

## Reducing Inventory Levels in a Supermarket through the Six Sigma Method

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### Abstract

Being one of the most active industries in an increasingly globalized world, the retail sector has become a rapidly developing sector in Türkiye. Businesses in this sector must follow inventory policies that enable them to minimize costs and maximize profits to be able to survive on the market. For this reason, effective management of inventory is crucially important in this industry, as well as in others. The Six Sigma method, a management tool that emphasizes continuous improvement and increases the efficiency of processes, was used in the present study to reduce the inventory levels in a large supermarket offering both wholesale and retail products in Türkiye. In this study, the causes of high inventory levels were investigated by following the steps of the Six Sigma method. After the collected data were analyzed, some improvement actions were taken to reduce the inventory levels, and a monitoring system was established to ensure sustainability. It was found that there were deficiencies in the inventory tracking and demand forecasting processes. The main reason for this was found to be the purchasing organization. The results also revealed that unnecessary purchases were made. The Six Sigma studies on supermarkets in Türkiye are limited, so this study sets an example of Six Sigma, which is a systematic process improvement method for the retail industry.

### 1. Introduction

Türkiye has recently attracted substantial domestic and foreign investments, and the retail sector has become a rapidly growing sector in Türkiye. In this sector, competition is getting more and more intense in parallel with the growth rate, so companies need to follow an inventory policy that minimizes cost and maximizes profit to survive. In addition, they must use their existing resources in the most appropriate way. An inventory is the whole set of items that are held before they reach the end user. Inventory should be kept at the optimum level with the principle of minimum inventory and maximum availability, without raising costs or reducing sales.

The development of Six Sigma dates back to the 1980s. The American company Motorola sold its Quasar TV manufacturing company to the Japanese

company Matsushita in the 1970s due to its inefficiency. The idea of developing a new method in Motorola was triggered when Matsushita made sharp changes in the operation of the processes and significantly reduced the defect rate of the enterprise, and this led to the development of the Six Sigma method [1].

Six Sigma is an improvement method that pinpoints the root causes of problems and solves them. It can be briefly described as a method focusing on quality and efficiency to improve the products and processes in which the products are manufactured by following a scientific and systematic approach in line with the needs of the customers [2]. The Six Sigma method aims to achieve optimum performance in a process with product or service outputs [3]. It is a method that reduces defects in both service and production processes by utilizing data. The main

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objective of using this method in the organization is to minimize variability and to improve processes through data-based strategies [4].

The Six Sigma method is composed of five steps: Define, Measure, Analyze, Improve and Control. The initial letters of these steps form the acronym DMAIC, which is used as the name of the method. Pande et al. shared a roadmap for the implementation of this method. They explained how it increases not only the efficiency of companies but also customer satisfaction, while reducing costs [5]. The DMAIC method is implemented as follows. In the Define phase, an initial project description form is created. Considered highly important by Pyzdek, (as cited in Kumar et al.) this form specifies the nature of the problem, the launch and completion dates, team members, along with the scope and objectives of the project [6]. Then the actual work is undertaken. In the Measure phase, the potential root causes are identified using techniques like brainstorming or fishbone. The data about these root causes are collected and analyzed. As Tjahjono et al. note, the data can be analyzed using a number of tools, including pareto graphics and regression analysis [7]. In the Improve stage, some essential improvements are made based on the results of the analysis. Finally, in the Control phase, the project ends with the measures taken to ensure the sustainability of the improvements.

As one would expect, Six Sigma is not a magic wand. The method could be beneficial if adopted across the organization. Caulcutt explained how large companies that used the Six Sigma method, such as Motorola, General Electric and Black & Decker, improved their business processes. He explained how to apply the Six Sigma method and stated that the most critical key to achieving success is to make the method a corporate culture [8].

Six Sigma has proven itself by spreading since the day it was introduced as a process improvement tool. For example, in their study in the chemical industry, Deshpande et al. showed that the Six Sigma method significantly reduced the defects, increased customer satisfaction, and positively affected the market share and employee performance [9]. Kabir et al. increased the productivity and production quality of a company, manufacturing fans through Six Sigma [10].

Most of the earlier studies conducted using the Six Sigma method addressed manufacturing functions. However, the method is used not only in manufacturing, but also in the service departments of businesses, as well as in enterprises that provide direct

service. Chakrabarty and Tan examined Six Sigma studies conducted in the service sector. They identified critical success factors and quality parameters, along with key performance indicators that need to be tracked. According to these researchers, “time, cost, employee behavior, accurate information and timely information” are considered as critical quality parameters in this sector [11].

Blakeslee elaborates on how the Six Sigma method proved useful in boosting quality and competitiveness in baggage handling, in which the Sigma Level was 3. He shared the main principles and the steps to be taken [12]. Wyper and Harrison used the Six Sigma method to employ the right person in the right place, at the right time and with the right wage, which are the basic principles of human resources processes. First, they listed the customers of the process and prepared a process map. By using various Six Sigma tools, such as cause and effect diagram and pareto analysis, they managed to reduce personnel costs by 34%. In addition, there was an increase in customer satisfaction [13]. Sánchez-Rebull et al. obtained successful results by using the Six Sigma method in managerial and financial processes in a large German company producing canned food [14]. Mitreva and Kirovski improved the business processes of the microbiology unit in a public hospital serving in the Republic of North Macedonia by using the Six Sigma technique [15].

There are also studies in which the Six Sigma method was integrated with lean manufacturing techniques. Furterer and Elshennawy used Six Sigma and lean manufacturing tools together to improve the services provided in local government processes. As a result, they accelerated the financial transaction processes [16]. Mahmoud et al. developed product features in line with customer needs by the Lean Six Sigma method in a cement production facility [17]. Marrucci et al. integrated Lean Six Sigma and environmental management. They conducted a study to reduce the carbon footprint of a supermarket caused by food and packaging waste [18]. Lavin and Metter preferred the Lean Six Sigma method to improve the quality of health care services in an orthopedics hospital in the USA [19].

Gijo and Rao shared the problems encountered during Six Sigma studies and made suggestions based on their experience, rather than focusing on the success achieved. For example, commonly cited problems included but not limited to the work’s being either too narrow or too wide in scope, the lack of enough resources, issues of

coordination, being too hasty, mistakes made in choosing the project leader [20].

There is a paucity of research on the use of Six Sigma in the retail sector, a component of the service industry. A possible reason for this could be the prior development of the manufacturing sector compared with the service sector. There might be other reasons as well, such as the frequent use of advanced statistical tools with extensive data and the use of complex experimental designs in studies that use this technique. Therefore, researchers might have thought that the method was not appropriate for the service sector. Madhani noted that Lean Six Sigma applications in the retail sector are different from those in the manufacturing and other service sectors. According to Madhani, this difference could be attributed to the unique characteristics of the retail sector, such as the higher employee turnover rate, higher number of branches, customer relations and so forth [21]. In another study, Madhani proposed an efficiency-effectiveness framework to be used the Lean Six Sigma method in the retail industry. This framework aimed to reduce the costs and increase customer satisfaction [22]. However, except for Marrucci et al., no researchers have studied Six Sigma or Lean Six Sigma in supermarkets. This is also supported by Sreedharan and Raju because they reviewed 82 articles on Lean Six Sigma in the service sector, but none of them focused on supermarkets [23]. Similarly, Prakash et al. reviewed 63 articles on the use of Six Sigma in the service sector, but there was not a single study carried out on supermarkets [24].

The Six Sigma method is thought to be very difficult and burdensome for enterprises that do not use it. Given that they do not have enough resources, small and medium-sized enterprises (SMEs) may prefer not to use the method. The Six Sigma method is like a large toolbox. The important thing is to decide which tool to use where. In this study, the Six Sigma method is proposed for process improvement through practical tools without depleting the available resources. This study aimed to improve the inventory levels of a large supermarket in Sanliurfa through the Six Sigma method. Aiming to keep the inventory levels at the optimum level, it also aimed to strengthen the financial position of the company. In this business, excess inventory led to an increase in the products which needed returning. The products with a lower inventory turnover rate occupied a certain place in the warehouse, so they imposed an additional burden on the company. By applying the steps of the Six Sigma method, the present study investigated the

causes of the inventory, and it also aimed to increase the financial efficiency of the company by reducing the inventory levels. In short, the widely known DMAIC steps were used at a supermarket to suggest a practical application.

The method followed is detailed in the second part of the study. The results and the improvement actions taken are addressed in the third part, and the results are presented in the fourth.

## 2. Material and Method

In this study, the phases of Six Sigma were followed. First, the problem was defined in collaboration with the process owner, and the scope of the study was specified. Company management wanted to keep the inventory levels at an effective level to increase profitability and ensure sustainable growth. Therefore, purchasing processes and inventory turnover rates of products were monitored. One of the problems that has arisen recently is the increase in the financial value of inventory due to products with lower inventory turnover.

During the define stage, a project team was established with employees from all departments affected by the problem. The definition of the problem, the purpose of the study, its contribution to the business and its scope were discussed by the team consisting of employees in the inventory management, accounting department, store management and purchasing department. Then, the potential root causes were determined by brainstorming with the team. The root causes were evaluated on a 10-point Likert scale (1 point: Insignificant, 10 points: Very significant) and were ranked according to their level of importance.

Data were collected during the measure phase of the study. The first 10 products with the highest inventory level in terms of their financial value in the last six months were examined. Moreover, the first 10 products with the highest inventory level in terms of quantity in the last six months were investigated. Therefore, the inventory data of the first half of 2019 were obtained thanks to the software used by the supermarket. In this business, no previous research studies had been carried out on products with lower rates of inventory turnover and excess inventory. Therefore, the present study addressed products with lower rates of inventory turnover.

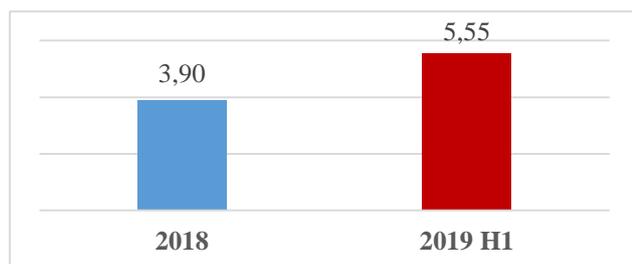
In the analyze phase, the data obtained during the measure phase and the inventories in terms of their

financial value and quantities were analyzed as two different groups. Finally, process defects that led to higher inventory levels were identified and associated with the root causes, and the most common reasons for the problem were revealed. Then, actions were planned to create inventories effectively during the improve phase. Finally, in the control phase, a monitoring system for inventory levels was suggested to clarify the benefits of improvement actions and to ensure their sustainability.

### 3. Results and Discussion

#### 3.1. Inventory Levels

The supermarket where the study was conducted was a large business that had been actively operating since 2018. The inventory levels in the supermarket in 2018 and in the first half of 2019 were examined. As seen in Figure 1, they increased by approximately 41% in the first half of 2019. This indicates that the problem required an urgent solution.



**Figure 1.** Inventory Levels (Million TL)

#### 3.2. Brainstorming

The potential root causes were identified in the brainstorming session held with the study team to investigate the causes of excessive inventory levels, and they were ranked from highest to lowest in accordance with the total score of importance level (Table 1). It was considered that there was not a particularly effective inventory tracking. Due to the organization of the purchasing team, repeated purchases were often made. The brainstorming session also revealed that there was difficulty in demand forecasting. Based on the potential causes, some detailed research was carried out.

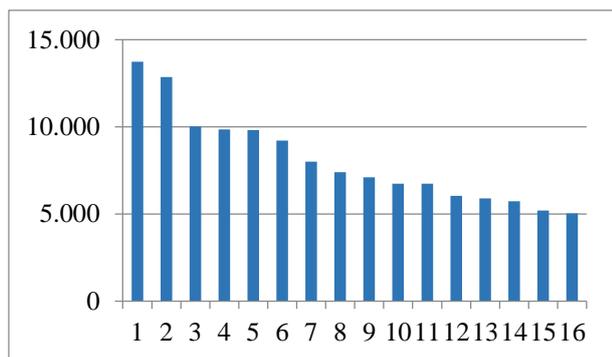
#### 3.3. Quantity-based Inventory Levels

First of all, the products that constituted the highest inventory level in terms of quantity were identified. In Figure 2, products with an inventory level above five thousand are shown. It is seen that Products 1 and 2 have a higher inventory level than the others. A detailed examination revealed that the inventory turnover rate of the first product was high, while the inventory turnover rate of the second product was relatively low.

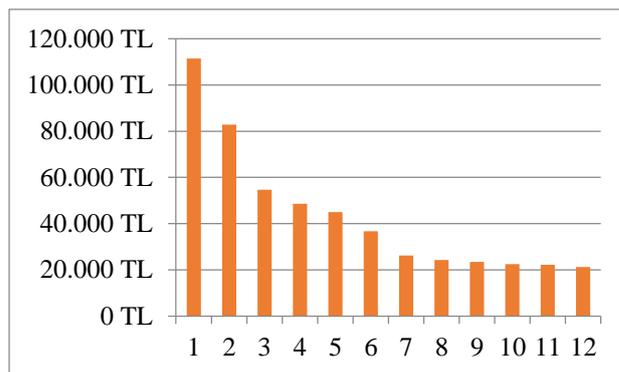
In addition, the products with the highest inventory level were also examined. It was seen that the top-ranking products in the graph showing value-based inventory levels in Figure 3 were almost the same products as those in Figure 2.

**Table 1.** Potential root causes of the problem

No	Root causes	Score
1	Failure to follow inventory turnover rates of products	30
2	More than one person making purchases in the same product group	28
3	Products' coming in many different brands	24
4	Offering appealing prices in the purchase of extra products	17
5	Uncertain customer demand	14
6	Some suppliers' having extended lead times	13



**Figure 2.** Products with the Highest Inventories Based on Their Quantity



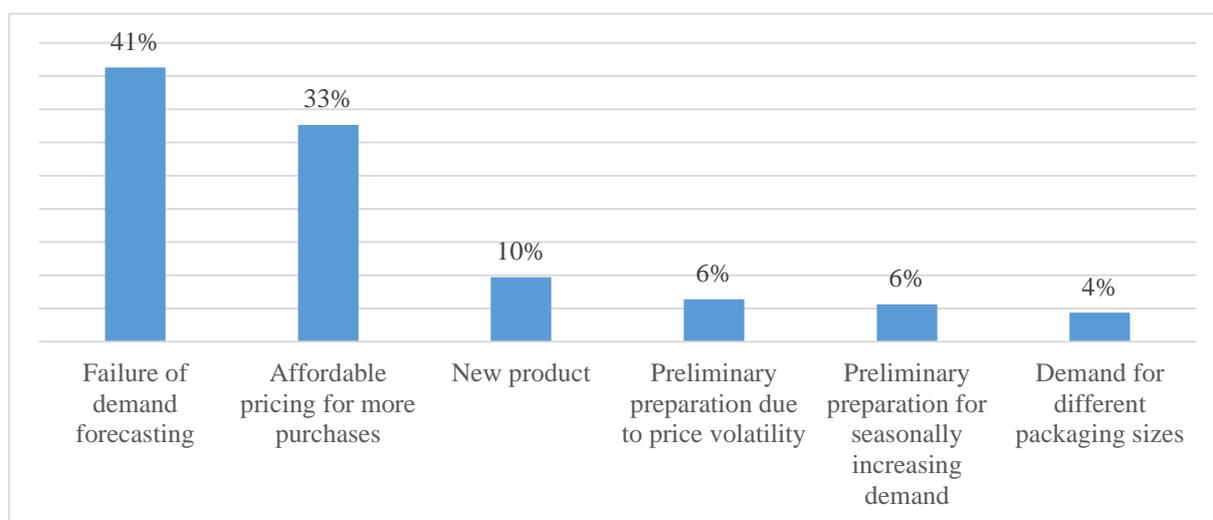
**Figure 3.** The Inventory Levels of the Products Based on Their Financial Value

### 3.4. Why is there a surplus of inventory?

Inventory data were examined and analyzed retrospectively in this study. Figure 4 shows the reasons for the inventory of products with a higher financial value and a lower inventory turnover rate. An analysis of the reasons in this group revealed that the major reasons were seeking reasonable prices in big purchases and not being able to forecast the demand. These reasons accounted for 74% of the inventory in terms of financial value in this group. On the other hand, there were also inventories prepared for preliminary purposes due to new products, price volatility and the volatility of seasonal demands. Customers demanded different product sizes, so the same product was more popular in some package sizes than in others. In fact, this was a special case which was related to the reason why the demand forecast was not accurate.

In the next phase of the study, the causes of excess inventory were associated with potential root causes identified during the brainstorming session. The results are presented in Table 2. All the potential root causes appear to be effective. However, the main problem was in the purchasing organization. In line with this, the functions of inventory tracking and demand forecasting were not efficient enough.

Another noteworthy point is that the fifth item, “Customer Demand Uncertainty”, which was a potential root cause, was found to be a key cause of excess inventory, although it was of relatively minor importance in the brainstorming session. Therefore, it is important to take actions that could shape customer demand and make it predictable.



**Figure 4.** The Causes of Excess Inventory

**Table 2.** Causes of excess inventory and root causes

Causes of Excess Inventory	Number of Root Causes					
	1	2	3	4	5	6
Failure of demand forecasting	X	X	X		X	
Affordable pricing for more purchases	X			X		X
New product			X		X	
Preliminary preparation due to price volatility				X	X	
Preliminary preparation for seasonally increasing demand			X	X	X	
Demand for different product sizes			X		X	

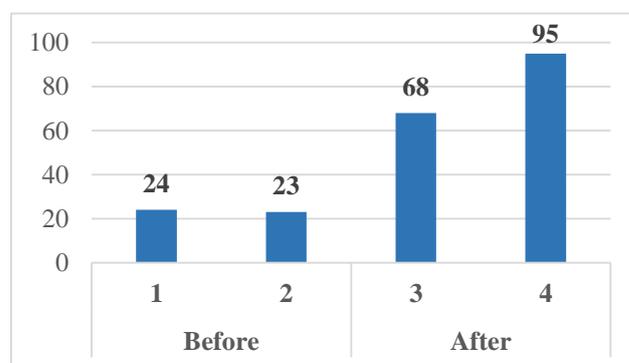
### 3.5. Improvement Actions

As a result of the analyses, some actions were planned to improve the process. Being the main problem, the purchasing organization was first examined. In line with the expertise of the purchasing staff and the total workload in the product groups, a scheme was prepared based on product groups. A preparation of a standard work instruction for regular inventory tracking, as well as a system in which inventory turnover rates to be followed based on a product/product group, were suggested.

Demand forecasting is not easy, particularly for supermarkets where the product portfolio is rather diverse. However, professional demand forecasting can be carried out using appropriate software. It is possible to reduce forecast deviations through both long-term and short-term data analysis. It is necessary to pay attention to many parameters, such as volatility arising from seasonal demands, different demands for different brands or different packaging sizes, and the performance of competitors.

It is possible to direct customer demands and make them even more predictable. Thanks to regular monitoring of inventory and demands, it is possible to take a number of actions such as making product combinations, highlighting, making departmental arrangements, discounting, and avoiding products/product groups that are not in demand. When the products with longer delivery periods were examined, it was seen that the problem arose, especially due to the suppliers outside the city.

After taking the necessary actions, we noticed that the sales performance of some of the products increased rapidly. An example of these products is shown in Figure 5. Various strategies were used for this product, including but not limited to discount, departmental arrangement, highlighting and printing brochures.



**Figure 5.** Monthly Sales of Product A (Qty)

### 4. Conclusion and Suggestions

This study revealed that process improvement can be achieved through the Six Sigma method without depleting the available resources. The Six Sigma method does not only use advanced statistical tools but also uses processes that can be improved with practical tools whenever necessary. The problems mentioned in this study can be solved using software investments in many supermarkets. However, what is

offered in the present study may not appeal to the needs of some businesses, especially those of SMEs that may desire to use process improvement techniques without making much investment.

The results indicated that most of the existing inventory was caused by inaccurate demand forecasts and excess purchases made by the supermarket due to affordable prices offered by wholesalers. When a relationship was established between the potential root causes that emerged while brainstorming with the team and causes of inventory, it was understood that there was a deficiency in the inventory tracking system and demand forecasting processes. The main reason for this was found to be the purchasing organization.

In this study, the purchasing function was reorganized. Necessary standards and work instructions were established. Several suggestions were made regarding demand forecasting. In order to make customer demands more predictable, sales and marketing techniques, such as product combination, highlighting, department arrangement, and discounting, were utilized. Consignment agreements

were recommended for products with longer lead times.

The realization of improvement actions helped achieve improvements in the inventory levels. A monitoring plan was prepared to ensure the continuity of the improvements. Based on this plan, outlined in Table 3, the purchasing unit was required to report regularly to the board of directors. Further research could investigate demand forecasting models.

### Contributions of the authors

The contributions of each author to the article is equal.

### Conflict of Interest Statement

There is no conflict of interest between the authors.

### Statement of Research and Publication Ethics

The study is complied with research and publication ethics.

**Table 3.** Monitoring plan

Items to be monitored	Monitoring frequency
Inventory Levels (Based on Product Groups)	7 days
Inventory Levels (Product-based)	7 days
Inventory Turnover Rates (Product-based)	7 days
Inventory Levels of Product Groups (Brand-based)	15 days

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