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THE IMPACT OF PLANNING TOOLS ON PRODUCTION AND INVENTORY ACTIVITIES

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Abstract

This article presents a set of case of studies elaborated on 42 companies located in Mexico, which have demonstrated an increase in logistics costs by not having employees knowledgeable in planning tools. The forecasts, order planning and inventory levels are elaborated empirically resulting in elevated costs in the areas of production, inventory, purchasing, etc. In the analyzed investigation, financial strategies are proposed such as Vendor Management Inventory, Just in Time, among others. Production and inventory planning and control systems are implemented, resulting in benefits such as reduced demand variability, cost reductions throughout lean manufacturing processes, appropriate inventory levels, adequate customer service levels, obtained an annual savings of $1,237,794.00 USD summing all the participating companies.

Keywords
Planning Tools, Production, Inventory, Planning and Control, Service Level.

1. INTRODUCTION AND LITERATURE REVIEW

One of the financial strategies that has been extensively studied in the industry is the application of Just in Time (JIT). This strategy depends upon the coordination of production programs together with supplier deliveries, as well as the efforts made to improve the material flow. The implementation of a Just in Time process is facilitated by linking suppliers and information systems, creating an integrated material flow [1]. Just in Time supply can magnify production benefits. The adoption of this practice in manufacturing, in addition to producing efficiency, also helps to avoid vulnerable manufacturing systems because production cannot solely rely upon overproduction and stock. To be

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effective, Just in Time requires a greater emphasis on the transmission of information and a more extensive degree of coordination with suppliers. The strategic objective is to have "sustained" success and satisfy all involved parts [2, 3].

Outstanding results have been obtained from studies that have been carried out in companies that operate under this strategy. Industries such as electronics and transportation, as well as equipment sectors located in various countries such as Finland, the United States, Japan, Germany, Sweden, Italy, and Austria, all confirm that Just in Time production practices positively affect their companies, both the efficiency of production and delivery [1]. In 2014, Caro provided a series of recommendations for the continuous improvement program within organizations since these are determining factors in business performance ratings [3, 4].

Vendor Management Inventory (VMI) on the supplier's behalf is another financial strategy that has an integrated focus on the customer-supplier coordination. The supplier decides upon appropriate inventory levels for each product (within the agreed limits), as well as policies to maintain these inventory levels [5]. Vendor Management Inventory requires that suppliers monitor inventory levels from the purchaser, and according to sales forecasts, provide periodic replenishments, deciding on quantities, shipping, and distribution [6].

The principal objective of this strategy is to reduce the bullwhip effect. At the same time, share investments are reduced maintaining high service levels [6, 7]. GlaxoSmithKline is a case that confirms the necessity of a dyadic information exchange, both vertically and horizontally. The application of Vendor Management Inventory has to be based upon an information exchange between members of the supply network, by means of vertical and horizontal communication. These types of information exchange not only minimize security investments, but also increase the responsiveness to customer requests [8].

Whatever the financial strategy may be, it should be chosen according to the company's specific situation and needs. What the strategy contributes to the organization is vital. Having an organized system where an internal and external coordination exists to obtain diverse benefits, among them the reduction in logistics costs [9].

From the point of view of its importance regarding organizational decision making, "relevant costs" could contribute to the determination of the appropriate company growth [10, 11]. One of the most important costs correlated with production and inventory activities in companies located in Mexico is the associated logistics costs. These costs represent 10.3% of total sales of which 40% are related to transportation costs and 60% are related to physical inventory, order processing, warehousing, and management of transportation operations planning, according to AT Estimates of Kearney contained in the Logistics Competitiveness Agenda 2008-2012 [12].

Nowadays, customers and companies have increased their requirements to reduce costs in the supply chain to be able to better compete in the market [13]. This forces managers to use improved tools for demand forecasting [14]. Projections or forecasts are vital for any business organization and for all important managerial decisions. The set of forecast tools to be used should be clearly identified to determine future sales and as such make the best decisions on production planning, production scheduling, and inventory levels [15].

Taking into account forecasts, organizations should employ an operational production scheduling or aggregate planning that establishes production indices for each product group or other categories in the medium term (3 to 18 months). This precedes the master program. The principal purpose for aggregate planning is to specify the optimal combination of production indices, workforce levels, and inventory levels.

Aggregate planning is responsible for monitoring if the capacity is adequate, as well as specifying additional requirements for overtime, subcontracting, additional workers, etc. for each product line [16]. Then, this plan is modified by means of testing methods or mathematics with the intention of deriving a final plan with lower costs [17].

Considering the aforementioned, inventory levels should be paid special attention to as they play an essential part in cost reductions. Logistics visionaries have spoken over the years about eliminating, or at least drastically reducing, inventory's function in modern supply chains [18]. The most efficient supply chains would not need any intermediate inventory because supply and demand would be in perfect synchrony. Without a doubt, this vision has its pluses: eliminating inventory would imply considerable reductions in logistics costs and more efficient order deliveries [17]. Inventory can be considered stagnant money because it occupies rack or shelf spaces waiting to be requested by customers. For this reason, it is necessary to reduce inventory levels.

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Heineken, a Dutch beer company, is one example of an organization that has achieved reductions in inventory levels. Heineken believed they could save money from inventory in transit if they could shorten forecasted delivery times. The company hoped that two things would happen. First, they hoped to reduce the need for inventory as well as the amount of money associated with this inventory. Second, Heineken thought that with a shorter projected time, forecasts would be more precise and there would be fewer emergencies and waste. Heineken has a scheduling system called Heineken Operational Planning System. This system reduces general inventory from 16 to 18 weeks down to 4 to 6 weeks, an impressive difference in transit time and a 30 to 35% cost reduction. For example, if inventory quantities were $10 million USD, more than $3 million USD would be saved, which would go directly to profits.

In this investigation, various planning tools configurations are developed and implemented to be able to propose an appropriate planning and control management for production and inventory within many companies. These planning tools will result in great monetary savings due to the avoidance of high costs generated by inadequate planning, excess inventory, material loss, inefficient warehouse distribution, etc.

2. METHODOLOGY AND METHODS

The first step in the developed methodology for these 42 case studies was the compilation of information and the elaboration of databases to subsequently perform the analysis and diagnosis of the company context. These steps helped to identify areas of opportunity that needed to be improved. Next, the financial strategy that the company currently used was assessed to see whether it was ideal for the company's operations. The demand, final product composition, manufacturing environment, and configuration of manufacturing systems were evaluated to conclude if the financial strategy is the most adequate and thus fulfil the financial objectives of growth and market participation. The Figure 1 describes all the alternatives that companies could have [21], for example, the manufacturing environment can be Make to Stock (MTS) with a configuration of manufacturing systems, such as process layouts must be product or cell and production processes must be continuous or mass, as well as other considerations including in production and inventory management like customer lead time. These configuration proposed by APICS were considered the best, therefore, any deviation presented by the companies in these configurations, was submitted to analysis and proposals were presented if this deviation caused some type of problem. Once clarifying this part, the following step was the production planning phase.

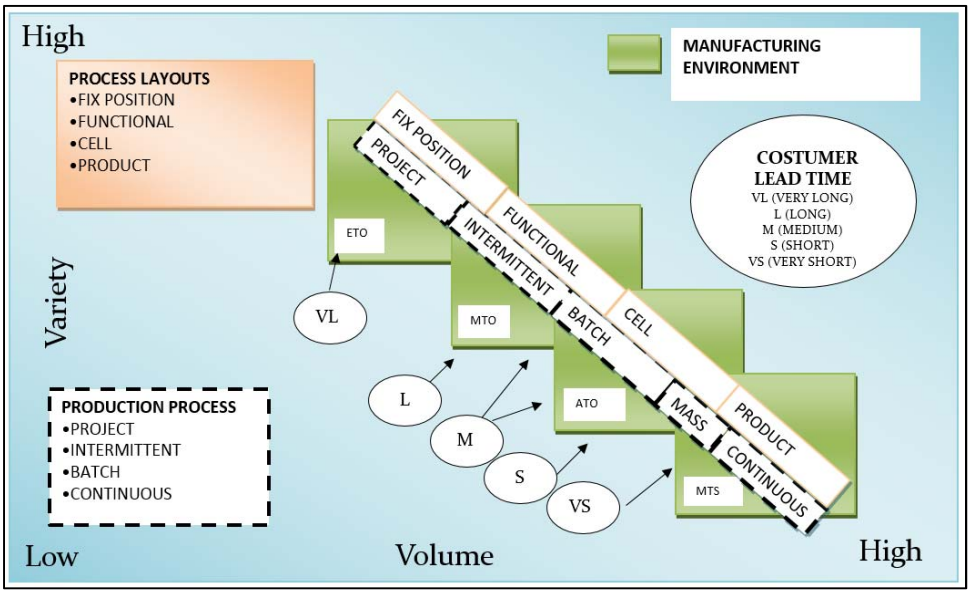

Figure 1: Manufacturing environment (*Make to Stock –MTS, *Assemble to Order –ATO, *Make to Order –MTO, *Engineering to Order –ETO), configuration of manufacturing systems, and other considerations taken from the course 'Manufacturing Process Environments' APICS, 2014 [21].

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A common practice in production and inventory planning and control is be able to differentiate products in a determined number of categories, and later apply a separate planning and control policy for each category. The reason for this is that not all of the products have the same importance for the company in terms of sales, marginal utility, market share, rotation, and competitiveness. In the majority of the cases, classification methods were used such as the traditional ABC Classification or the Analytic Hierarchy Process to be able to segment the study area.

Once the company's context had been analysed and the central problematic had been identified for the selected study area, information was researched to justify the implementation of the various methods. To be able to classify the problems and analyse them with greater ease, Table 1 was elaborated showing the frequencies of each method. The most common problem is the number 1 that falls into the principal subject of this document.

Table 1: Problems and frequencies presented by companies before being analyzed with the different planning tools.

SIMILAR PROBLEMS OF THE COMPANIES		
#	**PROBLEM**	**# OF COMPANIES**
1	There is not an efficient production planning, therefore it is not known with certainty what should be ordered and what should be produced.	14
2	Demand forecasts are unknown, therefore raw material is ordered empirically by means of managerial experience, generating an inefficient inventory control.	10
3	Excess inventory generates elevated holding costs because of low rotation or expiration dates.	9
4	Poor warehouse distribution with insufficient space for products causes them to be stored in other spaces or making pathways impassable generating unnecessary costs, personnel, and movements.	5
5	Poor inventory control means that there is not adequate safety stock, generating customer dissatisfaction by not fulfilling orders or on time deliveries.	4
	Total	42

Within the methods used to reduce demand uncertainty, various types of time series forecasts were found, such as the moving average, simple moving average, weighted moving average, Brown method, Holt method, Winters method, depending on the context of the company for which the forecast was developed.

To establish and maintain adequate inventory levels and reorder points, in these case studies stochastic methods were found such as Continuous Review (q, R), Periodic Review (S, T), maximums and minimums (s, S), and Newsvendor, considering safety stock to maintain an adequate level of customer service. Deterministic methods were also used, such as the Economic Lot Scheduling Production, Economic Order Quantity and its discount variants, independent orders with different frequencies, and pending orders to supply. Furthermore, in many cases the correct order load was reviewed with a Material Requirement Planning system, as well as the calculations performed for explosions in the Bill of Materials. In Table 2 is shown when the methods are used in accordance to the problem context.

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Table 2: Methods used depending of the problem context.

METHODS USED	CONTEXT COMPANY
Time series forecast moving average, simple moving average, weighted moving average, Brown method.	These methods were used for when the behavior of the demand had no tendency and the pattern was regular. Typically, they were applied when there was not enough data because they were small companies that had no records, because the information has been lost by migrating to the SAP system, or because they were just start-ups.
Time series forecast Holt method, Winters method.	These methods were used when the behavior of the demand had tendency and the pattern was regular. Typically, it was applied when there was enough data.
Stochastic methods such as Continuous Review (q, R), Periodic Review (S, T), maximums and minimums (s, S), and Newsvendor.	These methods were used when the behavior of the demand was highly variable, above 20% of variability according to the Coefficient of Variability (CV).
Deterministic methods were also used, such as the Economic Lot Scheduling Production, Economic Order Quantity and its discount variants, independent orders with different frequencies, and pending orders to supply.	These methods were used when the behavior of the demand was enough stable, below 20% of variability according to the Coefficient of Variability (CV).
Material Requirement Planning system, as well as Bill of Materials.	These methods were used to release the purchase orders of the materials necessary for the production of the final product according to the economic quantity set by the inventory levels models.

Below in the Graph 1 is presented each of the employed method for the company proposals. The ABC Classification and Economic Order Quantity were the most frequently used methods.

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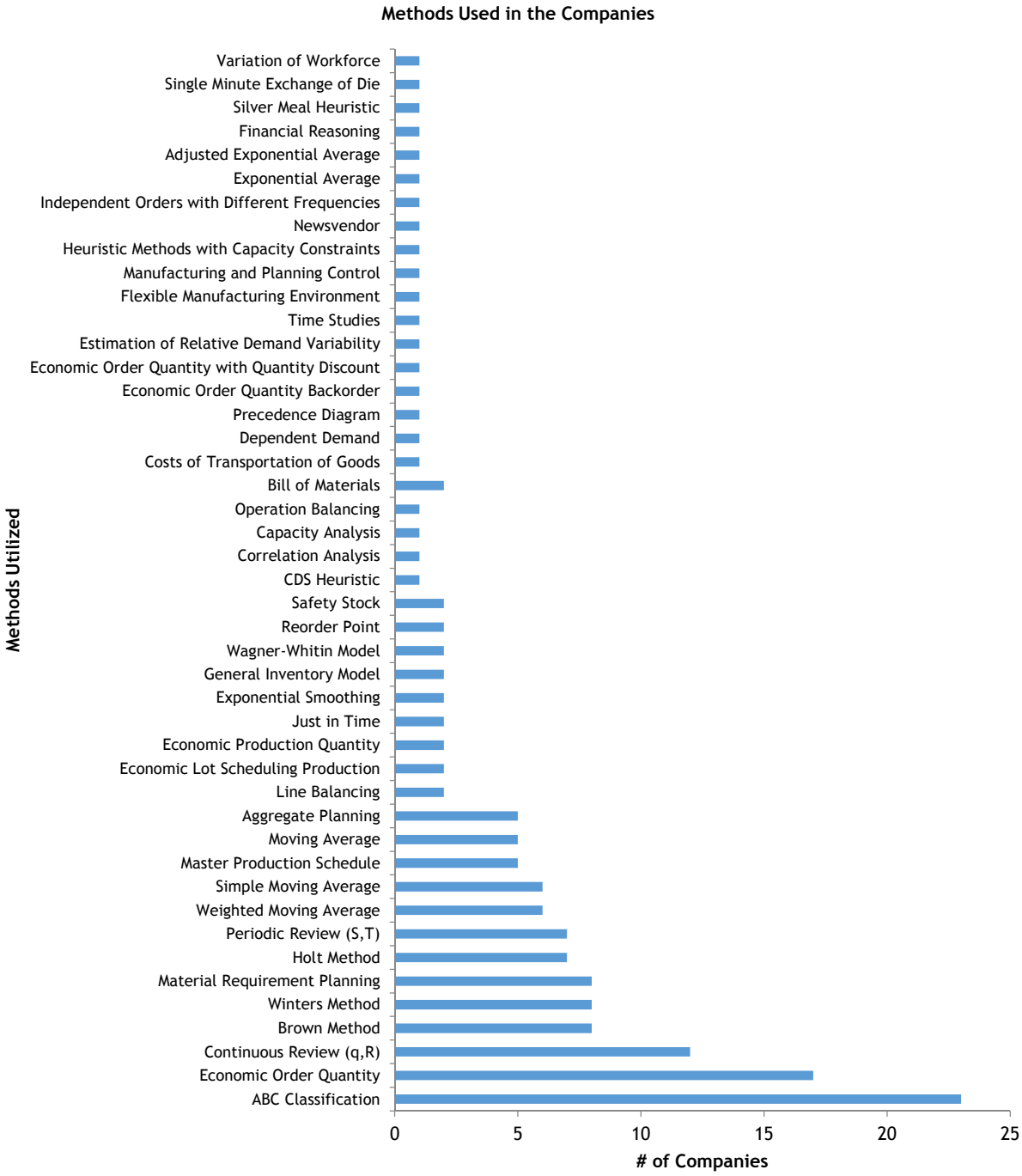

Graph 1: Proposed methods used to improve the current problem of the companies.

Next, comparisons of quantifiable benefits were performed, such as savings, effectiveness, increase in service levels, etc. to have a better vision of the impact of each proposal offered to the companies. It should be noted that 20 of the 42 companies are in the implementation process of the improvement proposal. Figure 2 shows the procedure that took place in a simplified way.

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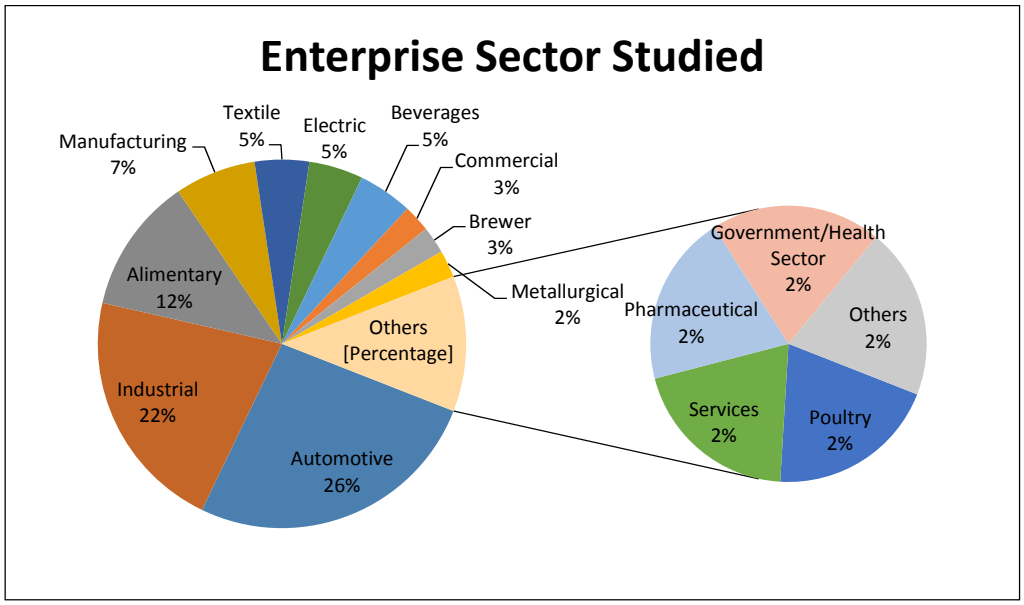
Figure 2: Designed methodology for the research developed for the 42 case studies.

3. RESULTS

In this section, the obtained results from the developed investigation are presented. Graph 2 shows the classification of the analysed companies with respective percentages. It can be observed that the automotive sector dominates with 26% of the companies analysed. Of the 42 companies, 27 are international and 15 are national.



Graph 2: Percentages representing the sectors of the analysed companies.

As it can be observed, the methodology was implemented in a variety of sectors with different context, which makes it difficult to describe each method and sequence used. However, Table 3 presents the beneficial results that have been obtained once applying the improvement processes in the companies. The most frequent result achieved was the elimination of excess inventory, which generated cost reductions and an increase in service levels.

Table 3: Classification of the benefits obtained from applying the planning tools according to the problematic.

OBTAINED BENEFITS IN THE COMPANIES		
#	**RESULT**	**# OF COMPANIES**
1	Elimination of excess inventory generating cost reductions and increases in service levels.	14
2	Greater efficiency in regards to processes, warehouse reconfiguration, etc.	10

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3	Elimination of empirical management concerning reorder points, order quantities, order timing, determining a more stable and certain quantity.	6
4	Employ efficient forecasts to have greater control on what will be produced.	6
5	Other benefits.	6
	Total	42

Table 4 shows the economic benefits obtained after the implementation of the proposed methodology (only 10 companies authorized the publication of these savings). Company 1 had the greatest cost reduction of $606,250.00 USD. Total yearly savings among 10 companies rose to $1,237,794.00 USD. Table 5 presents the increase in customer service levels from four companies that implemented improvement strategies. This can vary depending on the sector that was analysed. Improvements in customer service levels in studied companies increased anywhere from 5.4% up to 25.6% having implemented a proposed strategy more built towards the company's needs and objectives.

Table 4: Companies that generated cost reductions.

COMPANIES THAT ACHIEVED REDUCTIONS IN LOGISTICS COSTS	
COMPANY	**ANNUAL AMOUNT IN USD**
1	$606,250.00
2	$100,743.40
3	$281,250.00
4	$80,608.79
5	$16,867.88
6	$15,889.34
7	$10,190.36
8	$10,273.69
9	$68,846.08
10	$46,875.00

Table 5: Companies that improved customer service levels.

COMPANIES THAT INCREASED SERVICE LEVELS		
COMPANY	**PREVIOUS SERVICE LEVEL**	**OBTAINED SERVICE LEVEL**
1	80%	90%
2	78%	98%
3	90%	99%
4	78%	82.21%

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In the research process, it was detected that 5 of the 42 companies lacked an Enterprise Resource Planning system creating coordination and supply problems. It is suggested to consider implementing a system that has the capacity to integrate the different functions of the company. As Rodríguez de Cora et al. [20] states,

> *"...new information technology systems make a more fluid communication possible in real time, which comes from greater complexity within the relations between the different involved agents throughout the supply chain."*

Having a more coordinated and integrated supply chain with suppliers and involved agents will improve upon shared objectives, such as can be observed in the improvements in logistics costs and customer service levels once the analysed companies implemented proposed strategies.

4. CONCLUSIONS

According to the analysis of the 42 case studies that were developed in companies located in Mexico from 2013 to 2015, the common challenges were the lack of information due to null manage of databases or incomplete registration in any operation. Therefore, the organizational growth should be supported in regards to information registration, exchange, and analysis that allows for more precise decision-making. A database with information on logistics activities and their relation to costs systems should be employed.

Also, it is of the highest importance to use the financial strategy adequate that allows for the improvement of the organization's operational conditions and the profitability. It is also important to note that with an appropriate financial strategy and the correct integration of planning tools, multiple benefits can be obtained such as reduction in logistics costs, an increase in productivity, reduction in delivery times, and an increase in customer service levels, among others.

The most significant contribution to this work was the implementation of a methodology that involves planning tools and can take place in many productive sectors, from the private sector to the government sector, from manufacturing companies to service provider companies. It is also important to achieve a quantification of the economic impact by means of obtained costs savings and a qualitative impact by means of customer satisfaction. A change in culture, routine, and norms is necessary and recommended to be able to implement the planning and so to achieve these objectives at every level of planning.

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