

# How to solve the trade-off between capacity utilization and service level

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## Abstract

This article analysis the impacts caused by the increase in capacity utilization in the service level aggregated to commodity through the downstream movement. A case study was conducted in a steel producer. The case explores demand and capacity management to provide strategies which being implemented may diminish the impacts.

**Keywords:** Capacity utilization, demand and capacity management, service level

## Introduction

Since the intensification of globalization in the 90's, manufacturing companies have suffered severe pressure on profit margins. Only 12.5% of the leading manufacturing companies in USA performed better than the S & P 500 in the 90s (Wise and Baumgartner 1999). In order to escape the transactions based on price, they moved downstream, offering integrated and value-adding services to their customers (Gadesh and Gilbert 1998, Lovelock 1994, and Matthyssens Vandenbemt 1998, Wise and Baumgartner 1999).

The main reasons for this movement are to generate a more stable revenue more stable, to solve the increasing service demand by customers, since the commodity normally need to be processed before to be used, and generate the competitive advantage that can be achieved by the service (Oliva and Kallemberg 2003, and Aurano Ala-Risku 2005). But to ensure this stability in revenues and competitiveness, two factors are critical - capacity management and service level offered to the customer.

The service level offered can be changed if the capacity utilization increase (Haywood-Farmer and Nollet 1991). The lack of capacity may result in an inadequated service level and could bring the loss of customers. Otherwise, over-capacity can increase costs, because the labor impact in the service cost is high, making the business unviable (Adenso-Diaz et al. 2002). Although the authors did these considerations about the service level, they didn't propose any strategy that minimizes the effects on the service level.

Specifically about the impact of capacity management and capacity utilization in the service level offered, service managers are not good enough to manage the impact of the capacity in the service level offered (Armistead and Clark 1994). But some authors present demand and capacity management as solution to reduce that impact (Fitzsimmons and Fitzsimmons 2005, Klassen and Rohleder 2002).

Therefore, this article aim to understand which strategies of demand and capacity management bring positive impact to the trade-off between service level and capacity utilization

and the particularities in implementation. The focus of the article is B2B (business-to-business) services that add value to the commodity through downstream movement.

That subject has high relevance to commodity manufactures, which have held or will hold the downstream movement, because one of the big obstacles faced by those companies in that movement is the failure in the implementation of that strategy since those companies are focused on product and not in service (Oliva and Kallemberg 2003). To the users of such commodities, the relevance is to increase the probability to have their desired service level attended.

In the next sections will be presented concepts and key aspects of production capacity, service level and demand and capacity management, factors that affect the trade-off choices and can soften their impact by reviewing some of the published studies that enabled the development of the article. Next is shown the context of the studied company as well as the methodology used in the article. The last two sections are aimed to present the results obtained in the research and conclusions.

### **Production capacity in service**

Capacity in general can be viewed as a measure of the ability to create value of an equipment or system (McNair and Vangermeersh 1998). In the service industry, capacity can be defined as the greatest amount of output that can be obtained with a given set of resources (human, equipment and infrastructure) in a period of time (Lovelock, 1992). But the strong impact of the human factor in the calculation of the capacity in the service industry makes it difficult to define and calculate it. The most used measures of capacity are five (Watts et al. 2009). They are:

- Theoretical capacity - equipment or system capacity working all the time (24-7);
- Practical capacity - theoretical capacity reduced for the unavailable time in equipment or system;
- Normal capacity - capacity with the average utilization of an equipment or system in the last 3-5 years;
- Budget capacity - expected output from an equipment or systems for subsequent years;
- Actual capacity - production in a given actual period of time.

The definition of the capacity measure used by the company for its planning is not only an important factor in the impact on the service level but also in the capacity utilization. The use of theoretical capacity in calculating the capacity utilization can bring significant increases in utilization over the time because it affects positively the management decisions (Watts et al. 2009). But as the seasonality of the service demand depends heavily on human behavior (Wang and Olsen 2007), and it is usually have high volatility, using the theoretical capacity to analyze the trade-off can rise a high risk since it is the most difficult capacity to balance with the demand as it needs to invest in equipment and/or infrastructure. The capacity measure that best represents the trade-off mentioned is the actual capacity, since it is done day-by-day, and the service level depends heavily on its utilization.

### **Service level**

Service level can be defined as the percentage of orders delivered on time and is one of the most important factors for the success of a business service provider (Jeffery et al. 2008). It can be seen as a slice of service quality, which can be defined as the difference between

customers' perception of the service offered and their expectations in relation to it (Parasuraman et al. 1998).

One of the most used indices for measuring service quality is the SERVQUAL with its five dimensions (Parasuraman et al. 1998) - reliability, assurance, empathy, responsiveness and tangibles - being reliability the dimension correlated with the service level. Reliability is presented as the most important dimension in services with high variation in demand and with peaks that exceed the capacity, with more than twice the relative importance of the second dimension (Chowdary and Prakash 2007, Lovelock 1983), which confirms service level as a fundamental aspect for attracting and retaining customers.

But the SERVQUAL may suffer methodological problems when used in B2B services mainly due to the mentality and culture of the customers that are different from B2C (business-to-consumer). The INDserv is the proposed model for measuring service quality in B2B (Gounaris 2005). It also divided into five dimensions - potential quality, hard process quality, soft process quality, immediate output quality and final output quality - where hard process quality is correlated with the service level. Keep time schedules and meet deadlines are the items related to the service level defined previously. Both indices presented confirm service level as being a very important factor in the service quality, one of the most important factors for the success of the service provider, as mentioned earlier.

### **Demand and capacity management**

Some authors (Chase and Bowen 1991, Heskett et al. 1990, Lovelock 1984, Rhyme 1988) identified issues that make it difficult balancing the trade-off mentioned previously. The first is the lack of dexterity in service firms to change their capacity quickly to follow the demand fluctuation. This is a major cause of the negative impact of increased capacity utilization on the service level. Another important issue is the need to always deliver service levels consistent with the customer needs. And lastly they report the changes and uncertainties in demand. The three issues raised involve the balancing between capacity and demand and other factors.

In order to minimize the impact of this trade-off it is suggested to implement strategies of demand and capacity management. The capacity management is defined as the way to ensure that a service provider has the capability to meet this demand, and demand management as attempting to influence the customer when it requests the service by reducing and / or becoming more predictable variations on demand (Klassen and Rohleder 2002), since volatility in service is greater than in product, which makes it more difficult to balance.

The strategies related to demand management can be divided into explicit and implicit strategies, where the first involves scheduling at some level, taking direct action and being responsible for smoothing and the second try to change the consumer behavior, which can or can't influence the demand (Klassen and Rohleder 2002). The strategies related to capacity management can be divided into mandatory and optional, where mandatory are those that "must" be implemented by companies in an attempt to minimize the trade-off impact and the optional ones are usually held later in cases where mandatory was not sufficient (Klassen and Rohleder 2002).

To identify demand and capacity management strategies that rose positive impact on the trade-off was created Table 1 that summarizes the strategies presented by some authors (Fitzsimmons and Fitzsimmons 2005, Heskett et al. 1990, Klassen and Rohleder 2002). They are divided as presented previously, but some of them can be classified in both, demand and/or

capacity management.

*Table 1 – Demand and capacity management strategies*

	<i>Explicit Strategies</i>	<i>Implicit Strategies</i>
<i>Demand Management</i>	<p><i>Demand division</i></p> <p><i>Reservation/schedule customers</i></p>	<p><i>Price differentials</i></p> <p><i>Promoted other demands in low demand periods</i></p> <p><i>Service Differentials</i></p> <p><i>Inform and educate customers</i></p>
<i>Capacity Management</i>	<p><i>Mandatories Strategies</i></p> <p><i>Hire employees</i></p> <p><i>Layoff employees</i></p> <p><i>Schedule employees</i></p>	
	<p><i>Optional Strategies</i></p> <p><i>Share capacity</i></p> <p><i>Cross train employees</i></p> <p><i>Part-time employees</i></p> <p><i>Ajustable capacity</i></p> <p><i>Customer participation</i></p> <p><i>Temporary employees</i></p> <p><i>Tolerance overtime and idle resource</i></p> <p><i>Refusal to customers</i></p> <p><i>Hire subcontractors</i></p>	
<i>Demand and/or Capacity Management</i>	<p><i>Change hours or days operation</i></p> <p><i>Process automation</i></p> <p><i>Partition customers</i></p>	

The objective was not to detail every possible strategy, but to study the impact of each strategy on the trade-off, advantages and disadvantages, creating guidelines for implementing them.

## Context

With trade liberalization on imports in Brazil in the 90's, there was greater competition between commodities' producers and hence the flattening of margins. In addition to this factor, the country's growth has generated a lack of qualified labor, which slows the consumption of commodities, since they usually need to be processed before use. These factors coincide with the main reasons cited previously for downstream movement – stable revenue, increase service demand by customers and competitive advantage that the service can generate.

One of the solutions found by steelmakers to reduce the impact on margins due to the scenario presented was the movement to the downstream by cutting and bending rebar for use in construction. This advancement in chain also attended the main reasons for the movement.

Nowadays one of the biggest problems faced by this industry is the difficulty to match capacity to the demand variations. The construction market has the seasonality of its own chain and moreover there are the variations intrinsic from each customer process. To serve customers with the service level desired would require the industry's ability to plan for peak demand and withstand periods of idleness. This would result in an infeasibility of business, since the impact of labor in the cost of providing service is high and it would have a low utilization.

### **Research methodology**

The fact that the phenomenon studied is a contemporary event and the researcher has no process control, suggests choosing a qualitative methodology through case study. To select the company to be studied some factors were defined as facilitators in obtaining good results. First, it would require a historical knowledge of the company studied, since no one could implement any strategy and observe the result due to be a contemporary event. Moreover, the treatment of the business as a separate business unit of steelmaker would increase the probability of many strategies had been implemented prior to the study, because there would be specific areas of the business unit working on improvements to reduce the impact of trade-off studied. Finally the time that the steelmaker is working with this service would be another facilitating factor, since a greater knowledge by the company had been acquired and the probability of any strategy have been implemented would increase.

The steelmaker chosen for the study was the first in the country to perform this movement. It has units spread through the country, which improves the analysis of the strategies' impact since we can not only analyze each unit individually as well as the impact of treating them together. Moreover, the researcher had the opportunity to experience several of these historic events since he has been working in the studied company for several years.

Key people from areas - sales, marketing, production and operational planning - that are responsible to balance the trade-off were interviewed and historical events were analyzed with the objective to make a triangulating between the theoretical basis, interviews and analysis of historical events and find out what strategies listed in Table 1 would bring positive impact to the trade-off studied and the benefits, disadvantages and guidelines to implement each of them.

### **Results and analysis**

The presentation of results is divided in two parts. The first presents the results obtained with the strategies related to demand management. Then it is presented the results of strategies related to capacity management along with those that were classified as demand and/or capacity management.

#### *Demand Management*

The demand division proved to be very useful especially in the predictability of demand. According to interviewers, with detailed study of the most representative segments, it can, by dividing the demand, makes these segments' demand more predictable and creates incentives to reduce volatility. Restriction found in research refers to the difficulty of knowing in detail about a high number of segments that brings total representation in situations of high demand fractionation.

The reservation/schedule customer system also generates positive impact on the trade-off. It must possess the necessary incentives so that the number of confirmations is high to ensure greater stability in demand and that cancellations do not generate such discomfort to the

customer that make them give up to make reservations because the cancellation penalty. It would work as an anticipation of the demand, making it more predictable and increasing the probability of attendance on the date confirmed.

The price differential has not been confirmed by the triangulation as a viable strategy to reduce the impact of trade-off. Through historical analysis, price differential brings a change in the behavior of short-term demand but, unable to influence the chain cycle. However some interviewers suggested that it would be able to change this dynamic but should be something structured, to change the dynamic in long-term. In the beginning the strategy would not help to reduce the trade-off, but it could be treated to play this role in the future.

The promotion of other product and/or service demand in periods of low cut and bend service demand can't be confirmed as generating positive impact on the trade-off. On one hand the resources used by the company to cut and bend rebar can be used to produce other product /services, but all of them have a cycle similar to the service currently offered which would generate sets peaks in demands. In the other hand, promoting a product demand could fill the valleys since it could generate stock. But in historical analysis, it could be seen that when promoting these products, the demand of them generate a competition with the core service demand and in the end both customers don't have a good service even in the product that can be stocked. Therefore it is suggested to use the valleys to test new products and if it is approved they set up a structure to produce it.

The service differential was not feasible in reducing the impact of trade-off. Primarily because the needs of assertiveness in the customer delivery date in the same segment are not always similar. Depend on a number of internal customer factors that the service provider could not meet all, which may mean that the segments are not clearly defined. Further differentiation between segments, would generate a risk that some customers feel prejudiced against others due to differentiation of the service, which could lead to losses for the business. Because those factors, the risk of loss would be greater than the potential gain on the trade-off impact.

The last demand management strategy being considered was to inform and educate customers. In the historical analysis and some interviews it was presented as useful in to reduce the impact in the trade-off. But it was emphasized from the interviewers the risks of the customers become dissatisfied if they receive information as a low demand time, and because the high volatility in demand, at the moment that they order the service it has changed the situation. Because this risk is considered higher than the gain the recommendation was not to use strategy.

### *Capacity Management*

The three strategies - hire, layoff, and schedule employees - are considered as mandatory and they were treated in the research to find guidelines that increase gains. The critical factor for successful implementation of these strategies is to eliminate red tape to the process of hiring and laying off employees. If they can't do it, the process becomes slow and balancing capacity can't follow the demand volatility. This could be seen in the analysis of the company. As currently it spends a long period to hire an employee it doesn't use this strategy for monthly variations. To standardize the process in order to facilitate the training also accelerates the balancing process by reducing the learning curve for new employees. The loss of knowledge and increased operating costs due to more expensive shifts (weekends and evening) were mentioned as disadvantages and/or difficulties to implement these strategies.

Sharing capacity is a strategy that is already implemented in the company studied, but among plants of itself and not with other companies. The fact of having several plants across the

country facilitates to the process which was unanimously seen by interviewers as highly important to reduce the impact of trade-off. In historical analysis was also found that the strategy has generated good results in reducing the impact on the level of service during peak periods. The disadvantage in implementing this strategy is the increase of the total cost because the freight cost, since the plant which shares the capacity is typically farther away from the customer who is using the shared capacity. To minimize the impact of the freight cost is suggested to use the S&OP (sales and operating planning) process monthly to plan these shares as soon as possible, in order to gain time for the logistic area to contract these freights.

Cross train employees also have been implemented, with success, in the company for over five years to aid the balancing capacity not only because of the volatility of total demand as well as the change in the mix of orders. The company uses this practice only in different functions within the same area. But it is suggested to hold also between areas, which would bring even more efficiency to the process because the bottleneck moves through the areas and a cross trained employee should move with the bottleneck.

Adjustable capacity was implemented in the company six months before the research and it have delivered satisfied results. The low implementation investment is noteworthy. It just needed to study demand variation in each region and apply methods for fast capacity adjustments. Limitation research was aimed at the low efficacy in cases of high variations in demand.

Increasing customer participation was not viewed favorably by the interviewers. This happens because the transfer one step of the service to the customer would reduce the scope of service and at the time when the service is not offered completely you create the risk to lose a customer to the competence, mainly because the step in that process that would be feasible in terms of customer participation doesn't adding-value to the customer. The step isn't necessary if the customer will do the service by itself. It would bring more difficulties in involving its. This can lead to loss of customers. Historical analysis showed that some tests with this strategy are already made by the company, but it found a barrier that was identified by interviewers, which restricted the tests to a few customers. Just one customer tested approved the idea. It agrees that this strategy reduce the time to delivery date, but the others just viewed the difficult increase to ask an order because they didn't receive any formal incentive to do it.

Hiring temporary employees could not be analyzed with historical facts because the company does not allow this practice. Through analysis of the process can be seen that some activities that require less training and/or are not strategic, could be performed by temporary employees. The interviews also indicated that possibility and gains similar to mandatory strategies, but more agile and cheaper to implement. As a point of attention to implementation is suggested not to place these employees in activities that have direct contact with the customer or are the last step before delivery the full service, avoiding the increased probability of errors that couldn't be corrected before delivery to the customer.

Segmentation and refusal to customers despite being distinct strategies were treated together in the search because the issues are complementary and they make sense together. The segmentation strategy was partially discussed in service differentials, and as occur there, it was rejected by the interviewers. The refusal to customers was identified by interviewers as being an antithesis to one of the company's strategic goals, increasing participation of products and services offered by moving downstream. Also it would generate a reduction in customer confidence in the company due it wouldn't know when it can order or not the service. The analysis confirmed the company's position about refusal to customers. Never before the company avoided offering service to any customer, even during periods of high demand.

Tolerance overtime and idle resource are already implemented by the company and the use has been decreasing during the last year due to its high cost. But it is increasing its effectiveness. They weren't used in a planned way and because that it hides the process inefficiencies. In recent years they have been planned and has been successful in reducing the impact of trade-off. The company monitors the normal capacity utilization to take short-term decision and theoretical capacity utilization for long-term decision, to keep the level of utilization controlled and didn't reduce the service level offered. Interviewers confirmed that this change was necessary and validate the strategy to reduce the impact of trade-off.

Hiring subcontractors has already been used by the company on two occasions and with similar results. Once it contracted to execute a part of the service and the other to execute the whole service. In both cases there was only a transfer of responsibility and balancing problem, because the contract was exclusive and they didn't use their resource to offer the service to other companies and neither a demand forecast. The contract with them was not renewed. The interviewers evaluate that the strategy could have better results if it would be well planned. It suggests treating in the contract the demand variations and to subcontract just steps that doesn't depends on specific knowledge, so that the subcontractor can occupy its resources with other demands.

Changing the number of days and hours worked showed quite similar as mandatory strategies, with the same advantages, disadvantages and guidelines.

Last strategy of capacity management, process automation was seen by interviewers as the greatest potential for positive impact on the trade-off. Process steps that work on the flow of information were highlighted as major potential gain with automation. The analysis of business unit has demonstrated that large investments in recent years in process automation has occurred in stages of working on material flow, but the bigger complexities of the process are in the flow of information. The company realized this factor and last year began to invest in automation of information flow where the expected return has proved very attractive.

## Conclusion

Probably the main finding of this study is to validate the use of demand and capacity management as a solution to the trade-off between capacity utilization and service level, especially in B2B service companies with high volatility in demand and peaks that exceed the capacity. But not all strategies are useful for all business. Firstly because the market situation has high impact on the outcome of strategies, mainly from demand management. Furthermore the strategies related to capacity management depends strongly to internal process and company political and both of them are very specific for each company.

The demand management had less strategies validated in the study than capacity management. This was expected because it requires an interface with the external environment, the market, a less controlled variable, while in the capacity management most of the strategies depend only aspects controlled by the company. The dependence from the market generates risks in other factors beyond the service level, which invalidate some strategies.

To become the image of the company worse is the highest risk factor in the implementation of most of the strategies not validated, as pointed out by interviewers. Strategies that can bring positive impact in the trade-off but involve risk of change the company's image or even a possible reduction of service quality in other aspects, were naturally invalidate by interviewers suggesting that the risks don't outweigh the possible gains.

Even though the number of strategies validated on demand management is smaller

than capacity management, their impact on the trade-off should be high according to the interviewers. That happens because the company hadn't done so much about demand management in the last years.

Among the guidelines presented, some of them stand out for being part of various strategies. A strong standardization process to reduce the learning curve, a deep knowledge about customers and market to adjust strategies to them, eliminating red tape in internal processes (operations and human resources) and agility in making decision are key factors for the success of several major strategies.

An important subject pointed in this study is that the positive impact in the trade-off for strategies implemented together may be greater than the individual impact. The study didn't consider this aspect. It could lead to future research to examine which strategies should be implemented together to achieve better results. This research could also be developed for B2C service, which was not the focus of the presented study.

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