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Research Article

Identification of internal dynamics of Türkiye's furniture industry in the context of lean manufacturing integration maturity

Türkiye mobilya endüstrisinin iç dinamiklerinin yalın üretim entegrasyon olgunluğu bakımından belirlenmesi

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Abstract

This study's objective was to investigate lean manufacturing knowledge, awareness, and integration maturity in one of Türkiye's most significant furniture manufacturer clusters and discover the extent of tapped and untapped potential offered by lean manufacturing for the furniture industry. This study developed a survey-based data collection methodology consisting of five sections with different features. Seventy-five small to large enterprises were invited to participate in the study. Out of seventy-five, twenty-seven furniture manufacturers participated in the study. The study revealed that lean manufacturing awareness and integration maturity vary significantly. This variation could prove lean manufacturing is still far from becoming a mainstream modern management technique for members of the furniture manufacturing cluster in Bursa, Türkiye. According to 92.59% of the study participants, reducing manufacturing costs is the most common internal motivation that either triggered or has the potential to trigger lean manufacturing integration. Moreover, the amount of investment required (66.67%) to deploy lean manufacturing is the primary barrier encountered by the organizations, followed by a lack of training opportunities for workers with a percentage of 62.96%. This study was expected to serve as a valuable resource for academics and professionals intrigued by the extent of the relationship between lean manufacturing and Turkish furniture industry members.

Keywords: Lean Manufacturing, Furniture Industry, Integration Maturity, Lean Training, Modern Management Techniques

Jel Codes: L21, L23, L68, M11

Öz

Bu çalışmanın amacı Türkiye'nin en büyük mobilya üretici kümelenmelerinden birinin yalın üretim bilgi, farkındalık ve entegrasyon olgunluğunu araştırmak ve yalın üretimin mobilya endüstrisi için sahip olduğu potansiyelin boyutunu keşfetmekti. Bu çalışma kapsamında, anket tabanlı bir veri toplama metodolojisi geliştirildi ve yetmiş beş küçük, orta ve büyük ölçekli işletme çalışmaya katılması için davet edildi. Davet edilen yetmiş beş firmadan yirmi yedisi çalışmaya katıldı. Çalışma bulguları yalın üretim farkındalığı ve entegrasyon olgunluğunun katılımcılar arasında ciddi değişkenlik gösterdiğini ortaya koydu. Bu değişkenlik, yalın üretimin Türkiye'nin Bursa ilinde yer alan mobilya üreticileri kümelenmesi için ana akım modern yönetim tekniği olmaktan halen çok uzak olduğunun bir kanıtı olabilir. Üretim maliyetlerini düşürmek, katılımcıların %92,59'u tarafından yalın üretim entegrasyonunu tetikleyen ya da tetikleme potansiyeli olan iç motivasyon kaynağı olarak gösterildi. Ayrıca, yalın üretimi uygulamak için gerekli olan yatırım miktarı ve çalışanlara sunulan eğitim faaliyetlerinin yetersizliği katılımcıların sırasıyla %66,67'si ve %62,96'sı tarafından işletmelerin karşılaştığı birincil ve ikincil zorluklar olarak belirlendi. Bu çalışmanın Türkiye mobilya endüstrisi ile yalın üretim arasındaki ilişkinin boyutuna ilgi duyan akademisyen ve profesyoneller için değerli bir kaynak olması beklenmektedir.

Anahtar Kelimeler: Yalın Üretim, Mobilya Endüstrisi, Uygulama Olgunluğu, Yalın Eğitimi, Modern Yönetim Teknikleri

JEL Kodları: L21, L23, L68, M11

Introduction

Nowadays, all industries work in a dynamic internal and external environment and try to survive in fiercer competition amid the COVID-19 pandemic, severe economic difficulties, endless technological innovations, climate change, and increasing and evolving consumer demand. Within these circumstances, organizations have reconsidered their manufacturing systems to adapt to the new industrial dynamics and global megatrends (Lukrafka, Silva & Echeveste, 2020:506). Optimizing the production system as a whole, increasing efficiency by eliminating all sorts of waste, identifying alternatives, and predicting the expected results of individual operational decisions to assess the risk associated with different scenarios are all mandatory actions to survive today's industry conditions (Seebode, Jeanrenaud & Bessant, 2012:195). Besides, according to the Intergovernmental Panel on Climate Change, industries account for 21% of global greenhouse gas emissions, and demand for the environmentally responsible product and service systems (PSSs) has recently increased (IPCC, 2014). Therefore, today, eliminating inefficiencies and waste associated with daily industrial operations is mandatory rather than optional. Based on these facts, it can be interpreted as the traditional production methods becoming insufficient and almost obsolete. Therefore, members of all industries have started to seek modern and efficient production management techniques. Lean Manufacturing (LM) is one of the modern production philosophies born due to the above-stated need that became obvious across all industries (Feld, 2000:50).

The lean manufacturing system's foundations were laid in one of the Japanese car manufacturers, Toyota Motor Corporation, in the 1950s under Eiji Toyoda's leadership and engineer Taiichi Ohno (Roser, 2016:71). In light of the information observed by Eiji Toyoda during his visit to the United States in 1950 to examine the Ford automotive company, they decided that the mass production system, which Ford pioneered for many years, was unsuitable for Japan (Fujimoto, 1999:54; Ohno, 1988:23). Toyota executives' decision was a turning point and led to taking the first steps toward the new production and management approach (Lander and Liker, 2007:3681).

The most striking difference between mass and lean production is observed within the production mentality and objectives. On one side, mass producers set themselves a maximized production target for a set of standardized products within the capacity limitations (Liker, 1997:32). According to this view, producing a better and more diverse product was too expensive or exceeded the labour capacity (Williams, Haslam, Williams, Cultler, Adcroft & Johal, 1992:321). On the other hand, lean producers have aimed for a precise production that follows demand in terms of time and quantity and varies in product mix (Melton, 2005:662). The lean manufacturers are also the ones that are constantly searching for excellence to achieve their organizational goals such as continuous cost reduction, zero defective goods, zero inventory, endless product variety, etc. (Åhlström:328, 1998; Hobbs, 2003:23).

Professionals and researchers have studied LM in the past, and it has been defined in several ways in the literature. In its traditional definition, LM is a group of tools and techniques that help identify and permanently eliminate waste (called Muda), enhance quality levels, optimize production time and achieve maximum possible cost reduction (Wilson, 2010:42). Regardless of its definition, LM is generally based on one main principle; "doing more with less" by reducing waste, becoming more flexible and responsive, using less material and fewer people, and consuming less space (Sundar, Balaji, & Kumar, 2014:1875; Van Dun, Hicks, & Wilderom, 2017:175). Another feature of lean manufacturing is that it changes how things are done within an organization's walls. It creates a whole new mindset for executives and employees. This new mindset empowers the employees, spreads responsibility to everyone in the organization's hierarchical structure, and creates a shared devotion. Responsibility means that someone owns and controls all aspects of his/her work, but it also raises the thought of avoiding costly mistakes (Emiliani, 2008:170). Transfer of responsibility is why LM requires more professional skills to be learned and applied creatively within a more fluid team atmosphere rather than a rigid organizational hierarchy. Such fluidity and team cohesion lead to LM becoming a company culture rather than a way of working (Bortolotti, Boscari, & Danese, 2015:185).

Moreover, as Elkington (1994) pinpointed with a great vision, the notion of sustainability is not only about economic survival in the long run but also involves fulfilling corporate environmental and social responsibilities (Elkington, 1994:91). Lean manufacturing has also proven its merit in contributing to environmental and social performance improvements (Tasdemir & Gazo, 2018:10). Furthermore, some industries, including but not limited to value-added wood products sectors, have been suffering from shrinking profit margins, and members of these industries significantly benefitted from lean manufacturing integration in the past (Buehlmann, Espinoza & Fricke, 2013:1539; Czabke, Hansen &

Doolen, 2008:77; Quesada-Pineda, Haviarova & Slaven, 2009:6; Velarde, Pirraglia, Van Dyk, & Saloni, 2011:31)

Although LM implementation and tools are generally encountered in the automotive sector, they are also frequently applied in other industries. For example, one of the sectors that could benefit the most from lean manufacturing is the furniture industry (Adams, 2002:327). Similar to the automotive industry, in the furniture industry, there is a production system based on the assembly of big and small parts, the use of different types of components according to the trends and models to be produced, and the waiting time of the customer is also concise (Hunter, Bullard & Steele, 2004:32). However, it is known that LM applications are pretty limited in the furniture industry. Abu, Gholami, Saman, Zakuan & Streimikiene (2019) explained the possible main reasons for this situation as follows; a) avoiding LM implementation costs and being afraid of failure, b) employees' fear of losing their jobs if they do not provide value-added work c) the lack of a systematic LM training and a supportive company culture.

Previous research studies have demonstrated the remarkable benefits of lean manufacturing in the furniture industry. For example, one study reported that the production efficiency increased to 21.7% thanks to successful lean implementation in a small-scale furniture company (Farfan-Quintanilla, Caira-Jimenez, Sotelo-Raffo, Raymundo-Ibañez & Perez, 2020:691). Another study reported that the productivity of drilling operations was enhanced by 27% due to the lean-based partial improvements in a workstation (Gazoli de Oliveira & da Rocha, 2019:172). Similarly, another research stated that a bottleneck in the furniture factory was eliminated by deploying specific lean tools, and a considerable improvement was achieved by approximately 16% (Alzubi, Atieh, Abu Shgair, Damiani, Sunna, & Madi, 2019:816). Finally, França, Dias, Freitag, Quelhas & Meiriño (2018) found an eight times reduction of the finished product inventory (nearly 88% reduction) as a function of effective implementation of lean philosophy was achieved (França et al., 2018:207).

Moreover, Sabri and Shayan (2004:1) pointed out that lean manufacturing applications could be challenging in the furniture industry due to the complexity of any furniture components and the extensive width and depth of the product mix. On the other hand, despite all these restrictions, the furniture industry's growth and sales continue to increase worldwide. Therefore, furniture manufacturers need a good production and marketing strategy to compete with domestic and foreign competitors in this large market (Gazo & Quesada, 2005:4). Furthermore, profit margins are getting tighter and tighter in the furniture industry (Raymond, 2002:1), and lean manufacturing with its zero-waste philosophy could be a real saviour for industry members.

In Türkiye, the furniture industry contributes to developing the local and national economy by creating job opportunities and establishing supply chain relationships with various other industries. It also has promising export potential. Generally, there are many job-shop-type small-scale enterprises in the Turkish furniture industry, most of which are family-owned and run based on traditional methods (Çoban, 2005:73). Small-medium- and large-scale enterprises have increased in the last 15-20 years (Gürpınar and Barca, 2007:41). However, lean production awareness and integration are not at the desired level in these enterprises, and industrial and academic studies on this subject are pretty limited. (Karşıyaka and Sütçü, 2019:87) have researched 5S applications for increasing productivity in furniture processes. In another study, lean production was integrated into the furniture industry using value stream mapping and simulation-based techniques (Gören, 2016:462). In a thesis study completed in 2019, Lean Six Sigma applications in the furniture industry were researched (Akgül, 2019:15). Although there is limited research on integrating one or a couple of lean tools in an industrial setting, no study assesses lean manufacturing integration's maturity level from a holistic perspective among furniture manufacturers in Türkiye. Bursa-Inegol region, located on the historical Silk Road, has been famous for its furniture industry since ancient times (Kahraman, 2018:1). According to Inegol Chamber of Industry and Trade 2019 reports, the number of exporter companies is 587, and the valuation of exported furniture products is approximately 554 million USD (IMOS, 2019:1). The objective of this study was to; 1) assess the lean manufacturing awareness and integration maturity levels of one of the most significant furniture manufacturer clusters of Türkiye located in the Inegol region and 2) to understand and document the extent of tapped and untapped potential of applying lean manufacturing in the furniture industry. Therefore, the study was expected to contribute to 1) the state-of-the-art addressing intersection zone of the furniture industry and lean manufacturing/management research streams from a holistic perspective and 2) expedition of the lean journey of Turkish furniture manufacturing firms by documenting the internal dynamics of the industry and barriers blocking full integration of lean manufacturing.

Methodology

One of the country's most significant furniture manufacturer clusters, located in Inegol, Bursa, was selected to identify lean manufacturing integration maturity level among Turkish Furniture Industry members. Inegol Funiture Industry Members Association (IMOS) member database was used to create a preliminary list of potential participants based on the inclusion/exclusion criteria in Figure 1. Two hundred active household and office furniture manufacturers were identified. Job-shop style micro enterprises (companies with less than ten workers including the owner and with a revenue of less than 3 million TRY, inactive companies, miscellaneous and accessories manufacturing companies were excluded from the pool of potential participants to compile a refined final database of 75 organizations. Within this study, the size-based categorization of enterprises was carried out per the SME definition of Small- and Medium-Sized Enterprises Development Organization of Türkiye (KOSGEB) (KOSGEB, 2021:1).

Inclusion/Exclusion Criteria

Target Potential Participants Pool Involved;
IMOS Member Wood-Based Furniture Manufacturers
(Small, Medium and Large Enterprises)

Excluding;

- Job-Shop Style Micro Enterprises
- Inactive companies
- Miscellaneous Products Manufacturers
- Accessories Manufacturers

Figure 1: Location of the furniture manufacturer cluster and inclusion/exclusion criteria used to create participant pool

Google Forms®, a web-based form and survey creator, was used to prepare the survey. This survey consisted of total of twenty-five questions in five sections; (1) the first section was designed to collect information on the company profile and the demographics regarding the the person answering the survey questions, (2) the second section consisted of questions to determine level of understanding on the basics of Lean Manufacturing, (3) the third section was aimed to identify primary motivation sources and external factors behind the decision of lean manufacturing deployment as well as to identify primary barriers that made the integration impossible or at least disrupted the overall process, (4) the fourth section was purposed with five questions to detect knowledge and use rate of specific lean tools, principles and techniques and perceived level of gains achieved post-integration that can be associated with Lean Manufacturing, and (5) the fifth section of the study contained questions to gather information on some financial and non-financial key performance areas such as work-related absenteeism, customer service level, defect rate and inventory cycle rate. The questions were laid out in random order, and no distinct separation of the survey sections was used to avoid potential participants' bias. With an exception for questions designed to collect information on company profiles and demographics, Likert-type Scales were used. Survey questions were determined and refined based on input from three subject matter experts from various higher education institutions. The survey included

a cover letter that encourages the recipients to participate in the study and explains the survey design, the purpose of the study, and how the company data will be handled and processed. The letter also included a section where participating firms were asked to select a team leader and at least three team members from various departments to answer the survey questions. Such a measure helped reduce, if not eliminate, the risk of answers becoming one individual's personal opinions. The participants were granted two and a half months to submit their responses to survey questions. During this period, e-mail (one round) and phone call (one round) reminders were used to ensure they received the invitation and knew their participation was expected and desired. The main data collection process took place before January 1st, 2020. Therefore, this study did not require an ethical committee approval document for the data collection process.

Results and discussion

Following the two and a half months response period, no new submissions were accepted. A total of twenty-nine firms have submitted completed surveys within the response period. Two submissions were excluded from the submission pool due to the incomplete answers within the survey's specific modules. Therefore, twenty-seven complete and acceptable submissions were subjected to analyses. Due to the relatively smaller sample size, some results were reported defragmented, as the percentage of total participants selected a specific answer to a specific question, rather than reporting based on Likert Scale scores and median values.

Professionals who provided survey responses on behalf of the organizations (team leaders) had various job titles from different levels of organizational hierarchy, such as executive managers, production planning managers, research and development (R&D) managers, information technology (IT) associates, project managers, production engineers, and human resources department managers. 6.3% of these professionals have been with their current employer for 15-20 years. 43.8% of participants have worked for their current firms for two to five years. 12.5% of participants have worked for their current employer for at least five years but no more than seven years. Another 12.5% of participants have also worked at their current firms for at least seven years but no more than ten years, as shown in Figure 2A. Only 6.3% of the professionals have worked for their current employer for more than 15 years but no more than twenty years. The age of the professionals who provided the survey responses for their firms also varied. The ages of 43.8% of the professionals ranged from 20 to 30. 31.3% of all professionals were 31-40 years old, whereas 25% were between 41-50 years old.

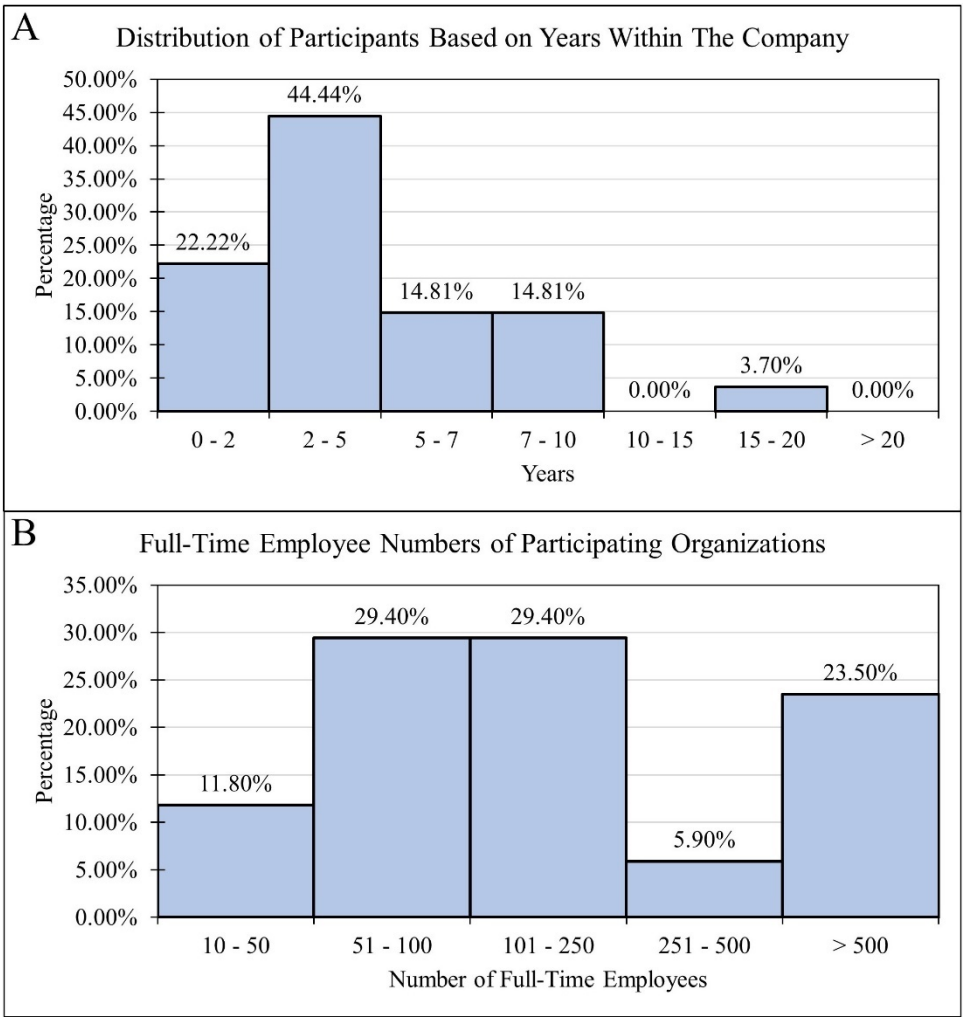

Figure 2: A. Distribution of survey participants based on years within the company. **B.** Full-time employee numbers of participating organizations

11.8% of the participating firms had 10 to 50 full-time employees, while the number of full-time employees for 29.4% varied between 51 and 100, as shown in Figure 2B. The same percentage share (29.4%) from the pie belonged to the firms with a full-time employee number of 101-250. Only one firm had several full-time employees between 251 and 500, while four reported having more than 500 full-time employees, as given in the figure.

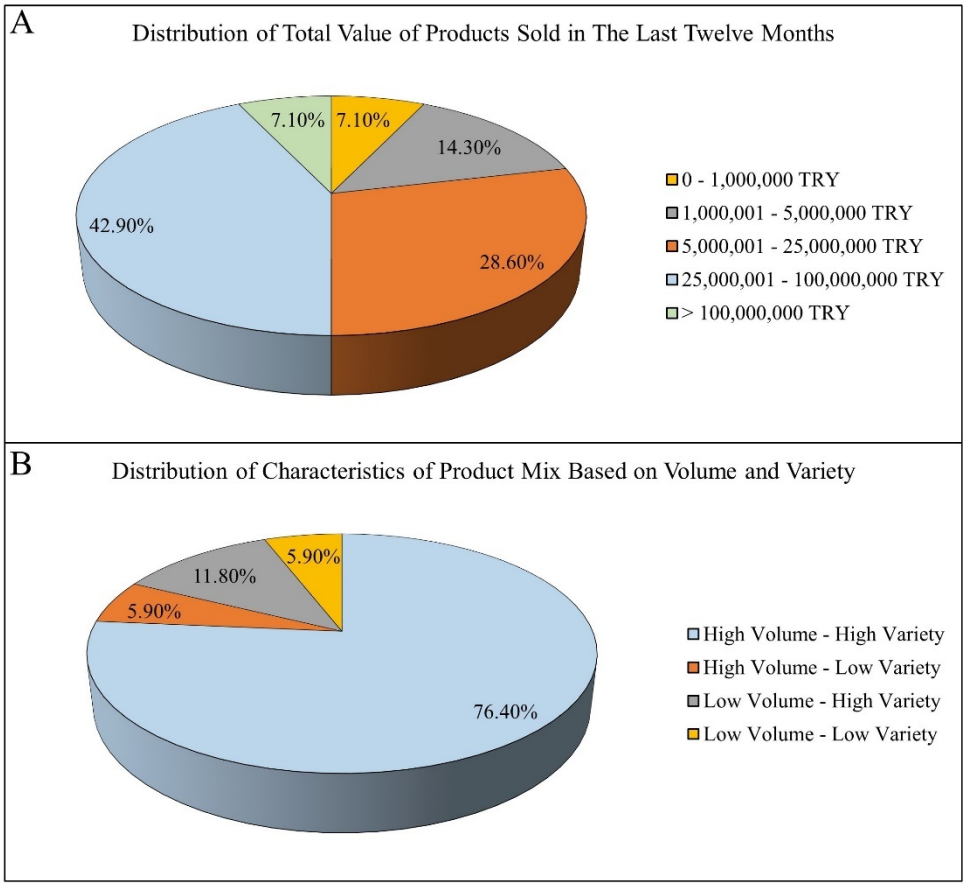

Figure 3: A. Distribution of the total value of products sold in the last twelve months. **B.** Distribution of characteristics of product mix based on volume and variety

The value of products sold in the most recent twelve months significantly varied among survey participants. As illustrated in Figure 3A, 42.90% of the participating firms claimed that the last twelve months' revenues were between 25-100 million TRY. 28.6% of the survey participants reported revenue levels varying between 5-25 million TRY. Only 7.1% of the firms reported 0-1 million TRY revenue for the last twelve months. Coincidentally, the same number of firms with a share of 7.1% also made the top of the reported revenues list and claimed to have revenues above 100 million TRY, as shown in Figure 3A. 14.3% of the participants stated that the last twelve months' documented revenues were between 1-5 million TRY.

When asked about the character of their current product mix in volume and variety, As shown in Figure 3B, 76.5% of the participating firms voted for the High Volume-High Variety option. In comparison, 11.8% of the firms stated they had Low Volume-High Variety. The product mix of 5.9 % of the participating firms consisted of products classified as High Volume-Low Variety. Another 5.9% were classified under the Low Volume-Low Variety option, all of which were small-sized enterprises. Most enterprises, which claimed to have a product mix representing a High Volume-High Variety characteristic, were medium- or large-sized organizations.

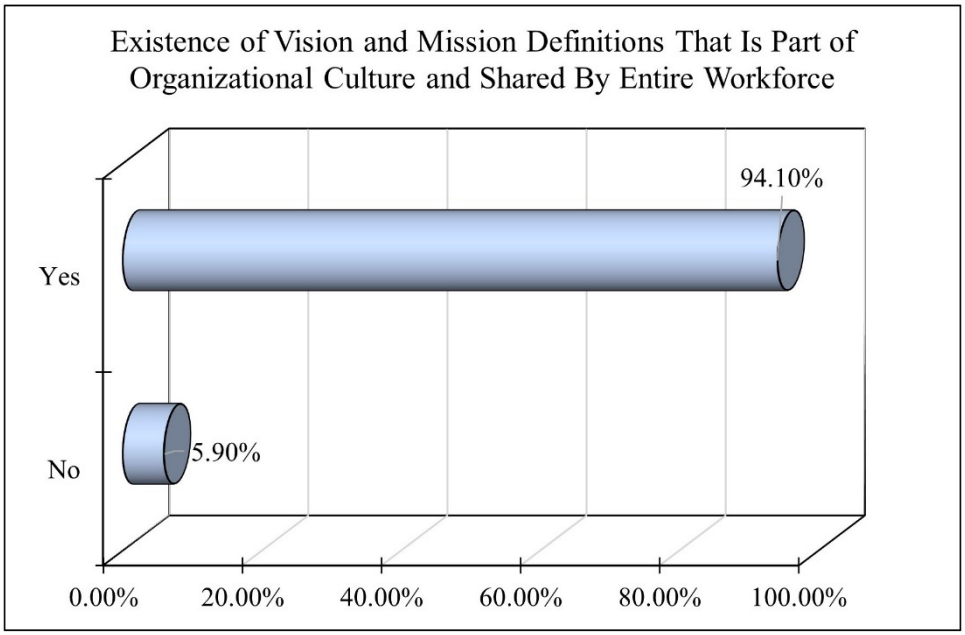

Figure 4: Existence of shared vision and mission as part of organizational culture

Lean is one of the most versatile modern management techniques and can be successfully deployed by members of any industry. However, every industry and even every member within an industry has distinct characteristics and dynamics explained by the contingency theory (Hines, Holweg, & Rich, 2004:10; Stonebraker & Afifi, 2004:5). Moreover, lean transformation requires a cultural change, and bringing the entire workforce to a level of lean understanding is necessary. Therefore, lean philosophy needs to be truly understood by the whole organization and should be integrated by acknowledging the contingency of each sector and sectoral member. Having a shared vision and mission definitions that are part of the organizational culture and understood by every workforce member is a good starting point. When the study participants were asked whether such vision and mission definitions exist, approximately 95% of them stated that they had shared them. In contrast, the remaining 5% reported such statements' absence, as shown in Figure 4.

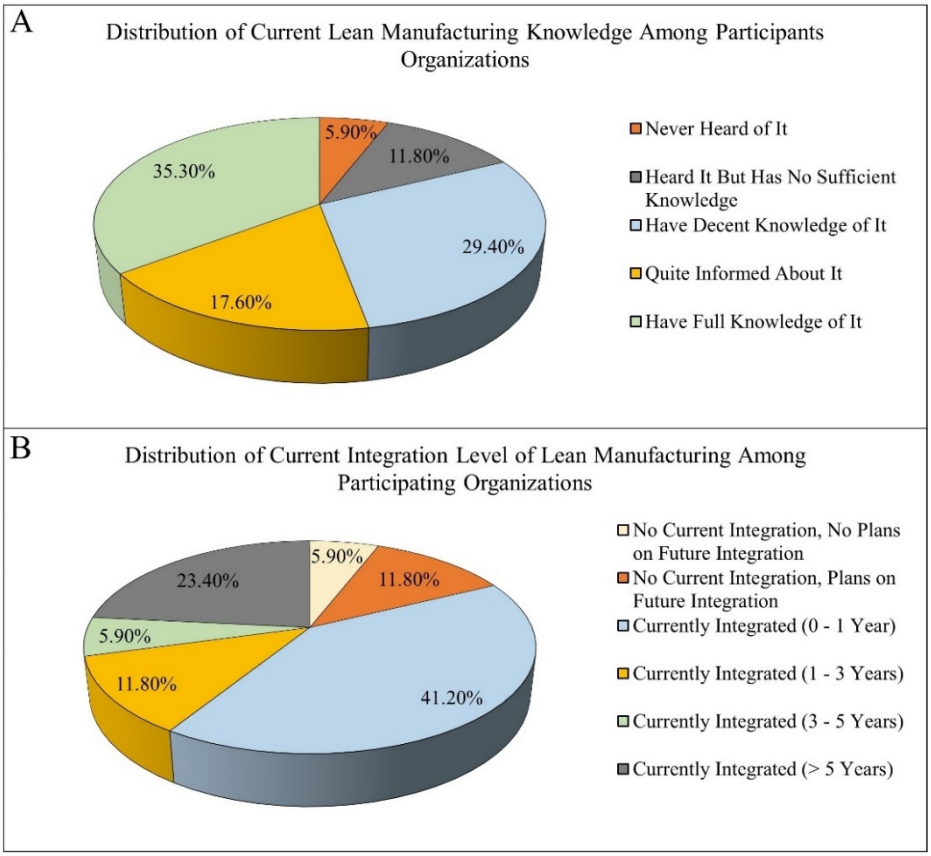

Figure 5: A. Distribution of current lean manufacturing knowledge among participants' organizations. **B.** Distribution of current integration level of lean manufacturing among participating organizations.

Concurrent with the vision and mission statements related question, firms were also asked to state the extent of overall awareness of lean manufacturing techniques and whether they are currently deployed within their organization. 35.3% of the survey participants claimed to have complete competency in lean manufacturing, whereas 17.7% either never heard of lean manufacturing (6%) or heard of it but lacked sufficient knowledge (11.80%), as can be seen in Figure 5A. On the other hand, 47% of all participants asserted that they have decent or comprehensive (but not complete) knowledge of lean manufacturing. Responses to the question regarding the current overall deployment rate of lean manufacturing revealed that approximately 6% of all participants did not integrate lean manufacturing with their manufacturing system and did not plan future integration. 41.2% of the participating organizations similarly have not currently deployed lean manufacturing but considering integration in the future, as presented in Figure 5B. On the other hand, another 41.2% of the participants confirmed that they have been integrating lean manufacturing with their manufacturing system for at least one year. The remaining 11.8% of study participants also implemented lean manufacturing, but it has been less than a year since its integration. This question's findings were also aware of those of the question asked to identify overall lean manufacturing understanding among participants. Survey participants who claimed to have at least a decent level of lean manufacturing knowledge also took action to at least partially integrate lean manufacturing with their manufacturing system.

Primary internal and external motivation sources that have already triggered or have the potential to trigger lean manufacturing integration were also investigated within this study. According to 92.59% of the study participants, reducing manufacturing costs is a critical internal motivation that either triggered or could trigger lean manufacturing integration, as shown in Figure 6. In addition, gaining a competitive edge, expediting the firm's advancement and growth, shortening delivery lead times, and increasing customer satisfaction levels were the following quartet that completed the top five most common internal motivations list with percentages of 81.48%, 77.78%, 77.78%, and 74.07%, respectively.

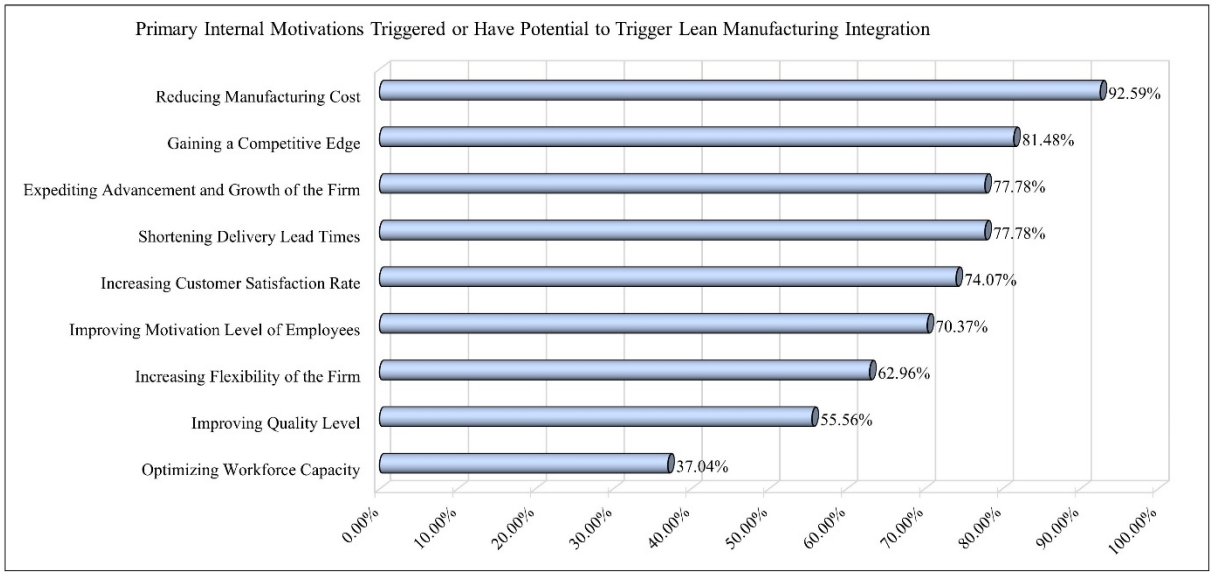

Figure 6: Primary internal motivations triggered or have the potential to trigger lean manufacturing integration

Previous studies from different countries reported that the most prominent reasons for lean applications are customer satisfaction, reducing manufacturing costs, and improving quality (Bamford, Forrester, Dehe & Leese, 2015:3; Vilkas, Koreckaja, Katiliūtė & Bagdoniene, 2015:884). Therefore, it can be concluded that the findings of this study were partially compatible with those of the above-listed previous studies. However, in Türkiye, the concerns related to manufacturing costs, delivery lead time, and market-wide competition in customer satisfaction were prioritized by the organizations as the internal motivation, which could be due to fast-changing product offerings driven by the customer demand.

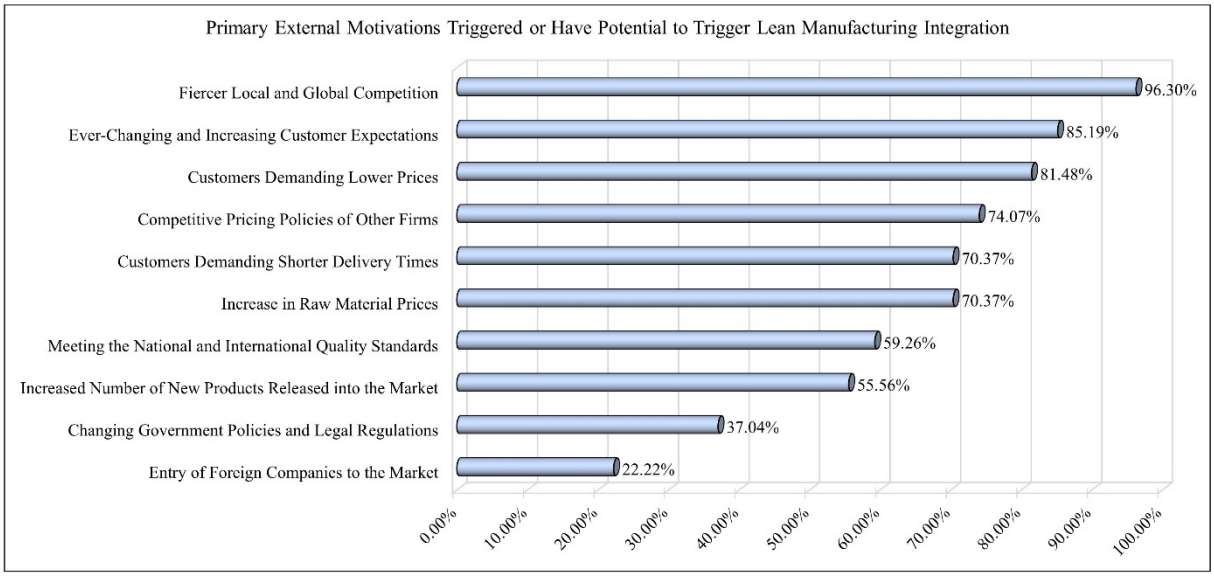

Figure 7: Primary external motivations triggered or have the potential to trigger lean manufacturing integration

As for the primary external motivations triggered or potential to trigger lean manufacturing integration, 96.30% of the participants named fiercer local and global competition, followed by ever-changing and increasing customer expectations with a percentage of 85.19%. Customers' lower price requests and competitive pricing policies of other firms in the market were identified as the third and fourth most common external motivations for a previous or future lean manufacturing integration, as represented in Figure 7. Customer demand for shorter delivery times and increasing raw material prices, sharing the same percentage level of 70.37%, were also among the primary motivations. Based on the findings, it can be interpreted that both primary internal and external motivations were concerned with customer satisfaction and competition in the market. Moreover, participating organizations were not only self-motivated to shorten the delivery lead times but also felt the pressure from their customers. Firms in the Inegol region were less worried about quality excellence, optimizing the workforce capacity, entering foreign companies into the market, and changing government policies/regulations and their impact on participating firms' operations.

Lean training is essential for a successful lean transformation or lean manufacturing integration (Coetzee, Van Dyk, & Van der Merwe, 2019:1). As shown in Figure 8, the availability of any form of official Lean Manufacturing Training for executives and workers was also investigated within this study. 29.4% of the participants claimed that any official lean manufacturing training is absent, and the current workforce's existing lean manufacturing knowledge and awareness are coincidental and function of personal curiosity. Official lean manufacturing training was available for executives, team leaders, and project managers, but the rest of the workforce's lean manufacturing competency is not satisfactory in 29.5% of participating organizations. On the other hand, 17.6% of the participants stated that an effective lean manufacturing training program is available for the entire workforce, and the optimal level of lean manufacturing competency is achieved throughout the organization. Moreover, 23.5% of the survey respondents claimed to have a lean manufacturing training program for some executives and workers. However, these firms also mentioned a lack of proper setting to implement training program outcomes.

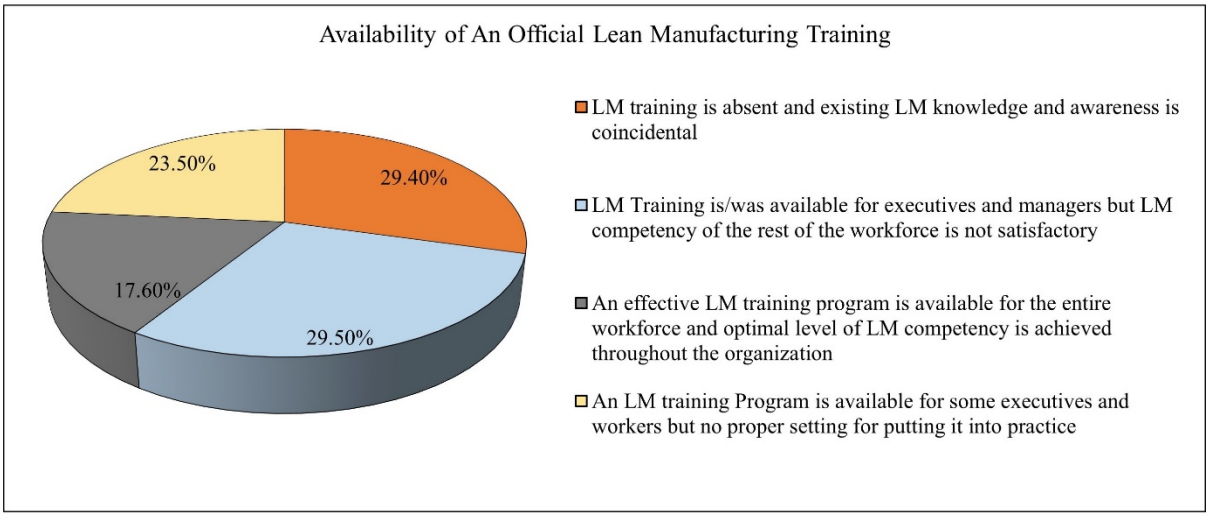

Figure 8: Availability of an official lean manufacturing training

As documented in another previous study, it is common for small- and medium-sized enterprises not to provide proper lean training for employees with different knowledge levels and job titles (Sahoo & Yadav, 2018:1). Authors of the same study asserted that this is a significant obstacle, which reduces employees' adaptation to lean culture and impairs healthy decision-making in case of a problem.

Table 1: Barriers and obstacles which hindered lean manufacturing integration or made the integration difficult

Barriers and Obstacles	Percentage
The required amount of investment to deploy LM is too high.	66.67%
No LM training opportunity is provided for workers.	62.96%
Lack of company-wide awareness of LM techniques and tools.	59.26%
The management is not interested in LM.	40.74%
LM was initially implemented but could not be sustained due to the high employee turnover rate.	37.04%
The workforce is not interested in LM and has hesitations.	37.04%
The workforce is not ready for the change and is not open to new methods.	37.04%
We do not know where to start. Guidance is required.	29.63%

The history of lean is full of incomplete or even not-initiated integration attempts by many organizations due to various barriers and obstacles such as lack of resources, time, and devotion. The study participants were also asked to answer a question regarding barriers and obstacles that kept their organizations away from lean manufacturing integration or at least made the integration difficult during the deployment phase. As presented in Table 1, according to 66.67% of the participants, the high amount of investment required to deploy LM is the primary barrier encountered by the organizations, followed by a lack of training opportunities for workers with a 62.96% selection rate. Lack of company-wide awareness of LM techniques and tools (59.26%) and lack of interest in LM from the management (40.74%) were also determined to be among the most significant barriers and obstacles faced by members of this furniture Manufacturing cluster. As given in Table 1 and reported by 37.04% of all participants, factors such as high employee turnover rate, workforce's lack of interest, hesitations in lean integration, and unreadiness for a change also made the list of most common barriers and obstacles halted or interrupted lean transformation journeys.

Some previous studies also supported the findings of this study. (Chaple, Narkhede, Akarte & Raut, 2018:10) reported that investment is a severe and chronic problem, especially for small- and medium-sized enterprises. Therefore, they tend to use only lean tools that require less investment, such as 5S, total preventive maintenance, etc. On the other hand, previous research has revealed that lean production techniques can be applied without significant investments and funding, but sometimes these applications could be less visible and fall short (Boyer & Sovilla, 2003:118; Rose, Deros & Rahman, 2013:686). These techniques are only a tool and guide during difficult decisions and solving the problem, not the solution itself (Arumugam, Antony & Douglas, 2012:1). Therefore, organisations' workforce should develop a particular understanding of all lean tools for successful lean implementation and transformation. This is the key to a flawless integration and application of lean philosophy and techniques (Yadav & Desai, 2016:3). According to a previous study, understanding the lean concepts

and correct application of lean techniques requires special training and development of specific competencies, which is an essential indicator of the enterprises' lean integration maturity (Salah, Rahim & Carretero, 2010:10). On another front, company-wide lean awareness and management support become a prominent factor. Persuading workers to think and act in a new way could be difficult for companies. Top management that fails to adopt the lean vision within this period could intentionally or unintentionally block the lean implementation.

Although many barriers and obstacles were deemed crucial and impactful by the participating firms, a high percentage have gone ahead and at least partially integrated lean manufacturing, as discussed earlier in this section. The most commonly known and integrated LM techniques and tools were evaluated within a more focused and micro-level investigation to disclose the extent of partial and comprehensive lean manufacturing integration across the organisations. Respondents were allowed to select more than one tool for the questions addressing participants' knowledge level and integration maturity of lean manufacturing techniques and tools. Based on the defined Likert-type scale, responses claiming partial knowledge and above were combined and reported under an inclusive category titled as having at least partial knowledge. Comprehensive knowledge of any tool was also reported separately to ensure an accurate and detailed discussion of findings. The same procedures were applied to integration maturity questions as well. It was found that Standard Work Principles (Work Standardization) was the LM technique claimed to be comprehensively known by most firms, as shown in **Table 2**. The technique was reported to be at least partially known by 92.59% of the participants and followed by 5S (Workplace Organization) with a percentage of 88.89%. Process Mapping, Overall Equipment Effectiveness, and Just-In-Time (JIT) methodology also comprise the top five most well-known techniques and tools. These tools and techniques were claimed to be known at least partially by 85.19% of the participants. 5S was the LM tool comprehensively known by 22.22% of the firms. Real-Time Notification System (Andon) was the lean tool that was partially known by the fewest participants, with a percentage of 55.56%. This tool was also comprehensively known by only 7.41% of the participants.

PDCA Cycle, KANBAN, Genchi Genbutsu and Gemba are at least partially known by 62.96% of study participants. As shown in Table 2, these tools were also among the ones claimed to be fully known by the fewest number of organizations, with percentages of 7.41%, 11.11%, and 11.11%, respectively. When the integration maturity of lean tools was investigated, a different pattern was observed, as documented in the same table. It was found that Kaizen Blitz and Process Mapping were at least partially integrated by 70.37% of the participating firms and followed by 5S, OEE, Value Stream Mapping, Error Proofing (Poka Yoke), and PDCA cycle, all having percentages of 62,96%. The most miniature integrated lean tools and techniques were Andon (by 44.44%), Genchi Genbutsu and Gemba (by 44.44%), A3 Thinking (by 48.15%), and Cellular Layout (by 48.15%). Although Production Levelling was deployed onto the manufacturing system of 51.85% of participants at least partially, none of the organizations fully integrated it. Visual Factory practices and Andon systems were among the tools with the lowest complete integration levels with a shared percentage of 7.41%. More interestingly, no lean tool was fully integrated by more than 18.52% of the participating organizations. Furniture manufacturing steps may have the most suitable characteristic for deploying cellular layout. However, 51.85% of participating organizations never considered that option. These results showed that this manufacturing cluster members are currently far from an acceptable level of integration maturity.

Table 2: Most commonly known and integrated (by participating organizations) Lean Manufacturing techniques and tools.

Lean Tools	Has Comprehensive Knowledge	Has At Least Partial Knowledge	Partially Integrated	Comprehensively Integrated
Standard Work Principles (Work Standardization)	22.22%	92.59%	59.26%	11.11%
5S (Workplace Organization)	25.93%	88.89%	62.96%	11.11%
Process Mapping	14.81%	85.19%	70.37%	11.11%
Overall Equipment Effectiveness (OEE)	14.81%	85.19%	62.96%	14.81%
Just-in-Time (JIT)	22.22%	85.19%	59.26%	14.81%
Jidoka (Autonomation)	11.11%	81.48%	55.56%	11.11%
Value Stream Mapping (VSM)	14.81%	81.48%	62.96%	11.11%
Production Levelling	14.81%	81.48%	51.85%	0.00%
Cellular Layout	14.81%	81.48%	48.15%	18.52%
Visual Factory (Shop Floor Management)	14.81%	81.48%	55.56%	7.41%
Total Productive Maintenance	18.52%	81.48%	55.56%	11.11%
Kaizen Blitz	18.52%	77.78%	70.37%	18.52%
Error Proofing (Poka Yoke)	14.81%	77.78%	62.96%	11.11%
One-Piece-Flow	11.11%	77.78%	59.26%	11.11%
Takt Time	11.11%	74.07%	55.56%	14.81%
Single Minutes Exchange of Dies (SMED)	14.81%	70.37%	59.26%	18.52%
A3 Thinking	14.81%	70.37%	48.15%	11.11%
PDCA Cycle	7.41%	62.96%	62.96%	11.11%
KANBAN	11.11%	62.96%	44.44%	11.11%
Genchi Genbutsu and Gemba	11.11%	62.96%	59.26%	11.11%
Real-Time Notification Systems (Andon)	7.41%	55.56%	44.44%	7.41%

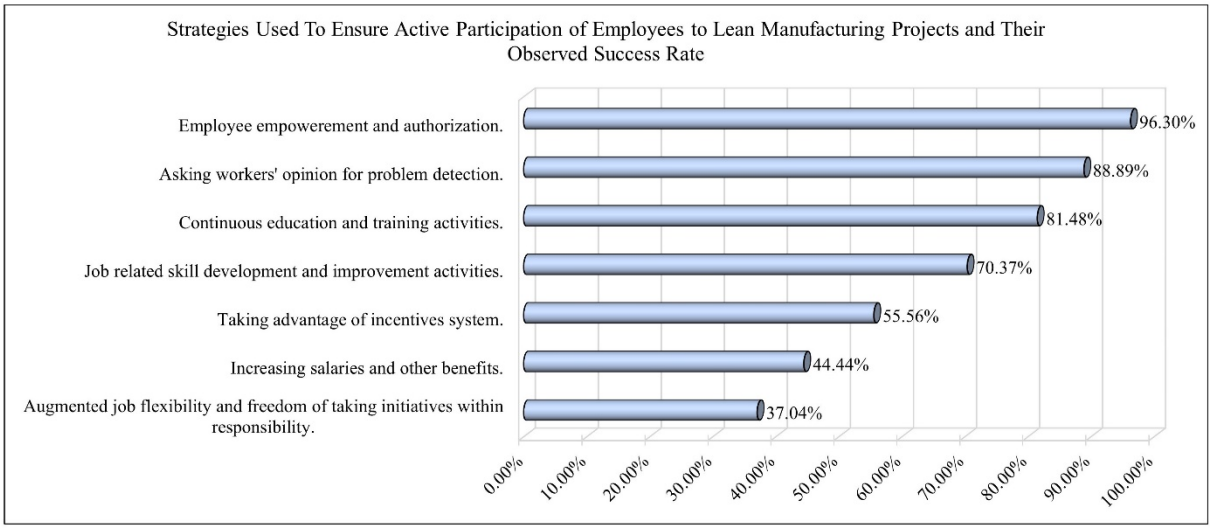

Figure 9: Strategies used to ensure active participation of employees to lean manufacturing projects and their observed success rate

Most lean manufacturing integration efforts are prone to failure without active employee participation and contribution (Delbridge, 2005:15). Therefore, assessing lean manufacturing integration maturity also involves investigating strategies used by furniture manufacturers to ensure employees' active participation in lean manufacturing projects. The observed success rate of each strategy was also part of this study, as shown in Figure 9. By 96.30% of participants practising lean manufacturing, the employee empowerment and authorization strategy was listed as at least above average successful on a Likert-type scale. According to study participants, the other most commonly used and acceptably successful strategies were obtaining workers' opinions for problem detection and continuous education and training activities, with 88.89% and 81.48%, respectively. Job-related skill development and improvement activities were also picked by 70.37% of study participants to be at least above average successful. As shown in Figure 9, 55.56% of the participants claimed that taking advantage of the incentive system was at least above-average in promoting employee participation in lean manufacturing projects. Increasing employee salaries and other benefits along with augmented job flexibility and freedom of taking initiatives was deemed at least above average successful by only 44.44% and 37.04% of the participants, respectively. Based on the above-stated findings, it can be interpreted that non-financial strategies were observed to be better successful in ensuring employee engagement in lean manufacturing projects.

Some organizations may prefer to start lean integration with optimization of production and inventory management systems, while others may prefer to channel their efforts into facility design and layout. No dogma dictates only one correct way of integrating lean. The measure of success for any lean integration is not the starting point but how key performance indicators (KPIs) are changed post-integration and how much of this change could be attributed to lean transformation efforts. In the light of this information, participants were invited to evaluate their inventory management systems and facility layouts from lean principles. Moreover, information on post-integration levels of some KPIs and observed lean gains were also collected. The results of such analysis are graphically illustrated in Figure 10A-D.

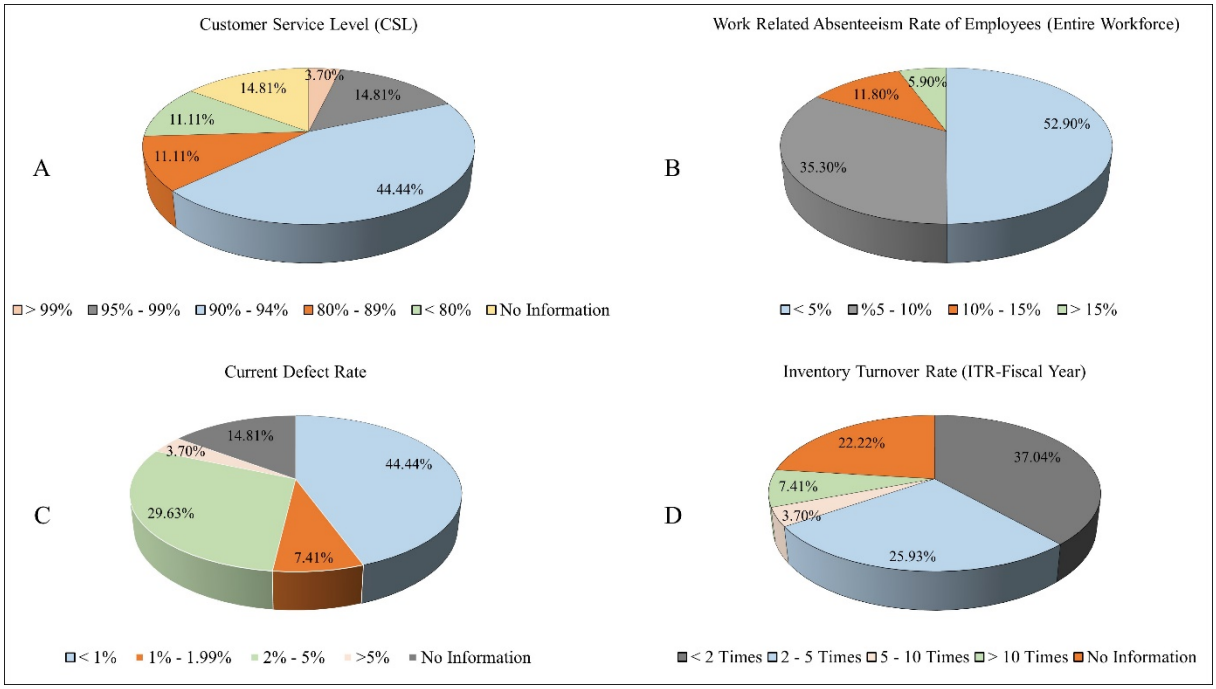

Figure 10. A. Distribution of customer service level (CSL). **B.** Work-related absenteeism rate of employees. **C.** Distribution of current defect rate. **D.** Distribution of inventory turnover rate.

For 44.44% of the study participants, the customer service level (CSL) was between 90-94%. A cumulative 37.03% of all participants reported that their CSLs were between 80 and 90%, whereas 3.70% achieved customer service levels higher than 99%, as shown in Figure 10A. The work-related absenteeism rate of employees also varied among the participants. 5.90% of participating organizations disclosed an absenteeism rate higher than 15%, while 52.90% of the firms claimed to have absenteeism rates lower than 5%, as illustrated in Figure 10B. The percentage of participating firms with a work-related absenteeism rate between 5-10% was around 35.30%. Upon completing the data collection and before the manuscript preparation, to have a snapshot of the impact of the COVID-19 pandemic on the target industry segment's daily operations, all participating firms were re-contacted and provided with an opportunity to update their answer for the question targeting the work-related absenteeism rates. Almost all of the firms stated that the absenteeism rate went up at least twice compared to pre-pandemic days. The current defect rate was another KPI investigated to draw a better big picture of the furniture manufacturing cluster of the Inegol region. As presented in Figure 10C, 44.44% of study participants had less than 1% current defect rate, while 7.41% of all reported current defect rates were between 1-2%. A noteworthy 29.63% of the firms were identified to have current defect rates varying between 2-5%. On the other hand, for some reason, 14.81% of the participants either did not want to disclose this information or did not have this information available at the time of data collection. Such low defect rates of furniture manufacturers could be associated with the high degree of re-workability of furniture parts and finished products. As shown in Figure 10D, the last recorded inventory turnover rate (ITR) for 37.04% of the participants was less than 2, indicating room for improvement. Almost a quarter of participants stated that their ITRs were between 2 and 5 times in the last fiscal year. In a similar situation to the current defect rate analysis, 22.22% of participating organizations lacked information to answer this question. Such outcomes proved that there were either severe issues with control and tracking of daily operations or that industry members were hesitant to disclose performance data due to fierce competition within the industry.

Table 3: Improvements achieved in the last twelve months and perceived impact of lean manufacturing integration on each improvement category

Improvements Achieved in The Last Twelve Months	Percentage of Participants That Said Integration Was Quite or Very Impactful on Improvement Category
Waste Reduction	88.89%
Lower Inventory Levels	85.19%
Increased Customer Satisfaction Rate	81.48%
Reduced Cost per Unit	77.78%
Scrap Rate Reduction	74.07%
Enhanced Inter-departmental Communication	66.67%
Quality Improvements	62.96%
Productivity Improvement	59.26%
Improved Workplace Organization and Worker Safety	55.56%
Reduced Machine Setup Time	51.85%
Increased Employee Morale	51.85%
Shorter Delivery Lead Times	44.44%
Reduced Down Time	44.44%
Smaller Production Batches	44.44%
Increased Flexibility	44.44%

All participating firms reported some crucial improvements achieved in the last twelve months and were asked to rate the impact of partial or complete lean integration on the reported improvements as listed in Table 3. Participants who stated that lean integration was either "quite impactful" or "very impactful" on a specific improvement category were combined and reported in one column of the table as a cumulative product of survey results for a more reader-friendly manuscript. According to 88.89% of study participants, waste reduction was the improvement category, in which the impact of a previous lean integration was significant. Lower inventory levels and increased customer satisfaction followed the waste reduction category with 85.19% and 81.48%, respectively. The improvement categories of reduced cost per unit and scrap rate reduction were also reported to be significantly impacted by previous or current lean integrations, with 77.78% and 74.07%, respectively. Improvement categories least associated with lean integration were shorter delivery lead times, reduced downtime, smaller production batches, and increased flexibility, as shown in Table 3. Only 44.44% of the participants associated these improvement categories with a previous or current lean integration.

As can be interpreted from the findings of this study, both at macro and micro levels, lean understanding and maturity, expected/experienced results gains of lean integration, lean competency level of the workforce, lean education opportunities, primary motivation sources and barriers vary significantly across participants. This variation could support the claim that lean manufacturing is still far from becoming a mainstream modern management technique for members of the furniture manufacturing cluster located in the Inegol region. If they could further tap the potential of lean manufacturing, more constant and significant benefits could be obtained with increased integration maturity.

Conclusion

Within the scope of this study, the lean manufacturing knowledge level and integration maturity of one of Türkiye's most significant furniture manufacturer clusters were investigated. Based on the study's findings, participants of the study were mainly aware of the power and potential of Lean Manufacturing. However, few companies have undertaken a comprehensive or full lean integration to harness that potential. For many organizations, reducing operational expenses and fiercer competition within the sector were the main internal and external motivations for considering lean manufacturing. Nevertheless, firms that undertook even a partial lean integration observed significant gains on various fronts. Such findings of this study can be summarized that Inegol, Bursa, and Türkiye's furniture industry members vary in level of lean manufacturing understanding and integration regardless of company size and their overall integration maturity level is far from desired.

Moreover, the undiscovered portion of lean philosophy outweighs the discovered areas by furniture manufacturing organizations. Therefore, Turkish furniture manufacturers could benefit from more comprehensive lean manufacturing integration. This study also proved that lean manufacturing is a versatile modern management technique deployed in any industry. Finally, this study proved that lean

manufacturing is still in the discovery phase and continues its infusion across industries in emerging economies such as Türkiye.

Channelling more effort into lean manufacturing/management and the value-added wood products industry could help tap the potential within the intersection zone. Future research in the subject matter could involve conducting similar studies with larger sample sizes, exploring the dynamics of various furniture Manufacturing clusters located in different regions of Türkiye, and investigating the evolution of lean integration maturity through time-phased repetitive studies. It could even be taken one step further and studies focusing on co-deployment of more than one modern manufacturing/management technique such as lean and six-sigma or lean and green could be sought after.

Although some firm conclusions could be derived from the results of this study, it also had some limitations, such as; (1) relatively small sample size due to the chronic hesitancy of some industry members to participate in this kind of study and (2) lack of generalizability feature of the study findings due to its regionally confined focus that was a function of the study design and objectives set to investigate dynamics of a particular furniture manufacturing cluster.

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References

Abu, F., Gholami, H., Saman, M. Z. M., Zakuan, N., & Streimikiene, D. (2019). The implementation of lean manufacturing in the furniture industry: A review and analysis on the motives, barriers, challenges, and the applications. *Journal of Cleaner Production*, *234*, 660–680.

Adams, L. (2002). Get lean and improve quality. *Quality*, *41*(10), 44.

Åhlström, P. (1998). Sequences in the implementation of lean production. *European Management Journal*, *16*(3), 327–334.

Akgül, F. (2019). *Yalın Altı Sigma: Mobilya Endüstrisinde Bir Araştırma*. Fen Bilimleri Enstitüsü.

Alzubi, E., Atieh, A. M., Abu Shgair, K., Damiani, J., Sunna, S., & Madi, A. (2019). Hybrid integrations of value stream mapping, theory of constraints and simulation: application to wooden furniture industry. *Processes*, *7*(11), 816.

Arumugam, V., Antony, J., & Douglas, A. (2012). Observation: a Lean tool for improving the effectiveness of Lean Six Sigma. The TQM Journal.

Bamford, D., Forrester, P., Dehe, B., & Leese, R. G. (2015). Partial and iterative lean implementation: two case studies. International Journal of Operations & Production Management.

Bortolotti, T., Boscari, S., & Danese, P. (2015). Successful lean implementation: Organizational culture and soft lean practices. *International Journal of Production Economics*, *160*, 182–201.

Boyer, M., & Sovilla, L. (2003). How to identify and remove the barriers for a successful lean implementation. Journal of Ship Production, 19(02), 116-120.

Buehlmann, U., Espinoza, O., & Fricke, C. (2013). Adaptation of Lean in the wood industry. In *Advances in Sustainable and Competitive Manufacturing Systems* (pp. 1539–1551). Springer.

Chaple, A. P., Narkhede, B. E., Akarte, M. M., & Raut, R. (2018). Modeling the lean barriers for successful lean implementation: TISM approach. International Journal of Lean Six Sigma.

Coetzee, R., Van Dyk, L., & Van der Merwe, K. R. (2019). Towards addressing respect for people during lean implementation. International Journal of Lean Six Sigma.

Coban, S. (2005). Kayseri Mobilya Sanayinin Diş Ticaret Yapisi Ve Sorunlarina Yönelik Bir Araştirma. *Karamanoğlu Mehmetbey Üniversitesi Sosyal Ve Ekonomik Araştırmalar Dergisi*, *2005*(2), 73–82.

Czabke, J., Hansen, E. N., & Doolen, T. L. (2008). A multisite field study of lean thinking in US and German sec ondary wood products manufacturers. *Forest Products Journal*, *58*(9), 77.

Delbridge, R. (2005). Workers under lean manufacturing. The essentials of the new workplace: A guide to the human impact of modern working practices, 15-32.

Elkington, J. (1994). Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development. *California Management Review*, *36*(June 1992), 90–100. https://doi.org/10.2307/41165746

Emiliani, B. (2008). The equally important "respect for people" principle. *Real Lean: The Keys to Sustaining Lean Management*, *3*, 167–184.

Farfan-Quintanilla, Z., Caira-Jimenez, M., Sotelo-Raffo, F., Raymundo-Ibañez, C., & Perez, M. (2020). Applying SLP in a lean manufacturing model to improve productivity of furniture SME. *International Conference on Intelligent Human Systems Integration*, 690–696.

Feld, W. M. (2000). *Lean manufacturing: tools, techniques, and how to use them*. CRC press.

França, S. L. B., Dias, D. F., Freitag, A. E. B., Quelhas, O. L. G., & Meiriño, M. J. (2018). Lean Manufacturing Application Analysis in the Inventory Management of a Furniture Industry. *International Joint Conference on Industrial Engineering and Operations Management*, 207–219.

Fujimoto, T. (1999). *The evolution of a manufacturing system at Toyota*. Oxford university press.

Gazo, R., & Quesada, H. J. (2005). A review of competitive strategies of furniture manufacturers. *Forest Products Journal*, *55*(10), 4.

Gazoli de Oliveira, A. L., & da Rocha, W. R. (2019). Productivity Improvement Through The Implementation Of Lean Manufacturing In A Medium-Sized Furniture Industry: A Case Study. *South African Journal of Industrial Engineering*, *30*(4), 172–188.

Gören, H. G. (2016). Yalın üretim için değer akış haritalandırma ve simülasyon: Mobilya sektöründe bir uygulama. *Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi*, *23*(4), 462–469.

Gürpınar, K., & Barca, M. (2007). Türk Mobilya Sektörünün Uluslararası Rekabet Gücü Düzeyi ve Nedenleri. *Eskişehir Osmangazi Üniversitesi İİBF Dergisi*, *2*(2), 41–61.

Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: a review of contemporary lean thinking. *International journal of operations & production management*.

Hobbs, D. P. (2003). *Lean manufacturing implementation: a complete execution manual for any size manufacturer*. J. Ross Publishing.

Hunter, S. L., Bullard, S., & Steele, P. H. (2004). Lean production in the furniture industry: The double D assembly cell. *Forest Products Journal*, *54*(4), 32.

IMOS. (2019). *Rakamlarla Inegol*. https://www.imos.org.tr/

IPCC. (2014). *Climate Change 2014 Mitigation of Climate Change - Working Group III Contribution to the Fifth Assessment Report of the Change Intergovernmental Panel on Climate* (O. Edenhofer & T. Z. and J. C. M. (eds. . R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. S (eds.)). Cambridge University Press. https://doi.org/10.1017/CBO9781107415416

Kahraman, K. (2018). Mobilya Tarihi. *İnegöl Mobilyacılar ve Marangozlar Odası Özel Yayınları*.

Karşıyaka, O., & Sütçü, A. (2019). Mobilya Üretim Süreçlerinde Verimliliği Artırmaya Yönelik 5S Uygulamaları. *Bilge International Journal of Science and Technology Research*, *3*(2), 87–101.

Lander, E., & Liker, J. K. (2007). The Toyota Production System and art: making highly customized and creative products the Toyota way. *International Journal of Production Research*, *45*(16), 3681–3698.

Liker, J. K. (1997). *Becoming lean: Inside stories of US manufacturers*. CRC Press.

Lukrafka, T. O., Silva, D. S., & Echeveste, M. (2020). A geographic picture of Lean adoption in the public

sector: Cases, approaches, and a refreshed agenda. *European Management Journal*, *38*(3), 506–517.

Melton, T. (2005). The benefits of lean manufacturing: what lean thinking has to offer the process industries. *Chemical Engineering Research and Design*, *83*(6), 662–673.

Ohno, T. (1988). *Toyota production system: beyond large-scale production*. crc Press.

Quesada-Pineda, H., Haviarova, E., & Slaven, I. (2009). A value stream mapping analysis of selected wood products companies in Central America. *Journal of Forest Products Business Research*, *6*.

Raymond, A. (2002). Battling the challenge of foreign imports. *Mid American WoodWorking Expo, Columbus, OH. Retrieved on July*, *1*, 2005.

Rose, A. N. M., Deros, B. M., & Rahman, M. N. A. (2013). Lean manufacturing practices implementation in Malaysian's SME automotive component industry. In Applied Mechanics and Materials (Vol. 315, pp. 686-690). Trans Tech Publications Ltd.

Roser, C. (2016). *Faster, better, cheaper in the history of manufacturing: from the stone age to lean manufacturing and beyond*. CRC Press.

Sabri, S., & Shayan, E. (2004). Lean strategies for furniture manufacturing. *Proceedings of the Fifth Asia Pacific Industrial Engineering and Management System Conference*, 1–8.

Sahoo, S., & Yadav, S. (2018). Lean production practices and bundles: a comparative analysis. *International Journal of Lean Six Sigma*.

Salah, S., Rahim, A., & Carretero, J. A. (2010). The integration of Six Sigma and lean management. International Journal of Lean Six Sigma.

Seebode, D., Jeanrenaud, S., & Bessant, J. (2012). Managing innovation for sustainability. *R&D Management*, *42*(3), 195–206.

Stonebraker, P. W., & Afifi, R. (2004). Toward a contingency theory of supply chains. Management Decision.

Sundar, R., Balaji, A. N., & Kumar, R. S. (2014). A review on lean manufacturing implementation techniques. *Procedia Engineering*, *97*(1), 1875–1885.

Tasdemir, C., & Gazo, R. (2018). A Systematic Literature Review for Better Understanding of Lean Driven Sustainability. *Sustainability*, *10*(7), 2544. https://doi.org/10.3390/su10072544

Van Dun, D. H., Hicks, J. N., & Wilderom, C. P. M. (2017). Values and behaviors of effective lean managers: Mixed-methods exploratory research. *European Management Journal*, *35*(2), 174–186.

Velarde, G. J., Pirraglia, A., Van Dyk, H., & Saloni, D. E. (2011). Lean Manufacturing in the US South Atlantic Region: An overview of the current state of implementation in the secondary wood industry. *International Wood Products Journal*, *2*(1), 30–37.

Vilkas, M., Koreckaja, I., Katiliūtė, E., & Bagdonienė, D. (2015). Adoption of lean production: Preliminary evidence from Lithuania. Procedia-Social and Behavioral Sciences, 213, 884-889.

Williams, K., Haslam, C., Williams, J., Cultler, T., Adcroft, A., & Johal, S. (1992). Against lean production. *Economy and Society*, *21*(3), 321–354.

Wilson, L. (2010). *How to implement lean manufacturing*. McGraw-Hill New York.

Yadav, G., & Desai, T. N. (2016). Lean Six Sigma: a categorized review of the literature. International Journal of Lean Six Sigma.