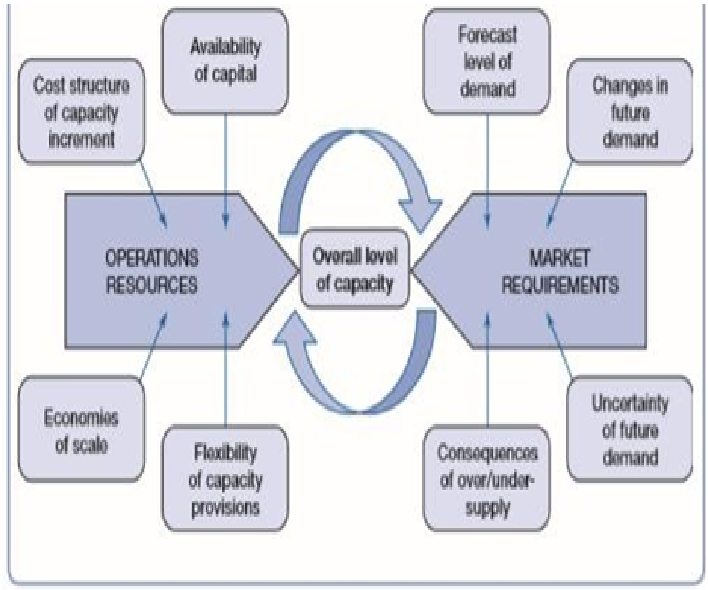

Figure 1: Some factors influencing the overall level of capacity.

The researcher see that Increasing or decreasing capacity by itself is not as important as ensuring that the entire supply chain, from order entry to delivery, is designed for effectiveness. Capacity decisions must be made in light of several long term issues such as the firm's economies and diseconomies of scale, capacity cushions, timing and sizing strategies, and trade-offs between customer service and capacity utilization. Therefore this research focuses on how managers can best revise capacity levels and best determine when to add or reduce capacity for the long term. The type of capacity decisions differ for different time horizons. Both long-term as well as short term issues associated with planning capacity and managing constraints are important and must be understood in conjunction with one another. While we deal here with the long-term decisions shown below in the capacity management framework, short-term decisions centered on making the most of existing capacity by management it.

A Systematic Approach to Long-Term Capacity Decisions

Many researchers such as (krajewski ,ritzman , etc..) are agree about Long-term decisions for capacity would typically include whether to add a new plant or warehouse or to reduce the number of existing ones, how many workstations a given department should have, or how many workers are needed to staff a given process. Some of these decisions can take years to become operational. Hence, a systematic approach is needed to plan for long-term capacity decisions. Although each situation is somewhat different, a four-step procedure generally can help managers make sound capacity decisions. (In describing this procedure, we assume that management already performed the preliminary steps of determining the process's existing capacity and assessing whether its current capacity cushion is appropriate.)

1. Estimate future capacity requirements.
2. Identify gaps by comparing requirements with available capacity.
3. Develop alternative plans for reducing the gaps.
4. Evaluate each alternative, both qualitatively and quantitatively, and make a final choice.

Step 1: Estimate Capacity Requirements A process's capacity requirement is what its capacity should be for some future time period to meet the forecasted demand of the firm's customers (external or internal), given the firm's desired capacity cushion. Larger cushions than normal should be planned for those processes or workstations that could potentially become bottlenecks in the future. Capacity requirements can be expressed in one of two ways: with an output measure or with an input measure. Either way, the foundation for the estimate is forecasts of demand, productivity, competition, and technological change. These forecasts normally need to be made for several time periods in a planning horizon, which is the set of consecutive time periods considered for planning purposes. Long-term capacity plans need to consider more of the future (perhaps, a whole decade) than do short-term plans. Unfortunately, the further ahead you look, the more chance you have of making an inaccurate forecast. Using Output Measures The simplest way to express capacity requirements is as an output rate. output measures are appropriate for high-volume processes with little product variety or process divergence. Here, demand forecasts for future years are used as a basis for extrapolating capacity requirements into the future. If demand is expected to double in the next five years, then the capacity requirements also double. For example, if a process's current demand is 50 customers per day, then the demand in five years would be 100 customers per day. If the desired capacity cushion is 20 percent, management should plan for enough capacity to serve 3100>1-0.22=125 customers in five years.

Using Input Measures: Output measures may be insufficient in the following situations:

1. Product variety and process divergence is high.
2. The product or service mix is changing.
3. Productivity rates are expected to change.
4. Significant learning effects are expected.

Step 2: Identify Gaps: A capacity gap is any difference (positive or negative) between projected capacity requirements (M) and current capacity. Complications arise when multiple operations and several resource inputs are involved. Expanding the capacity of some operations may increase overall capacity. However, if one operation is more constrained than others, total process capacity can be expanded only if the capacity of the constrained operation is expanded.

Step 3: Develop Alternatives: The next step is to develop alternative plans to cope with projected gaps. One alternative, called the base case, is to do nothing and simply lose orders from any demand that exceeds current capacity or incur costs because capacity is too large. Other alternatives if expected demand exceeds current capacity are various timing and sizing options for adding new capacity, including the expansionist and wait-and see strategies illustrated in Figure 4.2. Additional possibilities include expanding at a different location and using short-term options, such as overtime, temporary workers, and subcontracting. Alternatives for reducing capacity include the closing of plants or warehouses, laying off employees, or reducing the days or hours of operation.

Step 4: Evaluate the Alternatives: In this final step, the manager evaluates each alternative, both qualitatively and

quantitatively. Qualitative Concerns Qualitatively, the manager looks at how each alternative fits the overall capacity strategy and other aspects of the business not covered by the financial analysis. Of particular concern might be uncertainties about demand, competitive reaction, technological change, and cost estimates. Some of these factors cannot be quantified and must be assessed on the basis of judgment and experience. Others can be quantified, and the manager can analyze each alternative by using different assumptions about the future. One set of assumptions could represent a worst case, in which demand is less, competition is greater, and construction costs are higher than expected. Another set of assumptions could represent the most optimistic view of the future. This type of "what-if" analysis allows the manager to get an idea of each alternative.
Typical objectives of aggregate plan

The many functional areas in an organization that give input to the aggregate plan , typically have conflicting objectives for the resources use of organization .six objectives usually are considered during development of a production or staffing plan and conflicts among them may have to be resolved : (krajewski & Ritzman , 1999 : 601)

1. Minimize cost – maximize profits: if customer demand is not affected by the plan , minimizing costs will also maximize profits of the company .
2. Maximize customer service: improving delivery time and on-time delivery may require additional workforce, machine capacity or inventory resources.
3. Minimize inventory investment: inventory accumulations are expensive because the money could be used for more productive investments.
4. Minimize changes in production rates: frequent changes in production rates can cause difficulties in coordinating the supplying of materials and require production line re-balancing.
5. Minimize changes in work-force levels: fluctuating work-force levels may cause lower productivity because new employees typically need time to become fully productive.
6. Maximize utilization of plant and equipment: processes based on a line flow strategy require uniformly high utilization of plant and equipment.

The steps of capacity planning and control

A sequence of capacity planning and control decision which need to be taken by operations manager is illustrated in (figure 2) , typically operations managers are faced with a forecast of demand which is unlikely to be either certain or constant . They will also have some idea of their own ability to meet this demand. Nevertheless, before any decisions are taken, they must have quantitative data on both capacity and demand. So the first step will be to measure the aggregate demand and capacity levels for the planning period. The second step will be to identify the alternative capacity plans which could be adopted in response to the demand fluctuations. The third step will be to choose the most appropriate capacity plan for their circumstances. (Slack et.al. 2010: 301)

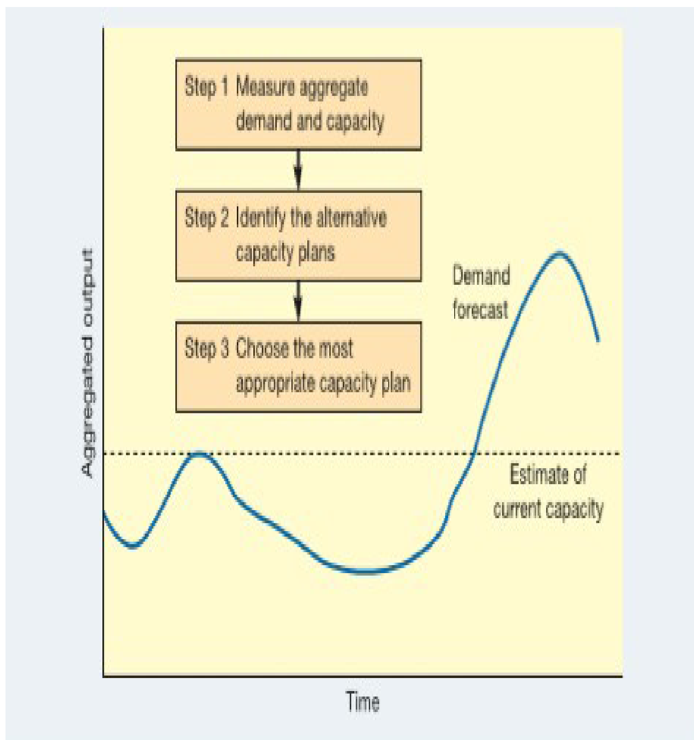

Figure 2: The steps in capacity planning and control.

Forecasting demand fluctuations

Although demand forecasting is usually the responsibility of the sales and/or marketing functions, it is a very important input into the capacity planning and control decision, and so is of interest to operations managers. After all, without an estimate of future demand it is not possible to plan effectively for future events, only to react to them. It is therefore important to understand the basis and rationale for these demand forecasts. As far as capacity planning and control is concerned,there are three requirements from a demand forecast. It is expressed in terms which are useful for capacity planning and control If forecasts are expressed only in money terms and give no indication of the demands that will be placed on an operation's capacity, they will need to be translated into realistic expectations of demand, expressed in the same units as the capacity (for example, machine hours per year, operatives required, space, etc.). Forecasting is a key input to capacity planning and control It is as accurate as possible .In capacity planning and control, the accuracy of a forecast is important because, whereas demand can change instantaneously, there is a lag between deciding to change capacity and the change taking effect. Thus many operations managers are faced with a dilemma. In order to attempt to meet demand, they must often decide output in advance, based on a forecast which might change before the demand occurs, or worse, prove not to reflect actual demand at all.

It gives an indication of relative uncertainty

Decisions to operate extra hours and recruit extra staff are usually based on forecast levels of demand, which could in practice differ considerably from actual demand, leading to unnecessary costs or unsatisfactory customer service. For example, a forecast of demand levels in a supermarket may show initially slow business that builds up to a lunchtime rush. After this, demand slows, only to build up again for the early evening rush, and it finally falls again at the end of trading. The supermarket manager can use this forecast to adjust (say) checkout capacity throughout the day. But although this may be an accurate average demand forecast, no single day will exactly conform to this pattern. Of equal importance is an estimate of how much actual demand could differ from the average. This can be found by examining demand statistics to build up a distribution of demand at each point in the day.

The importance of this is that the manager now has an understanding of when it will be important to have reserve staff, perhaps filling shelves, but on call to staff the checkouts should demand warrant it. Generally, the advantage of probabilistic forecasts such as this is that it allows operations managers to make a judgement between possible plans that would virtually guarantee the operation's ability to meet actual demand, and plans that minimize costs. Ideally, this judgement should be influenced by the nature of the way the business wins orders: price-sensitive markets may require a risk-avoiding cost minimization plan that does not always satisfy peak demand, whereas markets that value responsiveness and service quality may justify a more generous provision of operational capacity.

Seasonality of demand

In many organizations, capacity planning and control is concerned largely with coping with seasonal demand fluctuations. Almost all products and services have some demand seasonality and some also have supply seasonality, usually where the inputs are seasonal agricultural products – for example, in processing frozen vegetables. These fluctuations in demand or supply may be reasonably forecastable, but some are usually also affected by unexpected variations in the weather and by changing economic conditions.

Weekly and daily demand fluctuations

Seasonality of demand occurs over a year, but similar predictable variations in demand can also occur for some products and services on a shorter cycle. The daily and weekly demand patterns of a supermarket will fluctuate, with some degree of predictability. Demand might be low in the morning, higher in the afternoon, with peaks at lunchtime and after work in the evening. Demand might be low on Monday and Tuesday, Planning of the week and reach a peak on Friday and Saturday. Banks, public offices, telephone sales organizations and electricity utilities all have weekly and daily, or even hourly, demand patterns which require capacity adjustment. The extent to which an operation will have to cope with very short-term demand fluctuations is partly determined by how long its customers are prepared to wait for their products or services. An operation whose customers are incapable of, or unwilling to, wait will have to plan for very short-term demand fluctuations. Emergency services, for example, will need to understand the hourly variation in the demand for their services and plan capacity accordingly.

Balancing capacity change

During 2006 the price of oil (and therefore gasoline) shot up to unprecedented levels (in dollar terms). Why was this? Well, there was uncertainty in the supply of crude oil and demand from developing economies was growing, but the reason that these elements of supply and market uncertainty had such a dramatic effect was because there was a shortage of refining capacity. The oil companies had failed to plan for sufficient refinery capacity and the bottleneck in the supply chain had increased the fear of shortages. So, planning for capacity change must take into account that the lowest capacity, or 'bottleneck', part of the chain will limit the capacity of a whole chain of operations. For example, if the 800-unit capacity air conditioning plant, introduced earlier, not only assembles products but also manufactures the parts from which they are made, then any change in the assembly plant must be matched by changes in the ability to supply it with parts. Similarly, further down the chain, operations such as warehousing and distribution may also have to change their capacity. For the chain to operate efficiently, all its stages must have more or less the same capacity. This is not too much of an issue if the economic increment of capacity is roughly the same foreach stage in the chain. However, if the most cost effective increment in each stage is very different, changing the capacity of one stage may have a significant effect on the economics of operation of the others. Figure 4.10 illustrates the air conditioning plant example. Currently, the capacity of each stage is not balanced. This could be the result of many different factors involving historical demand and capacity changes.

The bottleneck stage is the warehouse, which has a weekly capacity of 900 units if the company wants to increase output from its total operations to 1,800 units a week, all four stages will require extra capacity. The economy of scale graphs for each stage are illustrated. They indicate that for the parts manufacturing plant and the distribution operation, operating cost is relatively invariant to the size of capacity increment chosen. Presumably this is because individual trucks and/or machines can be added within the existing infrastructure. However, for both the assembly plant and the warehouse, operating costs will be dependent on the size of capacity increment chosen. In the case of the assembly plant the decision is relatively straightforward. A single addition to the operation of 800 units will both minimise its individual operating costs and achieve the required new capacity. The warehouse has more of a problem. It requires an additional capacity of 900 units. This would involve either building units of sub-optimum capacity or building two units of optimal capacity and underutilizing them with its own cost penalties. The same issues apply on a wider scale when independent operations are affected by imbalance in the whole chain. Air travel is a classic example of this. Three of the most important elements in the chain of operations that provides air travel are the terminals that provide passenger facilities at airports, the runways from which aircraft take off and land and the aircraft themselves operating on all the various sectors, which include the airport. Each of these stages, in planning their capacity, is subject to different pressures. Building new terminals is not only expensive in terms of the capital required, but also subject to environmental considerations and other issues of public concern. The individual aircraft that use these facilities are both far smaller units of capacity in themselves and form an element in the capacity chain.

Results and Discussion

1. Reliability analysis: In Baghdad Company for soft drinks, there are six main types produced. This company stopped for producing (three products). Tables 1,2 summarized production and demand data for each products . It can be analyzed that the company has a problem in forecasting the demand. It is seen from the error rate in every type of six products. Moreover, the table 3 shows the biggest error rate comes from (green apple soft drink). The lack of production is due to the poor control that mainly lies in production planning and control. it is difficult for the quantity of production to meet the demand from customers.

Table 1: Demand from jan.2017- dec.2017.

Month	pepsi	Miranda	7 up	Green apple	shani	lemon
January	6078.382	465.5091	1727.209	572.7727	467.4091	108
February	9121.1	1050.936	2416.436	202.0818	800.4636	72.03636
March	9157.655	873.0727	3171.818	2.381818	1033.118	0.418182
April	5145.164	806.7818	1770.618	955.1091	675	333
May	9105.082	1024.836	2441.3	557.0091	799.5545	309.0091
June	7503.2	607.1	2098.209	292.0455	845.0455	191
July	9749.055	1240.045	3392.164	682	860.1273	218.2455
August	10344.14	1180.091	2897.173	533.0091	1227.009	321
September	5923.055	917.2818	2414.082	619.5	462.7091	280.5909
October	7581.618	1010.109	2768.691	722.0273	1285.036	146.7455
November	4879.9	280.8273	1504.164	387	591	92.01818
December	5611.564	982.5091	1403.955	184	558	86.26364

Source : Sales dept. data in Baghdad company for soft drinks.

Table 2 : Production capacity from jan.2017- dec.2017.

Products (packages)						
Month	**pepsi**	**Miranda**	**7 up**	**Green apple**	**shani**	**lemon**
January	5472.536	361.2636	1816.645	456.7273	288.5727	108.5455
February	9178.245	1214.618	2292.664	204	801.2364	71.90909
March	9069.491	725.2636	3394.618	0	1028.218	0
April	6785.591	1268.518	2105.509	1309.082	1194.536	630.9545
May	8110.491	750.2273	1879.445	553.3636	383.2727	357.2727
June	6763.218	603.9727	2200.164	63.95455	803.4273	0
July	9733.445	1130.145	3285.264	729.2636	796.4091	291.0545
August	10338.15	1139.373	2896.782	364.4182	1292.9	728.3
September	6313.045	946.3455	2413.873	618.5909	396.8182	0
October	7957.8	934.7636	2986.882	1095.745	1889.073	0
November	4108.518	277.8	1285.973	367.3636	602.0091	362.5545
December	5593.427	1270.091	1564.291	0	0	0

Source : Sales dept. data in Baghdad company for soft drinks.

Table 3: Error rate for production capacity during 2017.

Products	Gross demand packages	Gross production packages	Production vs demand	Error rate (%)
Pepsi	90199.92	2550.591	- 87949.329	97.5
Miranda	10439.1	9476.473	- 962.627	9.22
7 up	100639	5762.509	-94876.491	94.27
Green apple	2158.327	28122.11	25963.783	1202.95
shani	9604.472	10622.38	1017.908	10.6
lemon	11762.8	89423.96	77661.16	660.22

Source: prepared from researcher.

Production planning and control studied in this research are for six products. Pepsi soft drink has the biggest production deficiency level in all months for 2017. It is about (97.5 %).

Conclusion

Based on the research has been done, there are several conclusions:

1. Baghdad Company for soft drinks should apply the method of forecasting using additive decomposition (average of all data) it can overcome the problem of production shortages. This method can result in more accurate fore casting.
2. Baghdad company for soft drinks can be using one or more of strategies in aggregate production planning (chase strategy, level strategy and mixed strategy) and compared cost for each one to select the best method.

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