PAPER DETAILS

TITLE: Application of Lean Philosophy Approaches in Furniture Design Processes

AUTHORS: Eray Ersoy,Gülçin Cankiz Elibol

PAGES: 162-174

ORIGINAL PDF URL: https://dergipark.org.tr/tr/download/article-file/3389946

Mobilya ve Ahşap Malzeme Araştırmaları Dergisi
Furniture and Wooden Material Research Journal
Research Article - Araştırma Makalesi 2023-6(2), 162-174

Application of Lean Philosophy approaches in furniture design processes

Eray Ersoy[1], Gülçin Cankız Elibol[2*]

Abstract

Methodological approaches observed and applied regarding “Lean Philosophy”, which is a concept originating from production, became important tools that can offer solutions to different problems in several disciplines. In recent years, Lean Philosophy has been widely applied in different fields as "Lean Architecture", "Lean Design", "Lean Construction", "Lean Management", "Lean Hospital", "Lean Accounting". The main purpose of this study is to draw attention to the gains of Lean Philosophy, which can be defined as eliminating all kinds of waste and any activity that has no added value in the end use, to furniture design and production. Considering the effects of the design process on the whole enterprise, it is thought that design activities can contribute to a sustainable and more efficient interaction by incorporating concerns as modularity, inventory management, reduction of material consumption, reduction of labour and energy consumption, besides form and function concerns. As a qualitative research, this study embraces the document analysis method as a means of data collection and analysis. Existing prominent Lean Philosophy tools for manufacturing systems were analysed and some of them were adapted to design processes.

Keywords: Lean philosophy, furniture, design, production, productivity

Yalın Felsefe yaklaşımlarının mobilya tasarım süreçlerine uyarlanması

Öz

Üretim kökenli bir kavram olan “Yalın Felsefe” ile gözetilen ve uygulanan metodolojik yaklaşımlar kıt kaynakların etkin kullanımında, zaman içerisinde tüm disiplinlerde, farklı problemlere çözüm sunabilen önemli araçlar haline gelmiştir. Son yıllarda Yalın Felsefe’nin, “Yalın Mimarlık”, “Yalın Tasarım”, “Yalın İnşaat”, “Yalın Yönetim”, “Yalın Hastane”, “Yalın Muhasebe” gibi kavramlar ile farklı alanlarda da yaygınlaşarak uygulandığı görülmektedir. Bu çalışmanın amacı, her türlü israfı ve nihai kullanımda katma değeri olmayan her faaliyeti bertaraf etme olarak tanımlanabilen Yalın Felsefe’nin mobilya ve donatı elemanı tasarım süreçlerine katabileceği kazanımlara dikkat çekebilmektir. Tasarım sürecinin, üretim faaliyetleri gerçekleştiren bir işletmenin bütünündeki etkileri dikkate alındığında, tasarım faaliyetlerinin, form ve fonksiyon kaygılarının yanı sıra modülarite, stok yönetimi, malzeme tüketimlerinin azaltılması, işçilik ve enerji tüketimlerinin azaltılması gibi kaygıları da barındırmasının, sürdürülebilir ve daha verimli bir etkileşim ortamına katkı sağlayabileceği düşüncesi ortaya çıkmaktadır. Nitel araştırma olarak planlanmış bu çalışmada, veri toplama yöntemleri doküman tarama ve analiz olarak belirlenmiştir. Öne çıkan mevcut Yalın Felsefe araçları analiz edilmiş ve örneklendirilerek bazı araçların tasarım süreçlerine uyarlamaları yapılmıştır.

Anahtar kelimeler: Yalın felsefe, mobilya, tasarım, üretim, verimlilik

Article history: Received: 06.09.2023, Accepted: 29.11.2023, Published: 29.12.2023, *e-mail: gcelibol@yahoo.com
[1]Bursa Uludağ University, Vocational School of İnegöl, Department of Materials and Materials Processing Technologies, Bursa/Türkiye
[2]Hacettepe University, Faculty of Fine Arts, Department of Interior Architecture and Environmental Design, Ankara/Türkiye

To cite: Ersoy, E., Elibol, G. C., (2023), Application of lean philosophy approaches in furniture design processes, *Furniture and Wooden Material Research Journal*, 6 (2), 162-174, DOI:10.33725/mamad.1356240

1 Introduction

With the developments in globalization and increasing competition environment, design is seen as a strategic step that provides superiority. This competitive environment has led manufacturers to find new ways to deliver their products to a wider audience. Undoubtedly, it has started to gain importance for the consumer to have remarkable physical features in order for the products to be preferable in the competitive environment, in addition to the innovations put forward in their functional features. Thus, the importance given to design has gradually increased (Bezci 2022).

Since the first years of industrial history, companies have been in competition and are in a global race to increase their sales. Managers are looking for the fastest and most economical ways to produce and distribute products and services. As the pressure in global competition spreads from the East to the world, the survival of manufacturing firms depends on the ability to reduce production costs, improve products continuously and keep pace with changes in socio-technological developments. For this reason, lean production is seen as one of the keys to being efficient. Lean production can be defined as a production system that has no unnecessary elements in its structure and minimizes factors such as fault, cost, stock, labor, development process, production area, waste, customer dissatisfaction (Özçelik and Cinoğlu 2013).

The main purpose of lean thinking is to ensure that value flows uninterruptedly throughout the value creation process, starting from the raw material, and is quickly delivered to the end customer. In order to achieve this, it is necessary to look at the entire value chain as a whole, eliminate waste and direct all activities towards the goal of creating excellent value for the customer (Lean Institute - lean.org.tr).

The foundations of the lean management philosophy were laid as a result of Taiichi Ohno's on-site examination of the Ford Production System after the Second World War and his application of what he saw to the Toyota factory production processes with a different perspective (Apilioğulları 2010).

It is possible to define lean philosophy, which rises on the themes of respect for people and continuous improvement, as studies that contribute to making processes more efficient by focusing on eliminating waste.

Accordingly, 7 types of waste are basically defined in the production environment; faulty production, overproduction, stock, unnecessary work, transportation, movement, waiting (Öksüz et al. 2017).

Some sources also mention an eighth waste. The eighth waste has been referred to by several different names. This type of waste, which can be called differently as "unused creativity", "untapped brain", "human potential" and "skill", emphasizes in all definitions that the potential or talents of employees can be wasted and points to situations where their ideas are not used. Therefore, ignoring or not implementing improvement ideas from employees, assigning wrong, inadequate or incomplete responsibilities or tasks and not using their knowledge are also considered as a type of waste. In order to combat this eighth type of waste, which is caused by poor communication, lack of teamwork, poor management and inadequate training, management needs to encourage employees' ability to think critically and use continuous improvement feedback (Çanakçıoğlu 2019).

In Japan, where the Toyota production system, the origin of lean, was first realized in the 1950s, both money and raw materials were scarce and waste was very costly. Toyota had

to survive in this difficult environment. Toyota waged a war against waste by realizing at the time that scarce resources were being wasted in shoddy processes. During these years, Ohno formed the backbone of the “Just In Time” based Toyota Production System and identified seven types of waste. The production philosophy to reduce these identified wastes included several factors such as respect for people, teamwork, reduction of inventories and continuous maintenance which increased Toyota's productivity and performance compared to other automobile manufacturers. With continuous improvement efforts and flexible production, processes became more qualitative and both the variety and quality of products increased (Lodgaard et al, 2016; Wan and Chen 2009) (Derin 2017).

Lean production thinking has started to be adopted as a management approach over time. As explained above, lean management is based on "lean production thinking". As a result of the studies carried out within the framework of lean production, lean management philosophy has emerged (Tikici et al. 2006). Organizations converting to lean systems will give higher priority to operational issues compared to philosophical issues(Marvel and Standridge, 2009: 92).

With a focus on enhancing (customer) value and eliminating/reducing waste from a system's perspective, it can be argued that the lean philosophy and its basic elements address both design and production processes (Jørgensen and Emmitt, 2009: 228).

According to some recent studies, this trend of thought, which originated in Japan and started in the 1950s with the philosophy of lean production, has started to be adopted in all disciplines since the beginning of the 2000s. "Lean Management", "Lean Construction", "Lean Architecture", "Lean Hospital", "Lean Accounting", etc. "Lean Philosophy" applications focusing on sectors, processes and people have become addressed to many different fields.

In a study focused on health services (Çilhoroz and Çakmak 2020), the concept of Lean Leadership, which has an increasing importance in the management processes of enterprises and is evaluated within the scope of the Lean Management Approach, is the subject of research. In another study focused on the health sector (Taşdemir et al. 2021), it was stated that the application of lean thinking principles in health enterprises will ensure that patients wait less between processes, patients' treatments are started much faster, unnecessary analyzes are not performed, laboratory analysis results are delivered to doctors much faster, many more patients are treated within a day and costs are reduced in this way.

It is seen that there are also studies carried out in the field of logistics. Akben and Güngör (2018) stated that, the most important difference between the supply chain and the lean supply chain is that; in the traditional model, the focus is on activities during and after the production process, economically to the end customer and without creating major confusion; while in the lean supply chain approach, the focus is on eliminating waste along the chain and obtaining value.

In another study on lean organization principles (Çakırlı Akyüz and Çetin 2009), lean organization principles were discussed from philosophical and managerial perspectives, and it was aimed to examine the applications in the automotive supply industry and to measure the gains obtained from these applications.

In this context, the field of furniture design appears as a virgin field of study where high added value outputs can be obtained. This study focuses on the application of Lean philosophy approaches to furniture production and design processes. It is thought that lean

philosophy in production processes can find many application areas within the framework of lean production. However, this study focuses on design processes rather than production processes. The aim is to analyze furniture design processes and to develop suggestions for production on a sectoral basis.

2 Method

The study was planned as qualitative research. Qualitative research can be defined as research in which qualitative information collection methods such as observation, interview and document analysis are used and a qualitative process is followed to reveal perceptions and events in a realistic and holistic manner in a natural environment (Yıldırım 1999).

Document search was used as the data collection method. Document search and document analysis are information gathering methods used in qualitative research to support the information obtained through interviews and observations (Yıldırım 1999).

Document analysis regarding Lean Philosophy was used to analyze the data and the analysis results were used to adapt production process based Lean Philosophy tools to the design processes. Within this framework, document search was made on several national and international scientific databases. The search keywords were “lean philosophy”, “lean design”, “lean production” and “lean management”. The results in this framework were analysed in a detailed manner. The tools, which were suitable for adaption, are given under the following headings and suggestions for furniture design processes are presented

3 Using Lean Philosophy Tools in Furniture Design Processes: Analysis and Matching Suggestions

Although Lean Philosophy is a culture that can be spread to all areas of life and can even be included in our daily lives individually, it can be reported rationally by using some systematic methods, especially in applications in businesses. There are many methods that can also be described as Lean Philosophy tools. Among these methods, 5 approaches that stand out in terms of adaptability to design processes are included in the scope of this study. These approaches are Kaizen, JIT and Kanban, Poka Yoke, DOE - Design of Experiments and VSM - Value Stream Mapping.

3.1 Kaizen Approach: Standardization and Continuous Improvement of Processes, Operations and Products

3.1.1 Standard Work

The word standard is defined as "made or separated according to a certain type, measurable, uniform, single form" according to the Turkish Language Association. Standardization can be related to some features of a product as well as to the execution of processes such as design, production and sales.

Considering the design process of furniture and fittings, it is possible to improve and maintain product quality with some standards to be created for the relevant product group. At the same time, standard product production can eliminate some uncertainties that may lead to inefficiency in production and enable more efficient, faster and more controllable processes to be designed with various improvements.

The accuracy of the product and production processes to be produced can be measured in environments where standards are set. Measures can be taken against faults with repeated

measurements so that they do not occur again and it is possible to make improvements to products and processes.

3.1.2 Kaizen

Kaizen is a Japanese word for improvement. Thus, the desire to continuously improve system performance leads repeating the gap assessment step (Marvel and Standridge, 2009: 98). It is formed from the combination of the words Kai and Zen, which mean change and better in Japanese. It is used in the sense of continuous improvement and development. Masaaki Imai, who created this philosophy, mentioned that managers at all levels should create separate strategies for the implementation of continuous improvement philosophy in enterprises. Continuous improvement is a concept that expresses a rapid improvement in processes and a reduction in costs to increase customer satisfaction in a certain period of time (Buzlu 2011: 58) (Arıcı 2019).

3.1.3 Possible Gains That Can Be Obtained by Using These Methods in Furniture Design Process

Technical drawings, which are the outputs of the design process and at the same time the inputs of the production process, are the main reference that defines the materials, determines the material consumption amounts and determines the workflows to be realized in the production processes. For this reason, significant gains can be achieved when standardization, one of the lean philosophy methods, is considered at the product design stage. The first and most important process in which standards can be set and improvements can be made through kaizen studies is the design process.

A common design and production language can be observed by designing the product groups and product families to be produced within certain standards in terms of material, colour, size and configuration (variable features). In this way, both quality standards can be maintained and production processes in which faults are minimized can be carried out more efficiently. Standards can be determined in the design process with examples such as making certain products in standard sizes, defining variable sizes alternatively with a similar approach, designing modular products, considering the machine capabilities and tolerances, determining material alternatives, etc.

It is often not possible to make improvements in a non-standard product production process where each production is unique in itself. When products produced with a variety of different colours, sizes and configurations are standardized with certain design criteria at the design stage, it will be possible to carry out forward-looking kaizen that is improvement studies. Both product designs and production processes of the relevant product will be continuously improved.

3.2 JIT and Kanban Pulling System

3.2.1 JIT (Just in Time)

There are different definitions of JIT (Just in time production). Some definitions limit the system only to the reduction of inventories. However, JIT should be considered in a broader context. JIT is effective not only in activities related to manufacturing but also in other areas of the production system, from materials handling to warehousing, from maintenance and repair to engineering design, from sales to top management. JIT is a strategy that aims to achieve significant and sustained improvement in work efficiency through the prevention and elimination of time and resource losses throughout the enterprise. In short, the

philosophy of JIT aims to achieve the least cost and highest customer satisfaction with the participation of all units (Emiroğlu 2014).

Just in time, production is an approach to produce the required product in the required quantity and is a material management system that requires the material required in the production process to be available at the point of need at the required time and targets "zero inventory". It is a system that utilizes all potentials by using the cheapest and error-free production in the shortest time, with the least waste and the most flexible use of all production factors with the least use of resources. (Emiroğlu 2016).

3.2.2 Kanban Pull System

One of the important approaches that form the basis of the lean philosophy is that the system can enable the customer to pull the desired value from the producer instead of supplying mass productions to the consumer. It is possible to call this integrated approach a pull system.

The information flow, which enables the pull system to operate, is called "Kanban". Kanban is a card showing the type and quantity of the product withdrawn. This card is sent as a production order from the next process to the previous one. In this way, all manufacturing processes are connected to each other. Suppliers are also part of this system and they should adjust their production according to the quantity and time of withdrawal (Güner and Karaca 2004) (Türkan 2010). Although some of the techniques provided better results depending on the firm size, practices such as setup reduction, multifunction employees and the Kanban system provide better organizational performance regardless of firm size (Marvel and Standridge, 2009: 92).

A production process triggered by a customer order is considered an appropriate example of a pull system setup.

3.2.3 Possible Gains That Can Be Obtained by Using These Methods in Furniture Design Process

When the orientations of end users regarding furniture preferences are examined today, it is seen that customer demands and expectations are diversifying day by day and therefore manufacturers have to create a wide variety of alternatives. From this point of view, it is not known what will be used causes furniture manufacturers to be unable to keep stock at the product level. In order to provide fast service at the right time in multi-product production processes, effective inventory management that can be realized at raw material and semi-finished product levels can reveal more accurate results in terms of costs.

One of the important approaches that can contribute to the solution in this regard is modularity and the other is the common part approach. Designing the parts that will form the products according to a modular coordination can enable a semi-finished product to be transformed into more than one product. In other words, a part that may belong to one product can also be used in another product. If the same parts in terms of configuration such as dimensions and holes are designed as a common part, they can be used in more than one product. It is seen that common parts that can quickly turn into different products from the semi-finished product level facilitate production and contribute positively to the delivery of parts to the right place at the right time in production.

Production units that are activated by customer orders stand out as one of the best examples of the pull system. It is possible to establish a Kanban system in a production

assembly line triggered by an order. It is possible to manage the semi-finished product stocks created before the assembly line with Kanban cards (work orders) coming from the assembly. If the relevant semi-finished parts are common parts that can be used in more than one final product, both the functionality of the Kanban system and the end-to-end speed of production can be increased. By taking these methods into consideration during the design process, it can also contribute to reducing the stock quantity and diversity at the raw material, semi-finished product and finished product levels.

With the common part approach and design processes where modularity is considered, the functionality of JIT and Kanban Pull Systems can be increased and the efficiency of operational processes can be improved.

3.3 Poka Yoke; Defect Preventing Devices

Poka Yoke is considered as one of the lean production techniques and is basically defined as a mechanical and electronic mechanism that prevents and eliminates human defects (Pekin and Çil 2015). It is seen that many possible defects can be eliminated by observing the Poka Yoke approach which is defined as defect prevention in the design processes and operation times can be reduced in both production processes and after-sales assembly processes.

3.3.1 Possible Gains That Can Be Obtained by Using This Method in Furniture Design Process

Many Poka Yoke applications can be implemented in technical drawings. These drawings are the result of design processes and guide production operations.

Some examples of applications in furniture design and production can be listed as follows;

- Marking the screw points on the cabinet body and furniture doors that can ensure the quick assembly of hinges and hinge bases in the right place.

- In order to prevent a part to be used in product assembly from being installed in the wrong direction, the distances of the fasteners (minifix, dowel, etc.) to the edges are differentiated so that the part can be assembled correctly in one direction.

- Marking of fixing points for accessories such as drawer runners, handles, legs, etc. on the part during operations such as drilling, etc.

- The moulds, jigs and fixtures used in the production and assembly processes can eliminate individual errors in the operations. Again, the design process is where the necessary equipment design and analysis should take place.

As seen in all these examples and dozens of examples that can be multiplied specifically for the design process, great gains can be achieved by observing the Poka Yoke method in the design process. Faulty production can be prevented and the efficiency and speed of the relevant production processes can be increased.

3.4 DOE (Design of Experiments)

Main philosophy; It is the design that will eliminate critical problems in production with the idea that "quality is designed together with the product". By taking previous design verification results as data, a design is made that will prevent problems that may occur during production in subsequent designs (Womack PJ, Jones DT, 1998).

DOE method can be effectively applied in product design processes that repeat production. Especially in standard product groups, the inferences made through iterative production can contribute positively to the principle of continuous improvement.

Today, it is possible to see that different software and drawing/design programs with simulation capabilities are actively used in the DOE process.

3.4.1 Possible Gains That Can Be Obtained by Using This Method in Furniture Design Process

Design processes in furniture and decorative applications can be quite painful, depending on the complexity of the product being designed. Especially when designing a product or a construction with dimensions whose limits have not yet been tested, an environment is created in which the designer can make mistakes. Such uncertainties are either resolved by trial and error or the ideal product is moved away from the ideal product with excessive (waste) or incomplete (defective product) solutions.

Experience and knowledge come to the fore in the quest for the ideal product. Experience and knowledge may also be insufficient for some application details or physical exertion for aesthetic purposes.

When unnecessary material and labour costs are added to the difficulties mentioned above, the efficiency of the process becomes highly questionable. Knowing and applying the right research methods and techniques in design activities, can contribute positively to process efficiency. For this reason, the simulation method, which is a powerful research method and technique, has an important place in furniture and decoration applications. Especially 3D design programs with simulation capability can provide unique facilities to designers in this regard.

When the design outlines of the product are formed in the content described above, the technical design process, which can be defined as detail, begins. Observing the criteria to be determined and included in the design process at this stage can enable significant gains in terms of form or function. While many of these criteria depend on the properties of the material (raw material) to be used, some of them are determined by the preferences of the decision-makers in the design process.

Some sample study titles that can be done in this context can be listed as follows:

- For products that use different materials such as metal, wood and glass, solid modelling software with simulation capabilities is used to ensure the robustness of the design, to calculate the amount of load the product will carry within safe limits, and to select the right profiles and thicknesses of material.

- In order to make the best use of the sizes of raw materials that can be supplied in standard sizes, some changes can be made to the dimensions of the product/part without neglecting the ergonomics of the product.

- Differentiation of parts sizes formed by the product in order to eliminate potential visual errors. As an example of this issue, we can consider the dimensioning of the parts that make up a cabinet body consisting of four panels. While the side panel depth measurement is determined as 330 mm, the depths of the bottom and top panel parts can be determined as 329 mm. In this example, part sizes are differentiated to prevent (+-) error tolerances in the production processes from turning into a visual problem in the final product.

- Depending on the features of the CNC drilling machines, placing all hole axis distances in the holes to be defined for the fasteners at 32 mm and its multiples can be considered as another example. In this way, in line with the machine capabilities, several holes on the part can be processed simultaneously and production time can be shortened.

The number of examples above can be multiplied. By carrying out many such detailed analyses using solid modelling in CAD/CAM programs with simulation capabilities, it will be possible to resolve potential problems at the design stage before production.

3.5 VSM (Value Stream Mapping)

One of the most important techniques used in the transition to a lean production philosophy is VSM. VSM can be applied not only in the manufacturing sector but also in the service sector. VSM includes all the processes that take place until a product arrives at the factory as a raw material, goes through certain production processes and reaches the customer as a finished product. VSM shows the material and information flows for a product. These flows can be used to find waste and sources of waste by identifying activities that add or do not add value to the product. Future situation maps are created by making improvements in the process to eliminate/reduce current wastes (Adalı et al., 2017).

3.5.1 Possible Gains That Can Be Obtained by Using This Method in Furniture Design Process

It is known that space and product design processes are carried out in a way that can effectively respond to needs and take into account ergonomic factors. The placement points are as important as the functionality of the furniture designed for a space. Positioning product placements in accordance with the flow of activities within the space is an important space design criterion. In terms of efficient use of space and equipment, the flow of activities planned to be carried out in the space should be observed. The gains that can be achieved with a correct space design are similar to the gains that can be achieved with the correct layout in a production workshop. The venues of cafes, restaurants and fast-food chains especially their kitchens that try to provide fast service to crowded groups of people can be considered as striking examples in this regard.

4 Results and Discussion

The methodological approaches followed in Lean Philosophy, which originated in manufacturing, can be used as an important tool in all disciplines for the efficient use of limited resources.

One of the most important features of lean production techniques is that they enable production operations to continue with far fewer inputs and costs. Therefore, the adoption of lean production techniques will lead to the accumulation of much more resources in the hands of firms than before. In other words, capital accumulation will accelerate. The accumulated capital can be transformed into new investments, and workers who are no longer needed within the scope of existing jobs can be employed in new investments (Çakırlı Akyüz and Çetin, 2009).

Therefore, lean transformation includes the elimination of all kinds of activities that do not create value in the organization, the reduction of the amount of production factors used, the use of advanced technology equipment and qualified workforce and the prevention of

faults before they are made based on the principle of doing the right job at once. Lean transformation, which is referred to as "Lean Production System" in practice, aims to achieve the highest efficiency with the least input by providing a high level of performance (Türkan, 2010).

The fact that interior space and furniture design processes will be handled with this systematic thought, which has an engineering infrastructure at its basis, is considered as an interdisciplinary field of study where high value-added outputs will be obtained.

In the first part of this study, there has been a classification of waste types. With this perspective, the table below tries to summarize how the methods discussed in the study can contribute to reducing some possible types of waste. Gains, related to the findings of the comments conducted within this study, can be followed systematically through Table 1. The numbers given below the table represent the gains.

Table 1. Expected gains of regarding furniture design and manufacturing processes

	Objectives						
	Fault-free production	Reduction of stocks	Decretion of standby times	Elimination of unnecessary tasks/works	Elimination of unnecessary transport	Reduction of unnecessary acts	Utilizing labour force
Standard work	1	2			3		4
JIT / Kanban		5	6				
Poka Yoke	7, 8						
DOE	9			10			
VSM					11	12	

1 With the production of standard parts and products and the determination of quality standards, it will be possible to reduce faults.

2 With the standardization of raw materials, it will be possible to reduce stock diversity and to provide minimum stock levels.

3 Effective use of the areas and reduction of unnecessary transportation will be possible by determining the materials at raw, semi-finished and finished product levels.

4 Technical office personnel working with drawing and design will be able to have a more productive working environment.

5 It will be possible to reduce the stocks of semi-finished and finished products, by using common parts that can be used in different products.

6 It will be possible to gain flexibility in production and to increase the ability to respond quickly to incoming orders with the parts that can be used in different products.

7 Faulty production and faulty assembly can be completely prevented by using markings while preparing technical drawings and production data.

8 It will be possible to perform fault-free operations with molds and fixtures that will be designed for being used in production processes.

9 Preparing computer simulations for the productions that will firstly take place will contribute to avoid labour, material and time losses.

10 Simulations will reduce unnecessary processes and operations.

11 Unnecessary transports will be minimized by considering VSM criteria in interior design.

12 Unnecessary movements can be minimized by considering VSM criteria in interior design.

According to Letens et al. (2011: 83), future research may want to further expand the current framework through the identification of additional LPD system components that facilitate continuous improvement from a systems and multilevel perspective.

5 Conclusions

Based on the results of the research, the following conclusions were reached;

- Looking at the processes involved in interior and furniture design, the first step is to produce design sketches and 3D visual studies, followed by technical product drawings and detailed solutions, and then the next step is to develop the product itself so that the final product can be used as a model.
- The outputs of design studies are almost a constitution for all departments in the organization where operational activities are carried out.
- The variety of materials defined in the design processes is supplied by the purchasing department. For this reason, design process decisions directly affect the purchasing budget.
- The choices and decisions made during the design process regarding raw materials, semi-finished and finished products have a direct impact on stock and inventory management either positively or negatively.
- The main reference for work orders in the workshops and factories, where the production of furniture is carried out, are the technical drawings.
- Production flows and all the operations are carried out in accordance with the details specified in the technical drawings.
- Considering the impact on other departments/processes in a furniture manufacturing company, the first and most important area where Lean philosophy should be applied is the design process.
- Design activities that address modularity, industrial design, inventory management, reduction of material consumption, reduction of labour and energy consumption can contribute to sustainable success.
- The adoption of the Lean Philosophy, whose main purpose is to eliminate all kinds of waste and every activity that has no added value in the end use, and the application of its methods in design processes can provide great gains in terms of efficiency not only in the design process but also in the entire value chain.

Acknowledgement
Authors would like to extend their sincere thanks to Gülfer Çetinkaya for her kind contributions.

Author Contributions

Eray Ersoy: Conceptualization, Data curation, Investigation, Project administration, Resources, Writing – original draft, Writing – review & editing. **Gülçin Cankız Elibol:** Formal Analysis, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing.

Funding statement
No financial support was received for the study.

Conflict of interest statement
The authors declare no conflict of interest

References

Adalı M.R., Kiraz A., Akyüz U., Halk B. (2017), Yalın üretime geçiş sürecinde değer akışı haritalama tekniğinin kullanılması: büyük ölçekli bir traktör işletmesinde uygulama, *SAU Fen Bilimleri Enstitüsü Dergisi*, 21(2), 2017, 242-251. DOI: 10.16984/saufenbilder.283787.

Akben, İ., Güngör, A. (2018), Tedarik zinciri ve yalın tedarik zinciri, *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi (ASEAD)*, 5 (7), s. 1-12.

Apilioğulları, L. (2010), *Yalın dönüşüm*, Sistem Yayıncılık, İstanbul.

Arıcı F. (2019), Sınırsız iyileşme ile örgüt performansı arasındaki ilişkinin incelenmesi: Kastamonu ilinde bir uygulama, *The International New Issues in Social Sciences*, 7 (2).

Bezci, İ. (2022), Tasarım tescilinde iç mekan tasarımlarına ilişkin görsel anlatımlara yönelik bir analiz, *Sanat ve Tasarım Dergisi*, 12 (2), 595-616. DOI: 10.20488/sanattasarim.1221928

Buzlu, H. B. (2011), *Kalite yönetim sistemleri*, Zeus Kitabevi Yayınları, İzmir.

Çakırlı Akyüz, N., Çetin, C. (2009), Yalın organizasyon ilkeleri ve uygulamaları üzerine bir araştırma, *Öneri Dergisi*, 8 (32), 1-14.

Çanakçıoğlu, M. (2019), Yalın düşünce felsefesinde israfla mücadele araçları, *Social Sciences Research Journal*, 8 (3), 270-282.

Çilhoroz, Y, Çakmak, C. (2020), Yalın yönetim bakış açısıyla yalın liderlik, *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, 8 (4), 1331-1339, DOI: 10.18506/anemon.648680

Derin, N. (2017), *İşletmelerde yalın yaklaşım*, Nobel Yayınevi, Ankara.

Emiroğlu, A. (2014), Yalın üretim, tam zamanında üretim ve hücresel üretimin organizasyon ve insan boyutu, *Leges Sosyal Bilimler Dergisi*, 1 (1), 263-287.

Emiroğlu, A. (2016), Yalın üretim ve tam zamanlı envanter yönetim stratejisi, *International Journal of Management Economics and Business*, 16, 71-85.

Letens, G., Farris, J. A., Van Aken, E. M. (2011), A multilevel framework for lean product development system design, *Engineering Management Journal*, 23 (1), 69-85.

Güner E., Karaca M.E. (2004), Tam zamanında üretim sisteminde tedarikçi ilişkileri ve en iyi parti büyüklüğü üzerine bir uygulama, *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, 19 (4), 443–454.

Jørgensen, B. and Emmitt, S. (2009), Investigating the integration of design and construction from a "lean" perspective, *Construction Innovation*, 9 (2), 225-240.

Lean Institute, www.lean.org.tr

Lodgaard, E., Ingvaldsen, J. A., Gamme, I., Aschehoug, S. (2016), Barriers to Lean ımplementation: perceptions of top managers, middle managers and workers, *Procedia CIRP*, 57, 595-600.

Marvel, J. H., Standridge, C. R.. (2009), Simulation-enhanced lean design process, *Journal of Industrial Engineering and Management*, (l) 2, n. 1, 90-113.

Öksüz, M. K., Öner, M., Öner, S.C. (2017), Yalın üretim tekniklerinin endüstri 4.0 Perspektifinden Değerlendirilmesi, *4th International Regional Development Conference (IRDC'2017)*, 21-23 September, Tunceli/Turkey.

Özçelik, T. Ö., Cinoğlu, F. (2013), Yalın felsefe ve bir otomotiv yan sanayi uygulaması, *İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi*, 12 (23), 79-101.

Pekin, E., Çil İ. (2015), Kauçuk sektörü Poka-Yoke uygulaması, *SAÜ Fen Bilimleri Enstitüsü Dergisi*, 19 (2), 163-170.

Taşdemir, N. Z., Yapıcı, F., Baş, H., Furvgi, A. (2021), Sağlık sektöründe yalın felsefe, *Samsun Sağlık Bilimleri Dergisi*, 6 (1), s. 11-17.DOI: 10.47115/jshs.783459

Tikici, M., Aksoy, A., Derin, N. (2006), Toplam kalite yönetiminin radikal unsurlarından birisi olarak yalın yönetim, *Elektronik Sosyal Bilimler Dergisi*, 5 (15), s. 20-33.

Türkan, Ö. U. (2010), Üretimde yalın dönüşümün temel performans kriterleri, *BAÜ Fen Bilimleri Enstitüsü Dergisi*, 12 (2), 28-41.

Wan, H. And Chen, F. F., (2009), Decision support for lean practitioners: A web-based adaptive assessment approach, *Computers in Industry*, 60 (4), 277-283.

Womack, P. J. and Jones, D.T. (1998), *Yalın düşünce*, Sistem Yayıncılık, İstanbul.

Yıldırım, A. (1999), Nitel Araştırma yöntemlerinin temel özellikleri ve eğitim araştırmalarındaki yeri ve önemi, *Eğitim ve Bilim*, 23 (112), 7-17.