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Effects of operational and structural conditions on inventory management in large manufacturing enterprises*

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Abstract

Inventory management is one of the key concepts for manufacturing enterprises in order to be successful. In some certain circumstances, many manufacturers suffer from inefficient inventory management because of their business environments. Many operational and structural conditions cause inappropriate inventory management and inventory related problems appear eventually. On the other hand, some abilities and technological opportunities of manufacturing enterprises drive their inventory management more efficiently. The aim of this article is to find out how these operational and structural conditions affect inventory management. Survey data was collected from 305 large manufacturing enterprises (LMEs) located in Turkey. It has been found that demand and capacity related issues are among the most significant for inventory management. It has also been found that some internal conditions such as ‘work flow breaks’ and ‘uncertainties in daily material usage’ are among the least significant for better inventory management.

Keywords: *Inventory Management, Managerial Performance, Inventory Movement, Inventory Problems*

Büyük ölçekli imalat işletmelerindeki işlemsel ve yapısal koşulların stok yönetimi üzerine etkileri

Özet

İmalat işletmelerinin başarılı olmalarında stok yönetimi önemli konulardan biridir. İş ortamından kaynaklanan bazı belirli koşullar altında, çoğu imalatçı uygun olmayan stok yönetiminden zarar görmektedir. Çoğu işlemsel ve yapısal koşul, uygun olmayan stok yönetimine neden olmakta ve neticede stokları ilgilendiren problemler oluşmaktadır. Diğer yandan bazı teknolojik üstünlükleri ve yetenekleri olan imalat işletmeleri stok yönetimini daha verimli yürütebilmektedir. Bu çalışmanın amacı, bu işlemsel ve yapısal koşulların stok yönetimini nasıl etkilediğini bulmaktır. Anket verileri Türkiye’deki 305 tane büyük ölçekli imalat işletmesinden toplanmıştır. Talep ve kapasite konularını ilgilendiren koşullar stok yönetimi için en önemli olarak bulunmuştur. İyi bir stok yönetimi için “iş akışında yaşanan kesilmeler” ve “günlük malzeme kullanımındaki belirsizlikler” gibi bazı içsel koşulların da en az önemli olanlar arasında oldukları bulunmuştur.

Anahtar Sözcükler: *Stok Yönetimi, Yönetsel Performans, Stok Hareketliliği, Stok Problemleri*

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1. Introduction

Availability of many parts, raw materials and components to usage in the right time and place require manufacturers to hold certain amount of inventories. When inventories are looked from a broad perspective, they possibly are in the form of input supplies such as energy, equipment and raw materials, output goods such as components and products as well as in the form of between input and output materials such as work-in-process or semi manufactures [1, 2]. Some large manufacturing enterprises (LMEs) can hold more than 500,000 different kind of parts in inventories while some medium sized manufacturers are in need of holding around 10 000 different kind of raw materials, parts and finished products [3]. Holding excess inventories negatively affects net cash flow. Excess inventories reduce revenues and profitability and increase costs. Excess inventories may negatively reflect on supply chain process effectiveness as well as competitiveness and managerial abilities of a company [4].

It has been proven that even if companies use just-in-time (JIT) production systems within some lean manufacturing practices, reducing effects in inventory levels of those practices will be different degrees in terms of inventory kind and industry [5]. Some studies indicate that finished product inventories are not reduced substantially in terms of quantity and holding days and the biggest reduction is in work-in-process inventories and next is in raw materials [6, 7]. These findings denote that new developed technologies do not remove inventories completely in manufacturing enterprises. Inventories continue to be a primary problem in companies. In a survey study on 294 manufacturers in Turkey, the manufacturers' primary goals to make production planning has been asked and 'to increase inventory turnover (answered 41.92% of them)' and 'to follow up production processes and inventory levels more solid and up-to-date (answered 34.36% of them)' answers took first three places [8].

Inventory management is significant for a manufacturing company operating in an inventory intensive industry since effective applications in it cause costs to decrease so that the company avoids severe results from material resource shortages [9]. Inventory management, as a system, consists of a series of politics and controls that explain what level will inventories be maintained; when they will be replenished, and how big their orders will be [1]. Who should manage inventories in a company? There is no universal answer to this question. The important point here is that there should be a mechanism conveniently fulfilling and balancing the wishes and constraints of all sides regardless of who manages inventories [10].

There is an impression formation about that the more the enterprises become larger, the more they use professional employees and techniques [11]. On the contrary, because of having a less flexible structure of large enterprises when compared to small and medium sized counterparts, a sudden inventory problem can be handled more slowly and costly. The aim of this study is to find out if there are some meaningful differences among the levels of negatively affecting factors on LMEs' inventory management. In accordance with this purpose, survey data were collected by a convenience sampling from 305 LMEs, located in Turkey and employed more than 250 employees. In the following sections first, negative or positive possible developments of the performances of inventory related managerial elements are presented. The reasons of enhancing or fluctuating inventory movements are explained in the third section. Research hypotheses are proposed in this section too. Methodology in which sample demographics and utilized data analysis are explained comes in the fourth section. Analysis findings and related interpretations are explained in the fifth section. Last section concludes the study and gives future directions.

2. Managerial Performance Indicators of Inventories

Key indicators of effective inventory management are related to how inventory system is planned and controlled as well as how companies' organizational architecture of inventory management is [12, 13]. In a study on those issues, it has been found that the more unfavorable operational and structural conditions manufacturing company has, the less the company be successful in managerial performance factors [14]. Another study on similar issues has been found that supply chain and information system inhibitors negatively affect operational performance [15].

It is obvious that collecting real quantitative data regarding the performance of manufacturing enterprises is very difficult especially when sample size is large. Because of this difficulty, performance measures explained in this section will be based on qualitative judgments of managerial stuff in manufacturing companies.

2.1. Working Conditions Performance

Enterprises should have a good information system to view accurate demand and inventory levels and to monitor policy and procedures consistently in order to develop an efficient inventory management system [16]. Having an enterprise-wide inventory management information system facilitates many inventory related technology usage [17]. In Sönmez's study, nearly all of the enterprises indicate that they make short and medium term production planning and a large amount of these indicate that they monitor performances in their enterprises [8]. An adequate technology, a specified inventory management strategy, an adequate inventory record keeping and auditing, and specified performance measures are the most important inventory related working conditions [13]. Management, as a first step, must give priorities and expectations that are necessary for accurate inventory records [18]. Among the reasons of inaccurate inventory record keeping are product coding mistakes, counting mistakes, taking a wrong product from stocks, not keeping record of defective inventories and late updates [2]. A total of 273 enterprises out of 294 monitor the performance of inventory records in Sönmez's study [8]. Accuracy of inventory records is 95-100% in 227, 85-94% in 36 and less than 85% in 10 of those enterprises. It is possible to manage inventories faster and accurately by having an adequate technology in measurement and evaluation areas. According to Shah and Shin's study, the more capital is invested to information systems, the less inventory levels will be in manufacturing enterprises [19]. Rules for measuring and evaluating inventory performance are in manufacturing strategy of the company [20]. Establishing a certain inventory management strategy in advance may provide inventories to be managed without any conflict with upper level strategies.

Cost and productivity are effectively analyzed by accurate and adequate inventory record keeping and auditing. Clearly identifying performance measurement criteria facilitates to analyze productivity as well. According to Sheldon, in order to begin with an accurate data, it is necessary to have a working team who is responsible for the accuracy of inventory records and takes charge of the process [18]. This working team consists of 7 members including a leader and supporting personnel. Accuracy is necessary not only for inventory records but also for monitoring at least weekly progress, warehouse space utilization measurements, scheduled activities of next week [18]. Sheldon states that the company should follow a systematic procedure to keep records of inventory documents and to determine standard operating processes [18]. Any inconsistency in inventory records cause some decrease in productivity of workers, some production or order of unwanted parts, some unfulfilled customers' needs, some stockouts and dissatisfaction [9].

2.2. Employee Performance

Employees as the first persons who directly deal with inventories, their well being in personal abilities as well as in their values taken from organization's culture may be one of the most significant performance indicators. In a study on automotive manufacturers, it has been found that if manufacturers are engaged employees to improve work processes, inventory levels are reduced substantially [21]. Employees know how to do their own jobs better than their employers do. Employees do not want anyone to make decision on any matter without considering their opinion at first. They do not want to deal with them as a machine. Thus, expectations of employees and expectations of manufacturers are in conflict [22]. From this point of view, providing employees to involve inventory related decision-making, being well trained of employees, specifying the responsibilities of employees, and employees' comfort for telling their problems or knowledge to management are among the indicators of how employees are good performers [12, 13]. All of the favorable characteristics of employees support an effective inventory management. Being well trained of employees provides them to solve problems easily and to do their jobs in an effective and timely manner [23]. In addition to this, it has been found that when expectations of managers in the direction of improvement of employees are increased, inventory levels are decreased in certain amounts [21].

In a survey study on how much ready the Turkish enterprises to enterprise resource planning (ERP) are, enterprises has been asked 'Did you trained your employees enough on enterprise-wide thinking?' and so the sample mean was 2.94 based on 4-point Likert scale. Enterprises have been asked 'Did you prepare your employees to work in a paperless environment?' in the same study and the sample mean was 2.72 [24]. These results may be an indicator that Turkish enterprises in this sample cover some distance on the employee training about ERP and inventory management but this is not enough. One of the good responses to uncertainties happening in manufacturing enterprises is investing to employees. Training is not enough by itself. Providing a culture in which employees are disposed to use all their abilities is necessary [25].

2.3. Decision Making Process Performance

Inventory management decisions are complicated. Inventory management decisions are behind intuitive power of decision makers because there are many kinds of jointly involved systems that must be coordinated, rationalized, adapted and controlled both physically and conceptually. Any decision about any production part is a decision that considers relations with other similar parts, total inventory investment, aggregate plan of the organization, production-distribution systems of vendors and customers, and entire economy [3]. When management becomes less effective about inventory decisions, its services become weaker, costs become higher and return on investments become lower [9]. Faster, logical, scientific and adaptable decision-making are among significant performance indicators to monitor qualified procedures when inventory related decisions are being made.

Following a logical procedure as in the scientific decision-making process does not only analyze decision alternatives sufficiently but also makes decisions faster. It is possible to make decisions faster only when decision-making steps are followed systematically. Involving scientific methods in decision-making procedures is also an important factor to make right decisions. Many decision models can be integrated with computer supported inventory systems when making a decision about inventories [9]. Computer support may decrease the risk of making a wrong decision. Inventory related decisions must not be in conflict with other decisions of the company. All departments have to be informed simultaneously. Therefore, providing no development in inventory management and any confusion are eliminated.

2.4. Problem Solving Performance

As Sheldon states the success is achieved by a constituted team of inventory management only when the team members are well trained and practiced [18]. There are many problem-solving instruments to facilitate determining and eliminating underlying inventory problems. Easier inventory problems are the ones that are possibly subject to become habits as well. Any cultural change cannot be provided if those habits are not practiced and not being expected in every team effort.

Informal applications and measurements in inventory management will decrease productivity and cause inconvenient utilization of workforce, machine, and material [9]. The faster the inventory problems are determined, the faster preventive actions for the solution are taken. A faster determination of the problem, its acceptance, no hiding of it, solving without any damage are among performance indicators of overcoming the problem. Only if there is a business environment open to innovation then higher problem solving performance (PSP) is expected [23]. Accepting and displaying of a problem without hiding is also an indicator of willingness to solve. Not giving any damage to company's other departments or workstations by the solution alternatives is an indicator of how the problem is solved successfully. For the last thing, ability to solve inventory problems faster is appreciated as a performance indicator because this provides solving the problems before they get bigger and spread throughout the whole operations.

3. Operational and Structural Conditions Causing Inventory Movement

LMEs are exposed at different levels to operational and structural conditions causing inventory levels increase or decrease, transporting inventories from place to place, holding inventories for a short or long period and so causing some change in their movement levels. Because of these varieties of exposition levels, affecting degrees of featuring performance indicators in managerial success of inventories will be in variety. Factors causing inventory movement and so affecting inventory management are explained under main headings in this section.

As will be explained in section 5, exploratory factor analysis has been used in order to determine the internal consistencies of aforementioned four managerial performance factors (indicators) of inventories. All of the factors have been loaded but 'employee performance' has not. Therefore, all of the following hypotheses are separated by three (with the exception of 'employee performance') additional hypotheses in parenthesis that are depicted by a, b, c letters in the meaning of 'working conditions performance (WCP)', 'decision making process performance (DMPP)' and 'problem solving performance (PSP)' respectively.

3.1. Effects of Material and Workflow Irregularities

Disordered locations of materials used in production processes and availability difficulties of those materials when they are needed constitute a serious problem especially for job shops having functional layout [26, 27]. Using these materials irregularly is one of the factors that can cause some irregular jobs on inventories [12]. Thus, inventories are not processed on time and effectiveness of their management becomes harder. Any irregularity on workflow is another factor that can negatively affect on inventory management. An irregular workflow causes some irregular inventory processes. This situation makes inventory related problems appear in irregular time periods [28]. On the other hand, higher setup costs increase inventory costs and levels. A longer throughput time also causes higher production and inventory costs [9].

3.1.1. Uncertainties in Daily Material Usage

Companies use inventories in order to balance production flexibility level and uncertainty of business environment [25]. Increasing uncertainty level also increases the level of uncertainty in daily amount of material usage. Manufacturers are in need of holding inventories of those materials in order to supply any sudden or unexpected needs. The reasons for shortages of materials can be lower delivery performance of suppliers (e.g. less or late delivery), inconsistent inventory records (e.g. unreliable warehouses), application of wrong inventory control rules (e.g. unexpected demand model changes), and unexpected or urgent changes in production schedules (e.g. order quantity changes by customers) [29]. A study on automotive manufacturers has been shown that because production of less complicated and smooth shape parts is easy and fast, their inventory levels are decreased, and on the other hand, especially work-in-process and finished goods inventories are increased for the parts requiring more process such as engine components and steel type [21]. The levels of these kinds of inventory movements cause certain changes in inventory related managerial performance indicators.

H_1 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'uncertainty about daily material usage', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.1.2. Workflow Brakes

Uncertainties appearing in production processes cause some supply and demand uncertainties as well within a company. Therefore, some preventive actions such as safety stocks, safety lead times and work with overtime are taken [29, 30]. Similar to this, because of excess resource loading, parts will be late from a previous workstation and supply shortages and delays happen in the following workstation [30]. Some part of production processes have to be stopped because of both workflow complexity and unbalanced production line in manufacturing enterprises with repetitive production systems and especially with functional layouts [26]. Coming materials, parts and semi manufactures from the other part of processes become waiting particularly in front of stopped processes. These waiting materials and parts negatively affect managerial performance indicators whether or not they are delivered to other places.

H_2 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'work flow brakes', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.2. Effects of Inconvenience in Physical and Economical Living Conditions

Some company features because of location may cause some specific troubles for inventories. Being away from suppliers, limited transportation abilities, difficulties in geography and climate produce inventory management problems. Enterprises are exposed to additional costs in order to adapt inventories to stock in appropriate places and make their deliveries in a suitable environment. However, many enablers in supply chain management and information system of an enterprise reduce negative effects of supply chain management and information system inhibitors on operational performance [15].

3.2.1. Willingness to Prevent Economical Instabilities

Many enterprises in Sönmez's study have given 'inflation and changes in exchange rate policy' as a reason to why they operate without production planning [8]. There is no inventory investment need in the periods of a stable economy. However, the opposite is true in the periods of expansion [3]. Effective policies to control the level of inventories are needed especially in an economical environment with an inflationary pressure. Having excess inventories in such an environment reduces both return on assets and productivity, and stabilizes cash flow. Inflation increases uncertainty and makes planning harder [31]. Higher inflation makes a desire to buy input materials before their prices become higher. That is why raw material inventories are increased. On the other hand, inventory levels are decreased because of holding inventories is more costly than holding equity and bonds when interest rates are increased [7]. Supplying input materials of production is obviously harder for any manufacturing company that suffers from the shortage of funds. Therefore, in order to use during uncomfortable periods, companies may prefer supplying plenty of input materials, parts and components to stock in the periods of no shortage of funds. Those kinds of inventory movements cause some changes in their managerial performance indicators.

H_3 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'willingness to prevent economical instabilities', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.2.2. At a Distance from Suppliers or Customers

It has proven that the more frequently the customers are communicated, the less inventory level will be [21]. When manufacturers ordered a material necessary for production, they want this order to be on hand in an appropriate time and as soon as possible. It is also necessary to deliver finished goods to customers as soon as possible. Being at a distance from suppliers or customers of manufacturers makes trouble for them to order in a timely and more frequently manner. An insufficient vendor support negatively effects operational performance of an enterprise [15]. A study on 82 Turkish manufacturers shows that delivery lead time and frequency takes first three places among other supplier selection criteria [23]. Enterprises may prefer holding inventory because of delays of an ordered product to be on hand [10, 32]. In Sönmez's study, 49.32% of enterprises have sad that they monitor supplier delivery performance [8]. The most significant reasons of supply fluctuations are late deliveries, shorter shipment times, production delays, a gap between production quantity and planned quantity, and standardized materials and production [33]. A study has shown that 92.3% of the reasons for shipment delays are lower performance of suppliers' shipments directly or indirectly [29]. If all participants of a supply chain work in collaboration, share information with each other, and institute a relationship based on trust, any possibility of inconsistently increasing inventories may be reduced [4, 23]. Having an inconstant lead time causes an increase in both inventory cost and throughput time. In a study by Rajeev, it has been found that there is a negative relationship between lead time and inventory management performance and a positive relationship between effectiveness level of purchasing and inventory management performance [9].

H_4 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'at a distance from suppliers or customers', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.2.3. Availability of Warehouses for Usage

After transportation costs in total logistics costs, warehouse costs and inventory carrying costs come next respectively [34]. Enterprises could have their own warehouses as well as could use exterior ones. In a study on several factories of a cement producer company, managerial personnel have mostly preferred outsourced warehousing in terms of decision-making factors on warehouses [35]. Warehouses can be used as a stock keeping unit as well as a combining centre, a transfer point, a classification centre, an assembly unit, a centre for returns, or as more than one of these purposes. While decisions are being made on warehouses, it is necessary to look at trends in the market and industry, goals of the firm, business plan, supply chain strategy, and outside regulations such as acts [35, 36]. Neglected warehouses may increase inventory damages inside. In general, 82 Turkish manufacturers in Ulusoy's study are not comfortable with the effectiveness of their warehousing [23]. Sometimes the problem of not fully utilization of warehouses can also appear. This can be caused from geometric shape of the product, disability to pile up orderly, some necessary rules in the layout system, and an inappropriate layout in warehouse or garbage systems [37]. An inadequate capacity of available warehouses can burden effective management of inventories. All of these unfavorable things about warehouses make inventory levels sometimes smaller and sometimes larger.

H_5 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'availability of warehouses for usage', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.2.4. Product Diversity

Product diversity brings about diversified raw materials, components and materials allocated to those products. Therefore, number of materials used in a product mix is increased substantially. This situation especially increases work-in-process inventories [6,38]. An increase in diversified inventory items makes their management harder. Different production performances appear for different product mixes. Thus, a focusing problem appears based on increasing product diversity. Using the same production planning and control, accounting and inventory management systems for all kind of products makes these problems bigger. For example, 'production planning and control system' can be well designed for product-A while 'inventory management system' can be well designed for product-B in a company. It is very difficult for both systems to perform equally for both products [22]. In a simulation study, it has been found that service level is decreased while product diversity is increased, and to satisfy service level, more safety stocks are needed [39].

H_6 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'product diversity', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.3. Effects of Demand and Capacity Changes

An irregular demand cause some irregular increase or decrease in inventory levels [40,41]. Changing inventory levels can make inventory holding cost increased and if it is caused stock shortage, sales may be decreased [42]. A factory with certain type of equipment, size and layout can operate economically in its regular operating system but it can operate less productive, for example with 30% throughput level. Similar to that, allowing a change at lead time makes serious changes in equipment, process technology, production control, and inventory policies [22]. Because of demand or capacity changes, each movement in inventories brings about a series of additional managerial activities and many problems appear because of these new activities.

3.3.1. Product Demand Fluctuations

An irregular demand is a key factor especially for the level of safety stock determination in many industries [21, 43]. Some product demand fluctuations are possible in many companies. Before the product demand will be increased, company tries to be ready for this by increasing inventories [10, 42]. In the period of decreasing demand, there are unnecessary backlogs. Therefore, as a wasted resource, the capital dedicated to these backlogs decrease productivity. A study has shown that 79.5% of the reasons for lower delivery performance are product demand changes [29]. It has been shown that flexibility is decreased and safety stock level is increased in a volatile market environment in Garg's study [39].

H_7 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'product demand fluctuations', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.3.2. Gap between Ordinary and Operational Production Capacity

A capacity strategy is based on a series of assumptions and forecasts necessary for a long period of market, technology and competitive action, and is a basic element of a manufacturing strategy in a company [20]. Using the capacity lower than ordinary capacity is an expected result for many manufacturers while production is running. This gap between ordinary and operational production capacity can make demand satisfaction too difficult. The manufacturers exposed to this situation try to protect themselves from capacity imbalances by increasing inventory levels while they are operating ordinary capacity. There is a limited capacity for each supply process and thus, it is limited to meet demand changes or past dues, whether or not they were forecasted before. Inventories are needed to satisfy this inflexibility [10]. A lower capacity causes stockouts frequently. Frequently having stockouts however, increases the tendency of higher levels in work-in-process and finished products inventories in a multi-stage dependent demand manufacturing environment. It can be said that capacity levels are an inverse function of inventory levels [44].

H_8 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'gap between ordinary and operational production capacity', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.3.3. Gap between Forecasted and Real Product Demand

In several studies, it has been found that the bigger the gap between real and forecasted demands the lower performance in production [43, 45]. In a simulation study, it has been shown that higher uncertainty levels in demand cause higher average inventory levels [41]. Some numbers of enterprises have given the answer 'no demand forecast because of market uncertainties' to the question 'why they do not plan' in Sönmez's study [8]. When demand forecasts are away from real demand, plans become imbalanced and thus, unnecessary inventory backlogs or shortages become appeared. Therefore, enterprises want to hold more safety stocks [33].

H_9 (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'gap between forecasted and real product demand', there are significant differences among these categories in terms of managerial performance indicators of inventories.

3.3.4. Gap between Forecasted and Real Time of Product Demand

A product's prospective demand time can be wrong determined sometimes. An excess inventory or an inventory shortage appears if demand occurs after or before the expected time. If an enterprise's time forecasts for demand are wrong it is also possible to face with old-fashioned product inventories [20]. In Safizadeh and Ritzman's study, it has been found that the more the gap between real and forecasted demand time is, the less production performance will be [45]. Therefore, shortages or old-fashioned products are both negatively affect the performance of inventory management.

H_{10} (a,b,c): When LMEs are categorized in terms of the degree to which they are affected by 'gap between forecasted and real time of product demand', there are significant differences among these categories in terms of managerial performance indicators of inventories.

4. Methodology

In this survey study, questions were asked to inventory management skilled personnel holding managerial positions in LMEs in Turkey. During 2008 spring semester, Bilecik Economics and Administrative Sciences Faculty students who were taking Statistics II course participated actively to collect the survey data. In order to consider a manufacturer as a LME, 'number of employees' criterion, which is the widely accepted one among several other criteria, has been chosen. Small-to-medium-sized enterprises (SMEs) are defined as ones that employ fewer than 250 employees [15]. Therefore, the enterprises in this study are considered as LMEs since each one of them employs more than 250 employees. The percentage of enterprises located in Marmara region is 70.16. Ankara, with 4.9 percent, and İzmir, with 4.9 percent, hold remarkable shares in the data being outside the Marmara region. City, production system and industrial distribution of the sample are shown in Table 1 and number of workers distribution is shown in Table 2.

Table 1 City, Production System and Industrial Distribution

City	n	%	Industry	n	%	Production System	n	%
Ankara	15	4.9	Durable cons. prods.	14	4.6	Job shop	16	5.2
Antalya	6	2.0	Iron steel	13	4.3	Batchprocessing	39	12.8
Bilecik	8	2.6	Food	35	11.5	Production line	47	15.4
Bursa	46	15.1	Chemical	15	4.9	Continuous	203	66.6
Çanakkale	4	1.3	Automotive supply	37	12.1	**Total**	**305**	**100**
Edirne	1	0.3	Ceramic	10	3.3			
Eskişehir	9	3.0	Textile	83	27.2			
İstanbul	115	37.7	Mining	8	2.6			
İzmir	15	4.9	Machinery	7	2.3			
Kırklareli	3	1.0	Furniture	8	2.6			
Kocaeli	17	5.6	Construction	8	2.6			
Manisa	10	3.3	Plastics	7	2.3			
Sakarya	8	2.6	Leather	6	2.0			
Tekirdağ	9	3.0	Others	54	17.7			
Yalova	3	1.0	**Total**	**305**	**100**			
Others	36	11.8						
Total	**305**	**100**						

Table 2 Number of Employees Distribution

	Number of Employees			**Number of Engineers**	
	n	%		*n*	%
250-300	106	34.8	0-10	130	42.6
301-500	95	31.1	11-20	53	17.4
501-1000	58	19.0	21+	79	25.9
1001+	46	15.1	Missing	43	11.1
Total	305	100	Total	305	100

	Number of Officers		**Number of Technicians**		**Number of Foremen**	
	n	%	*n*	%	*n*	%
0-20	108	35.4	183	60.0	184	60.3
21-50	99	32.5	57	18.7	58	19.0
51+	83	27.2	31	10.2	33	10.8
Missing	15	4.9	34	11.1	30	9.8
Total	305	100	305	100	305	100

Another set of question asked to respondents in the questionnaire is shown in Table 3. By these questions, which company belongs to which affecting level of an inventory movement reason has determined. This affecting level grouping initially determined as 'not at all', 'little', 'average', 'a lot', and 'very much'. Because of very few frequencies in both 'not at all' and 'very much' groups, they were combined with the nearest ones. Therefore, there are three formed groups namely 'not at all&little', 'average', and 'a lot&very much'. Although an ordinal scale was used to obtain the original data as shown in Table 3, this scale was reduced to a categorical scale in order to determine the categories (groups). Data obtained by an upper scale level can be used for a lower scale purpose either [46, 47].

Table 3 Questionnaire Section to Determine Affecting Degrees of Inventory Levels by the Conditions Causing Inventory Movement

	Affecting Degrees of Inventory Levels				
	Not at all	Little	Average	A lot	Very much
1. Uncertainties in daily material usage.	☐	☑	☐	☐	☐
2. Work flow brakes.	☐	☐	☐	☑	☐
⋮ ⋮ ⋮ ⋮	⋮	⋮	⋮	⋮	⋮
10. Gap between forecasted and real time of product demand.	☐	☐	☑	☐	☐

Table 4 shows the items of another section in the questionnaire that has measured performance indicators (factors) of inventory management. A similar study of Başaran and Acılar, based on SMEs, has been used to prepare these items [48]. Unloaded items of factors in Başaran and Acılar's study have been changed or removed. Several new items have also been included. New construct has been tried to consist of shorter and more understandable items as shown in Table 4. A five-point Likert scale has been used for the items (1 = strongly disagree, 5 = strongly agree). Reliabilities of the items can be seen in 'corrected item-total correlations' column in Table 4. SPSS 17 software package has been used to calculate these correlations and all of the following analyses. Although 0.5 is a threshold value for accepting an item to be reliable, none of the items has been removed from the construct because even the lowest values of item 6 and 15 are very closed to 0.5 [49, 50].

Table 4 Questionnaire Items for Inventory Management Performance

Working Conditions Performance	**CITC***
1. We use enough technology to control inventories.	0.559
2. We have a visible strategy regarding inventory management.	0.618
3. We record and audit inventories appropriately.	0.521
4. Our inventory related performance measures are certain and clear.	0.667
5. Inventory costs are controlled and reviewed regularly in our company.	0.644
Employee Performance	
6. Our employees are also involved to manage and control inventories.	0.496
7. Our employees are well trained about inventory control.	0.685
8. We provide sufficient on the job training about inventory control.	0.673
9. Responsibility areas are exactly specified for the persons who are in charge of inventories.	0.661
10. Our workers can deliver their inventory knowledge to managers easily.	0.666
Decision Making Process Performance	
11. We make inventory related decisions faster.	0.631
12. Our procedures are reasonable to make inventory related decisions.	0.651
13. We use scientific techniques to make inventory related decisions.	0.589
14. Our inventory related or other business decisions are not in conflict.	0.552
15. All departments in our company are informed about inventory related decisions.	0.472

Problem Solving Performance	
16. We figure out the problems about inventories faster.	0.646
17. The person or unit that causes an inventory problem accepts this immediately.	0.534
18. None of the problems that happen related to inventories is hidden.	0.559
19. None of our company units is damaged when solving inventory related problems.	0.536
20. We can solve inventory related problems faster.	0.591

** CITC: Corrected Item-Total Correlations*

5. Analysis Findings and Comments

First, the exploratory factor analysis was applied to the construct in Table 4. Principle components and varimax rotation methods were used. Performance factors (indicators) that are come into prominence as an effective management of inventories, factor loadings, and Cronbach's Alpha values indicating reliability of the factors are shown in Table 5. Although 0.4 loading value is the minimum value for an item is to be considered as an element of that factor, upper values mean more identification of the factor's structure [51]. Factor loadings change between 0.513 and 0.839 values in Table 5. Cronbach's Alpha values more than 0.6 are expected for factor's reliability [51]. The minimum Cronbach's Alpha value is 0.692 in Table 5. It can be said that all factors are reliable. The percentage of total variance explained is 60.05, Kaiser-Meyer-Olkin measure of sampling adequacy is 0.900, chi-square value of Bartlett's tests of sphericity is 1486.834 and it is significant with 78 degrees of freedom at the 0.001 level. Cronbach's alpha value is 0.881 for all 13 items in general.

As a result of starting with 20 items and 4 factors at the beginning (see Table 4), it is shown that the 'employee performance' factor did not loaded and item 9 of this factor were loaded in the WCP in Table 5. Therefore, as explained in the beginning of section 3, there are three factors taken into consideration namely 'a- WCP', 'b- DMPP', and 'c- PSP' in the following analyses.

Table 5 Exploratory Factor Analysis and Reliability Statistics

	Factor Loadings			**Cronbach's Alpha**
a-WCP				0.838
Item 1	0.677			
Item 2	0.680			
Item 3	0.839			
Item 4	0.584			
Item 5	0.687			
Item 9	0.534			
b-DMPP				0.692
Item 12			0.513	
Item 13			0.735	
Item 15			0.806	
c-PSP				0.757
Item 17		0.706		
Item 18		0.759		
Item 19		0.713		
Item 20		0.669		
Eigenvalues	*5.514*	*1.276*	*1.017*	
Total Variance Explained (%)	*42.415*	*9.813*	*7.822*	
Cumulative Variance Explained (%)	*42.415*	*52.228*	*60.05*	

In order to test the hypotheses in section 3, one-way ANOVA was used. First, homogeneity of variance assumption was examined by using Levene test. Table 6 shows Levene test results. If result of a Levene test is significant, it means group variances are not equal and this violates 'homogeneity of variance' assumption in those groups [51]. This assumption is violated for H_{2c}, H_{6b}, and H_{8b} hypotheses as shown in Table 6. Therefore, the relations defined in these three hypotheses will not be taken into account in one-way ANOVA Tests in Table 7. Hypotheses H_{2c}, H_{6b}, and H_{8b} will be analyzed by Kruskal Wallis test in Table 9 instead.

Table 6 Tests of Homogeneity of Variances for the Factors Affecting Inventory Levels

HYP		**a- WCP**	**b- DMPP**	**c- PSP**
H_1	*F*:	0.100	1.037	2.250
	p:	0.905	0.356	0.107
H_2	*F*:	1.675	0.188	7.464
	p:	0.189	0.829	**0.001*****
H_3	*F*:	0.144	1.557	0.173
	p:	0.866	0.212	0.841
H_4	*F*:	0.459	0.207	0.093
	p:	0.633	0.813	0.911
H_5	*F*:	0.324	0.584	0.867
	p:	0.723	0.558	0.421
H_6	*F*:	0.302	2.908	0.099
	p:	0.739	**0.056***	0.906
H_7	*F*:	0.409	0.089	0.054
	p:	0.665	0.915	0.948
H_8	*F*:	0.040	2.659	1.722
	p:	0.961	**0.072***	0.180
H_9	*F*:	0.182	0.327	0.324
	p:	0.834	0.721	0.724
H_{10}	*F*:	0.568	0.192	1.050
	p:	0.567	0.825	0.351

*HYP: Hypotheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

Frequencies for each category, their percentages and sample means of 5-point Likert scale are given with one-way ANOVA results in Table 7. Significant hypotheses are shown bold and marked with asterisks. According to the results of one-way ANOVA, H_{1b}, H_{3a}, H_{3c}, H_{7a}, H_{7c}, H_{8a}, H_{8c}, and H_{10c} hypotheses are supported. Inequalities of group means in these hypotheses can be said of significant levels. H_{1a}, H_{1c}, H_{2a}, H_{2b}, H_{3b}, H_{4a}, H_{4b}, H_{4c}, H_{5a}, H_{5b}, H_{5c}, H_{6a}, H_{6c}, H_{7b}, H_{9a}, H_{9b}, H_{9c}, H_{10a}, and H_{10b} hypotheses are not supported. Inequalities of group means in these hypotheses however, can be said of insignificant levels.

Table 7 Means and One-Way ANOVA Tests for the Factors Affecting Inventory Levels

				Means			Test Results			
	Categories of			a	b	c		a	b	c
HYP	**Affected Degrees**	n	%	WCP	DMPP	PSP		WCP	DMPP	PSP
H_1	Not at all&Little	213	70.5	4.392	3.990	4.021	*F*:	0.757	2.426	0.786
	Average	55	18.2	4.285	3.842	3.977	*df*:	2	2	2
	A lot&Very much	34	11.3	4.392	4.186	4.161	*p*:	0.470	**0.090***	0.456
H_2	Not at all&Little	217	71.2	4.389	3.980	4.071	*F*:	1.322	0.341	
	Average	58	19.0	4.382	4.023	4.035	*df*:	2	2	
	A lot&Very much	30	9.8	4.206	3.889	3.708	*p*:	0.268	0.711	
H_3	Not at all&Little	112	37.1	4.433	4.030	4.138	*F*:	2.873	0.779	5.020
	Average	88	29.1	4.244	3.902	3.838	*df*:	2	2	2
	A lot&Very much	102	33.8	4.402	3.980	4.066	*p*:	**0.058***	0.460	**0.007*****
H_4	Not at all&Little	136	44.7	4.343	3.919	4.002	*F*:	1.292	1.264	1.132
	Average	108	35.5	4.441	4.065	4.104	*df*:	2	2	2
	A lot&Very much	60	19.8	4.308	3.994	3.950	*p*:	0.276	0.284	0.324
H_5	Not at all&Little	164	54.0	4.392	3.978	4.038	*F*:	0.551	0.150	0.237
	Average	64	21.0	4.302	3.938	3.973	*df*:	2	2	2
	A lot&Very much	76	25.0	4.368	4.004	4.043	*p*:	0.577	0.861	0.789
H_6	Not at all&Little	78	25.6	4.423	4.017	4.026	*F*:	0.757		0.061
	Average	63	20.7	4.302	3.905	4.004	*df*:	2		2
	A lot&Very much	164	53.7	4.370	3.990	4.040	*p*:	0.470		0.941
H_7	Not at all&Little	103	33.9	4.476	4.032	4.180	*F*:	3.846	1.881	3.999
	Average	106	34.9	4.255	3.871	3.922	*df*:	2	2	2
	A lot&Very much	95	31.2	4.375	4.046	3.982	*p*:	**0.022****	0.154	**0.019****
H_8	Not at all&Little	189	62.0	4.445	4.025	4.112	*F*:	5.339		7.717
	Average	83	27.2	4.293	3.892	4.003	*df*:	2		2
	A lot&Very much	33	10.8	4.126	3.939	3.614	*p*:	**0.005*****		**0.001*****
H_9	Not at all&Little	179	58.7	4.401	3.963	4.077	*F*:	1.249	0.914	2.173
	Average	82	26.9	4.283	3.943	4.027	*df*:	2	2	2
	A lot&Very much	44	14.4	4.402	4.114	3.835	*p*:	0.288	0.402	0.116
H_{10}	Not at all&Little	194	63.6	4.393	4.017	4.102	*F*:	0.465	1.112	6.178
	Average	76	24.9	4.340	3.873	4.010	*df*:	2	2	2
	A lot&Very much	35	11.5	4.305	4.000	3.664	*p*:	0.628	0.330	**0.002*****

*HYP: Hypotheses, n: Valid Frequency, * p < 0.1, ** p < 0.05, *** p < 0.01*

In Table 8 on the other hand, the significant groups within the three groups of significant hypotheses are shown by the results of a post hoc test (Tukey HSD). It is shown that all of the three groups are different from each other for H_{2c}, H_{8c}, and H_{10c} but only two of the groups are different for H_{1b}, H_{3a}, H_{3c}, H_{7a}, H_{7c}, and H_{8a}. By looking at these results, it can be said that inequalities in group means mostly appear in PSP.

Table 8 Post Hoc Tests (Tukey HSD) for Significant Hypotheses

		a WCP		b DMPP	c PSP	
HYP	**Categories of Affected Degrees**	Average	A lot& Very much	A lot& Very much	Average	A lot& Very much
H1	Average			0.074*		
H2	Not at all&Little					0.019**
	Average					0.088*
H3	Not at all&Little	0.060*			0.006***	
	Average					0.058*
H7	Not at all&Little	0.016**			0.019**	
H8	Not at all&Little		0.010**			0.000***
	Average					0.015**
H9	Not at all&Little					0.095*
H10	Not at all&Little					0.002***
	Average					0.036**

*HYP: Hypotheses, * p < 0.1, ** p < 0.05, *** p < 0.01*

On the other hand, the hypotheses that have violated homogeneity of variance assumption are analyzed by Kruskal Wallis test and the results are shown in Table 9. Kruskal Wallis test is a kind of substitute for ANOVA in nonparametric analysis. According to the results of Kruskal Wallis tests, none of these hypotheses are supported. Inequalities of group means in these hypotheses can be said of insignificant levels.

Table 9 Kruskal Wallis Tests for the Hypotheses Violating Homogeneity of Variances

				Means		Test Results		
HYP	**Categories of Affected Degrees**	n	%	b DMPP	c PSP		b DMPP	c PSP
H_2	Not at all&Little	217	71.2		4.071	χ^2:		3.246
	Average	58	19.0		4.035	*df*:		2
	A lot&Very much	30	9.8		3.708	*p*:		0.197
H_6	Not at all&Little	78	25.6	4.017		χ^2:	0.171	
	Average	63	20.7	3.905		*df*:	2	
	A lot&Very much	164	53.7	3.990		*p*:	0.918	
H_8	Not at all&Little	189	62.0	4.025		χ^2:	1.002	
	Average	83	27.2	3.892		*df*:	2	
	A lot&Very much	33	10.8	3.939		*p*:	0.606	

HYP: Hypotheses, n: Valid Frequency

LMEs are significantly differentiated in inventory related WCP in terms of affecting degrees of inventory movement reasons indicated in H_3, H_7, and H_8 (see Table 7). By looking at the sample means in Table 7, it can be said that the average levels in H_3 and H_7 affect WCP more than other two-extreme affecting degrees. A living average level of anxiety in 'willingness to prevent economical instabilities (H_3)' and an average affecting level of 'product demand fluctuations (H_7)' in inventories decrease WCP more than other two-extreme affecting degrees. When looking at the sample means of 'gap between ordinary and operational production capacity (H_8)', it can be visually said that the more the inventory level is affected by this gap, the less the managerial performance will be. It is also possible to say that the more affecting degrees in inventory levels exist because of unbalanced capacities in LMEs, the less the inventory related WCP will be.

Inventory related DMPP factor is significant at the 0.10 level only for H_1 (see Table 7). This factor is insignificant for all of the other hypotheses. Different levels of affected degrees by inventory movement reasons of LMEs do not make any difference in DMPP except 'uncertainties in daily material usage'. However, when sample means of 'decision making processes' in Table 7 are viewed, it can be seen that the means of average degree groups are a little bit smaller than the other two-extreme groups except H_2. This situation can be interpreted as if the inventory movement reason affects LMEs with an average degree, DMPP decreases a little bit. If an inventory movement reason affects LMEs with 'not at all&little' degree, there will be no damage in their 'decision making processes'. On the other hand, if an inventory movement reason affects LMEs with 'a lot&very much' degree, problems in their 'decision making processes' will happen more frequently, and because of this reason, LMEs need to solve those problems as a priority. Therefore, DMPP will be enhanced in those affecting degree enterprises.

As indicated earlier, most of the differences and statistically more significant ones emerged in PSP. It can be seen from the sample means in Table 7 that an average affecting degree of 'willingness to prevent economical instabilities (H_3)' in inventory levels of enterprises makes their inventory related PSP lower than the other enterprises of two-extreme affecting degrees. A 'not at all&little' affecting degree of 'product demand fluctuations (H_7)' makes inventory related PSP higher than the other bigger affecting degrees. If the affecting degree of inventory levels, which is caused by the 'gap between ordinary and operational production capacity (H_8)', become higher, inventory related PSP will become smaller. This consequence is also true when the affecting degree of inventory levels, which is caused by the 'gap between forecasted and real time of product demand (H_{10})', become higher.

6. Conclusions and Future Directions

Regardless of how big they are, manufacturing enterprises of any sizes deal with inventories. As much effectively as inventories are managed, their opportunity costs, defects and damages will be decreased in the same proportion. Many developed production and management methods have concentrated on this topic until now. Even though all of those new developed methods exist, tasks and duties concerning inventory management still keep manufacturing enterprises busy.

The more the inventory level changes, the more a manufacturer interferes to inventories. Some burdens and complexities may happen because of this. Therefore, first, qualitative managerial performance indicators of inventories have been specified in this study. Second, some structural and operational conditions, causing inventory be moved and negatively affected, have been specified. Third, how those performance indicators differ in terms of three different affecting degrees of inventory levels have been investigated.

The first important contribution of this survey study is to provide an enlightening base for future researches by improving Başaran and Acılar's scale items [48]. A more comprehensive and reliable item list will possibly be developed in the future research by focusing on unloaded factors and items with a confirmatory factor analysis. As shown in Table 5, seven items, out of twenty, have not been loaded after exploratory factor analysis. In addition to this unexpected situation, item 9 is loaded in 'working conditions performance' although this item is originally designed for 'employee performance' factor. The reason of this may be due to the closed meaning of this item to 'working conditions performance'. In future studies, the number of questionnaire items can be extended, the more relevant and understandable items can be developed for 'employee performance', and those items can be tested by confirmatory factor analysis. It is also possible to develop a structural equations model by using PSP factor as an endogenous construct. The second important contribution of this study is to find out both the most and the least important reasons of inventory movement, which will consequently affect inventory management success. One-way ANOVA results have helped to achieve this. As can be seen from ANOVA results, it is possible to say that since PSP is the most affected, it is the most sensitive one. The most important inventory movement reasons affecting the PSP are 'demand and capacity changes'. 'Willingness to prevent economical instabilities' can be given as the second important reason. Many of the other reasons of inventory movement experienced in LMEs do not seem to display a significant effect on inventory management performance. The third important finding in this study is that there is no continuous decrease in some managerial performance indicators even though there is some increase in affecting degree of inventory levels because of inventory movement reasons. An average affecting degree can cause a worse result than other two-extreme degrees for some performance indicators. This consequence needs to be investigated by simulation methods in future researches.

Researchers should take into account that some limitations of this study can reduce the generalizability of its results. Sampling bias can exist due to the convenience sampling method used in this study. This limitation can be solved by choosing the sample enterprises randomly in future studies. Since many of the questionnaires were collected from the Marmara region and some cities nearest to it, regional bias of sampling may be a matter of concern in this study. In order to solve this bias concern, sample questions can be applied to some other large manufacturing enterprises in all regions of Turkey in future studies. However, the researchers should take into account that there are not so many large sized companies to choose. In addition to these considerations, accuracy of answers to the sample questions is limited to the individual judgments and knowledge levels of the respondents. This limitation was tried to be solved in this study by choosing the respondents generally from the higher managerial positions in those enterprises.

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