JOURNAL OF SCIENCE

PART A: ENGINEERING AND INNOVATION

Year / Yıl: 2019 **Volume / Cilt: 6** **Issue / Sayı: 4**

e-ISSN 2147-9542

Gazi University

Journal of Science

PART A: ENGINEERING AND INNOVATION

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GU J Sci, Part A, 6(4): 75-80 (2019)

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PART A: ENGINEERING AND INNOVATION

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The Effects of Innovative Demountable Furniture on User Preferences

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Article Info

Research Article

Received: 24/10/2019
Accepted: 18/12/2019

Keywords

Furniture,
Design,
Disassembled,
Demountable,
Innovation

Abstract

In this study, as an innovative approach, it is aimed to determine effects of demountable furniture on the preferences of residential users in Ankara. Demograhpic information and opinions of users regarding to demountable furniture were carried out with the help of a detailed questionnaire. 243 household users participated in the questionnaire. The obtained findings were evaluated with SPSS program. As a result, 66.7% of the participants prefer demountable furniture due to "easy transportation", 67.1% stated because of "dismantling and assembly" and 48.1% "assembling in place". On the other hand, 28.4% of the participants had problems due to the "need for a technician in assembling" of demountable furniture in their houses, 29.2% of them had "wear and tear of furniture pieces during dismantling" and 14% of them had "not being strong and durable" were determined. As a result, the diversification and strengthening of the fasteners used in demountable furniture with an innovative approach will contribute positively to the process.

1. INTRODUCTION

People spend a significant part of their lives, and need a variety of furniture to meet their action needs in indoor environments. Furniture has a very important place for creating homes and work places and meeting aesthetic and functional needs of users. In parallel with technological developments, new materials, tools and assembling techniques which are used in furniture production, are presented to consumers as an alternative design. Nowadays, demountable furniture; these features are preferred by manufacturers because of cost factors such as saving for labor gain, ease of transportation and transportation compared to the products produced in one piece.

In addition to traditional methods such as dowel and mortise jointing of furniture elements, a wide variety of fasteners made of materials such as metal and plastic are used in the construction of innovative demountable furniture assembled at the place of use and becoming widespread day by day [1,2]. Innovative approaches to the development of different new ideas shed light on the development of many alternative designs that enable the disassembling of furniture parts. If these furniture are stored in dismantled condition, they take up less space than fixed furniture. This situation is very important for manufacturers and sellers [3].

Innovative demountable furniture is a kind of furniture manufactured with new fasteners which are designed to be re-dismantled and assembled in pieces. All kinds of screws, hinges, handle and so on must be available. In addition, the installation guide is very important. Thanks to the innovations in the production brought about by the industrial revolution, furniture design and production that meets expectations of users, can be dismantled and installed, easily transported, can be easily adapted to new spaces with different solutions such as adding and decreasing has been started and the furniture concept that has been assembled by the user has entered the human life. Mostly modular demountable furniture is important in terms of time and energy loss and the fastest possible access to desired comfort conditions.

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The furniture can offer different variations by increasing or decreasing in different colors and sizes within the framework of needs and expectations [4]. Modular furniture is defined as a system that fully meets the needs by creating proportional divisions in order to meet the needs arising in the space in different proportions, bringing the modules formed side by side and / or on top of each other [5]. Today, there are many institutional companies like IKEA that produce and market innovative modular furniture [6]. It is reported in the literature that furniture using disassembled joining elements has positive effects on tensile and compression resistance compared to glued (fixed) furniture [3,7-11].

In the light of these findings in the literature, the research hypotheses developed in accordance with the purpose of this research are given below.

H1: Participants will want the furniture they want to buy to be dismantled.
H2: Participants will find the demountable furniture durable, reliable, easy to assemble and carry, and price suitability.

In order to test the hypotheses given above, the research method and findings developed according to the purpose of the research are explained below.

2. METHODS AND MATERIALS

This study aims to determine effects of innovative demountable furniture assembled at the place of use on user preferences. The demographic characteristics, questionnaire and statistical analysis are discussed as follows:

2.1. Participants

This study consisted of 243, residential users, randomly selected in Ankara. 60.1% of the participants were male, 39.9% were female, 80.7% were in the 18-25 age range, 19.3% were in the 26-45 age range, 15.6% were secondary graduates, 84.4% of them are high school graduates, 47.3% have 0-1500 TL income, 30.5% have 1501-3000 TL income and 22.2% have 3001-6000 TL income. Since the number of groups showing the distribution of demographic characteristics of the participants was not close to each other, it was not evaluated.

2.2. Questionnaire Design

The research hypotheses were measured with a questionnaire. The design of this questionnaire was valid and reliable in previous studies [12-15].

The questionnaire consists of two parts. These:

- General information for participants (gender, age, education level, income level, district and neighborhood of residence).
- Questions on demountable furniture (preference, features, durability, reliability, ease of installation, transportation and price-effectiveness of demountable furniture).

The survey was conducted in May 2019 by interviewing the participants face to face during the working hours of the day on weekdays and weekends.

2.3. Statistical Evaluation

The opinions of participants were evaluated in terms of properties of assembled demountable furniture as a dependent variable. In order to understand the obtained data from the research and to compare with the data obtained in the same way, frequency numbers and percentage values of the research data were calculated and Cronbach Alpha reliability tests of the data were performed. The research data obtained

from this study were tested with appropriate statistical methods and the findings obtained are given in a systematic order below.

3. RESULTS AND DISCUSSION

The Cronbach alpha reliability analysis of the data obtained from this study was conducted and as a result, the reliability value of the research scale, which included the evaluations of the participants about the disassembly of the furniture they wanted to purchase, was found to be 0.70. Previously, Cronbach [16], Kaplan and Saccuzzo [17] and Panayides [18] reported that alpha reliability coefficients for all elements can be considered reliable when the reliability coefficients are above 0.60. The Cronbach alpha value obtained in this study is above the indicated value. Accordingly, the data obtained can be considered reliable.

Firstly, the requests of the participants for the demountable features of the furniture that they intend to purchase were determined. As a result, the majority of the participants (88.5%) can buy demountable furniture. This result shows that the H1 hypothesis is generally supported (the participants will want to disassemble the furniture they intend to purchase). In relation to this result, the reasons why the participants want / prefer demountable furniture are given in Table 1 and graphical expression is given in Figure 1.

Table 1. *Reasons of participants to request demountable furniture*

Benefits of Demountable Furniture	**F**	**%**
Easy to carry home	162	66.7
During transport of the house can be demounted	163	67.1
Possibility to assemble furniture at the place of use	117	48.1

F: Number of frequencies, %: Percentage value

In Table 1, 66.7% of the participants preferred demountable furniture because it was easy to move home, 67.1% because they could be dismantled and installed during the transportation of the house and 48.1% due to the possibility of assembly at the place of use.

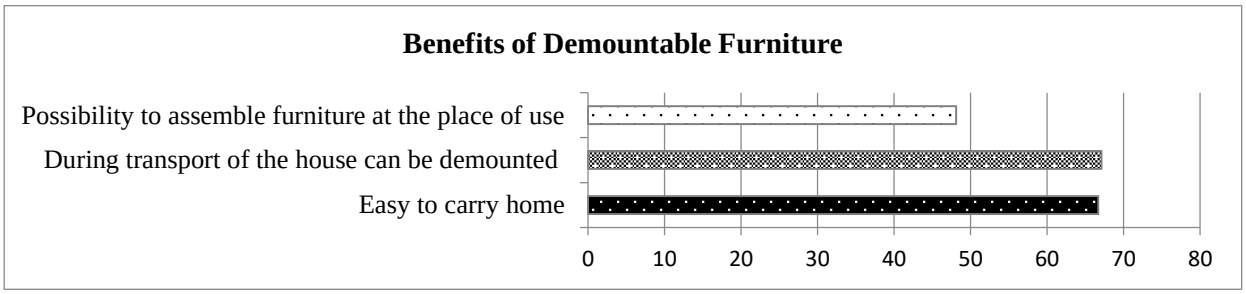

Figure 1. *Reasons of participants to request demountable furniture*

As a result, in questioning the furniture used by the participants in their houses was disassembled or not. A significant portion of the participants (59.7%) reported that the furniture was disassembled in their houses. In connection with this result, the reasons of the problems experienced by the participants regarding the demountable furniture in their houses are given in Table 2 and graphical expression is given in Figure 2.

Table 2. *Problems in the disassembled furniture in the houses*

Problems in Demountable Furniture	**F**	**%**
Need a technician for installation	69	28.4
Attrition of the components during disassembly and reassembly	71	29.2
The lack of robust and durable	34	14

F: Number of frequencies, %: Percentage value

Table 1 shows that 28.4% of the participants had problems due to the need of a technician in the assembly of demountable furniture, 29.2% due to the wear / tear of dismantled and assembled furniture parts and 14% due to the fact that they were not strong and durable.

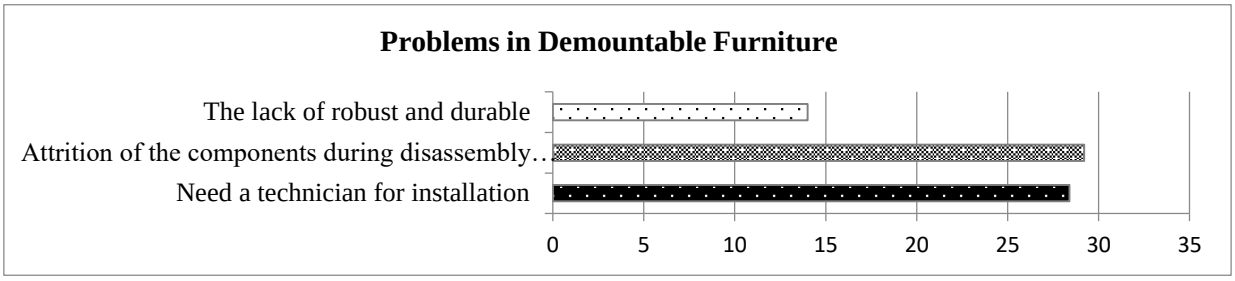

Figure 2*. Problems in the disassembled furniture in the houses*

As a consequence, the evaluations of the participants regarding the properties of the demountable furniture such as durability, reliability, ease of installation and transportation and price suitability are given in Table 3.

Table 3*. Features of demountable furniture*

Features of Demountable	Very Agree		Less Agree		Undecided		I do not agree		Never Agree	
Furniture	F	%	F	%	F	%	F	%	F	%
Durable	48	19.8	91	37.4	61	25.1	28	11.5	15	6.2
Reliable	50	20.6	107	44.0	57	23.5	16	6.6	13	5.3
Easy to install	154	63.4	42	17.3	25	10.3	10	4.1	12	4.9
Easy to carry	178	73.3	29	11.9	13	5.3	9	3.7	14	5.8
Price suitable	50	20.6	67	27.6	91	37.4	22	9.1	13	5.3

F: Number of frequencies, %: Percentage value

Table 3 indicates that 17.7% of the participants did not find demountable furniture durable, 64.6% found reliable, 80.7% found easy to assemble, 85.2% found easy to carry and 48.2% found the price to be appropriate. These results are consistent with those given in Table 1 and Table 2. These results show that the H2 hypothesis is generally supported (participants will find the demountable furniture durable, reliable, easy to assemble and carry, price suitable). However, it is noteworthy that a small proportion (17.7%) of the participants did not find the demountable furniture durable.

4. CONCLUSIONS

The general evaluation results of the research participants regarding the features of the assembled demountable furniture at the place of use are given below in a systematic order. The majority of the participants (88.5%) reported that the furniture they intend to purchase may be disassembled. This result shows that the general acceptance of innovative demountable furniture by consumers.

Furthermore, 66.7% of the participants preferred demountable furniture because it was easy to move home, 67.1% because they could be dismantled and installed during the transportation of the house and 48.1% due to the possibility of assembly at the place of use. This result shows that the favorable features of the demountable furniture such as ease of transportation and assembly have an important place in the preferences of consumers compared to the furniture produced in one piece.

Besides, 28.4% of the participants had problems due to the need of a technician in the assembly of demountable furniture, 29.2% due to the wear / tear of dismantled and assembled furniture parts and 14% due to the fact that they were not strong and durable. This result shows that a significant number of consumers experience problems with demountable furniture. According to these results, it may be suggested that furniture designers develop solutions to easily assemble the demountable furniture purchased by consumers without the need of a specialist, and manufacturers may use robust and durable

materials to prevent the wearing of demountable furniture parts. As a result, the diversification, strengthening and making it more economical of fasteners used in disassembled furniture with an innovative approach will make a positive contribution to the design and production and assembly process. The positive contribution of disassembled furniture such as ease of transportation, low transportation cost and assembly at the place of use should not be ignored. This innovative process for disassembled furniture can be made more effective through joint cooperation between universities and industry.

CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

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GU J Sci, Part A, 6(4): 81-91 (2019)

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PART A: ENGINEERING AND INNOVATION

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A Study on Determining the Criteria that Parents Consider When Buying Children's Room Furniture

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Article Info

Research Article
Received: 05/11/2019
Accepted: 18/12/2019

Keywords

Children's room,
Furniture,
Design,
Flexibility,
Changeability,
Innovation

Abstract

In this study, it was aimed to determine the effects of flexibility and interchangeability characteristics on furniture preferences by the criteria that the participants take into consideration when buying children's room furniture. The general information of the participants and their evaluations on children's room furniture were determined with the help of a detailed questionnaire. A total of 103 parents who participated in the playground of a shopping center in Ankara with their children participated in the survey and the results were evaluated with SPSS program. As a result, it is seen that the participants emphasize ease of use, durability, price suitability and material quality when buying furniture in children's rooms respectively. In addition, it was determined that storeability, partitionability and collectability characteristics were effective in the furniture preferences of the participants.

1. INTRODUCTION

"Civilized society is one that is struggling to make a better world for our children" [1,2].

Children are active participants in learning about the world around them. They begin to understand size by whether they can hold something in their hands or wrap their hands around it. They learn that things can be soft or hard, smooth or bumpy by touching them. To accommodate this active learning process, it is beneficial for the environment to reflect the size of the children and facilitate the children's ability to see and reach objects and feel comfortable within their surroundings. A space that is reflective of the children's physical size and abilities heightens their sense of confidence in their ability to perform simple tasks more independently. Appropriates sizes and elements such as windows, tables, chair and playground will prolong the children's interest and participation in constructive activities [3]. "When children feel comfortable in their physical surroundings, they will venture to explore materials or events around them." [3,4].

The impact of the environment in children's personality should not be ignored. Housing should be a living space that will protect physical, social and mental health. A house should be large enough to provide enough space for family members and provide privacy, safety and comfort conditions [5]. Today, children spend a significant amount of time in their room to play and study. If the interior equipment and auxiliary elements in the children's rooms are not planned at an optimum level, many problems such as injuries, serious musculoskeletal disorders, posture disorders and respiratory disorders can be seen in children using this environment. Unless there is a preventive approach to child health, it can cause permanent problems in later life of children. For this reason, parents have to take a multifaceted approach to the choice of furniture for their children. In addition, equipping the space to meet the needs of the children by taking the idea of children will help them feel safe and prepare for a successful future.

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The house, where an important part of the day is spent, is in a constant relationship with the user. As the economic and social situation affects individuals, housing user communication changes according to the conditions [6].The social environment, economic situation and lifestyle of the people constitute certain standards and the provision of standards increases the level of satisfaction [7]. In today's world where consumption culture is widespread, people make various choices by emphasizing their likes. People are influenced by their social class as they choose their choices and endeavor to adapt themselves to meet the standards of their class.

Today, as a result of contemporary life, residential areas divided into different spaces for different activities like, service, life and sleep etc. Spaces, were created according to different activities, were classified; Private, semi-private and open to the outside in the structure of the house [8]. The functional and perceptual quality of each residential space created according to the requirements of the action can be ensured by questioning the abstract, concrete or functional relationships between the demands and requirements of the user and the architectural features of the space, fixed / movable reinforcement elements and auxiliary elements (accessories, etc.). Briefly, when the relations between people, space and equipment elements are kept at optimum level, positive contributions will be provided to user happiness and comfort [9].

When the literature is examined about the furniture and the other housing equipment, a limited number of studies have been found in this subject.

Kurtoğlu and Koç [10] emphasized the importance of user needs, economic status and appreciation in the selection of furniture, which is also defined as movable reinforcement elements, and emphasized the necessity to consider such issues as usability, durability and longevity. It has been suggested that furniture, which is more expensive than other household goods, can be used for many years when it is chosen by considering the user-furniture relations and by making a good choice, therefore, it should not be purchased without a good research on price, quality, durability and variety. Eriç et al. [11], in the design and production of residential furniture can adapt to different places, with the addition of new parts in time or change within the internal equipment systems should be emphasized, emphasizing the fact that residential interior fittings are an industrial product, adapt to such spaces over time It has been suggested that adding new parts or going to internal equipment systems that may change within its own structure may be rational behaviors that can increase the current quality standard. Bilgin [12], in his study, examined the relations of goods and man-goods used by families; families have changed their belongings depending on socio-economic level (SED) and there is a certain harmony between the lifestyle and belongings of the users. According to information, during the 1980's it has changed the process of political and economic change people's consumption patterns experienced in Turkey revealed new consumer needs and expectations. With the increase in the purchasing power of Turkish consumers, the demand for different, high quality, aesthetic products that can be called "luxury products" has also increased.

On the other hand, in the studies focusing on children's rooms, Aleksić [2] defined the principles of a healthy environment in kindergartens and stopped the most appropriate design standards for children. Salvador [13] conducted research on product design, focusing on children's furniture (high chairs), and conducted research on issues that led to effective sustainability, waste reduction and product optimization. Adawiyah bte Jalaludin [3] offers a solution to repetitive stress and injuries due to the reduction of health problems between children and adults, musculoskeletal disturbance and incorrect ergonomics and improper posture at work stations. Wan et al. [14], China's rapid economic development emphasized that by improving people's living standards and raising people's health and environmental awareness, therefore, parents are choosing products made of non-toxic materials for their children and meeting the functional requirements. In Ruth's [15] study, emphasized that the design and production of furniture to be preferred for children, considering materials that do not harm for human health and safety principles, will protect children especially from indoor injuries and toxic effects. Ruth also stated that this is an important criterion for a healthy, safe and calm young generation. Another study in Finland, Toivonen [16] suggested that sales price plays an important role in the perception of product quality.

In the study of Yıldırım et al. [17], middle and upper income users' satisfaction and complaints were examined for the built-in furniture. At the end of the study, the users reported that the workmanship and material quality, size and storage capacity of these permanent furniture which made by the contractors, were not enough for satisfaction. It is seen that most of these complaints are concentrated in labor and material quality. In Akyüz's [18] study stated that the importance of the sales price decreased but the brand increased, with increasing education and income level.

When the literature on the subject is examined, it is clear that the innovative change that affects all areas of life is also reflected in the characteristics of children's furniture. Therefore; it is very important to use the findings with an innovative approach in the design of the interior elements by examining the lives and housing uses of families with different socio-economic levels [19]. When approached from this point, it is very important to meet the needs of the action and equipment in the rooms of our children, which will direct the future of humanity in many areas, in order to achieve a healthy structure and success. Within the framework of this approach, the above studies have not adequately examined the extent to which the children are able to meet their needs in matters such as the size and shape of the rooms where they spend a significant part of their lives, the qualities and materials of the equipment and auxiliary elements, and the density within the space. In this context, it is of great benefit to research children's rooms and find solutions to design new spaces or to improve existing spaces with the findings to be obtained. This study focuses on interior fittings and auxiliary elements, especially in children's rooms, and shows some possible practical answers to a wide range of design parameters. In this study, it is aimed to determine the characteristics that the parents will prefer for the design of children's room furniture depending on their demographic characteristics. Accordingly, the effect of the demographic differences of parents on the preference of children's room furniture will be tried to be determined. In the light of these findings in the literature, the research hypotheses developed in accordance with the purpose of this research are given below.

H1: Participants will consider the quality of workmanship, material quality, flexibility / changeability, functionality, durability and ease of use when purchasing children's room furniture.

H2: Participants will require extensibility, storability, partitionability and summability in children's room furniture.

The research method and findings developed for the purpose of the research to test the hypotheses given above are explained below.

2. METHOD

In this study, it is aimed to determine the issues that the participants take into consideration when buying children's room furniture. The characteristics of the parents, questionnaire design and statistical analysis are discussed below.

2.1. Selection of Participants

This study has randomly selected 103 parents, who were with their children in The Ankara Metrocity Shopping Mall playground, participated in this study. 18.4% of the participants were male, 81.6% were female, 60.2% were in the 26-35 age range, 39.8% were in the 36-45 age range, 44.7% were high school and 55.3% were high school graduates. In addition, 33% of the participants have income of 1500-4500 ₺, 42.7% of them have 4501-6000 ₺ and 24.3% of them have 6001 ₺ or more.

2.2. Questionnaire Design

The research hypothesis was measured with the help of a questionnaire. In the design of this questionnaire, residential furniture evaluation questionnaires were used which were found to be valid and reliable in previous studies [17,20,21]. The questionnaire consists of three parts. These are:

- General information of the participants (gender, age, education level, total monthly family income, number of children).
- Considerations when purchasing children's room furniture (workmanship quality, material quality, price suitability, fashionability, flexibility / changeability, functionality, durability and ease of use).
- Features required in children's room furniture in terms of flexibility and changeability (extensibility, summability, changeability, functionality, storability, partitionability).

The survey was conducted in May 2019 by interviewing the participants face to face during the working hours of the day on weekdays and weekends.

2.3. Statistical Analysis

In this research, a total of 103 participants 'parents' considerations when buying children's room furniture were measured with a questionnaire. Percentage values, averages and standard deviation values of the data obtained from the questionnaire were calculated, Cronbach Alpha reliability tests of the data were performed and whether the relationships between the independent variables were statistically significant was tested by single variance analysis (ANOVA). The means of the variables found important in the analysis of variance are expressed graphically.

3. RESULTS

The Cronbach alpha reliability analysis of the data obtained from this study was conducted, and as a result, the reliability value of the research scale, which included the evaluations of the participants regarding the issues taken into consideration when buying children's room furniture was found to be 0.83, and the reliability value of the flexibility / changeability scale was 0.76. In previous studies, Cronbach [22], Kaplan and Saccuzzo [23] and Panayides [24] reported that alpha reliability coefficients for all components can be considered as “reliable” when the coefficients exceed 0.60. The Cronbach alpha value obtained in this study is above the indicated value. Accordingly, the data obtained were considered as “reliable”.

In the first evaluation, %99 (102) of the participants had bed, 32% (33) of them had commode, 86.4% of them had clothes closet, 50.5% had them had dresser and 17.5% had diaper changer unit in their children's rooms.

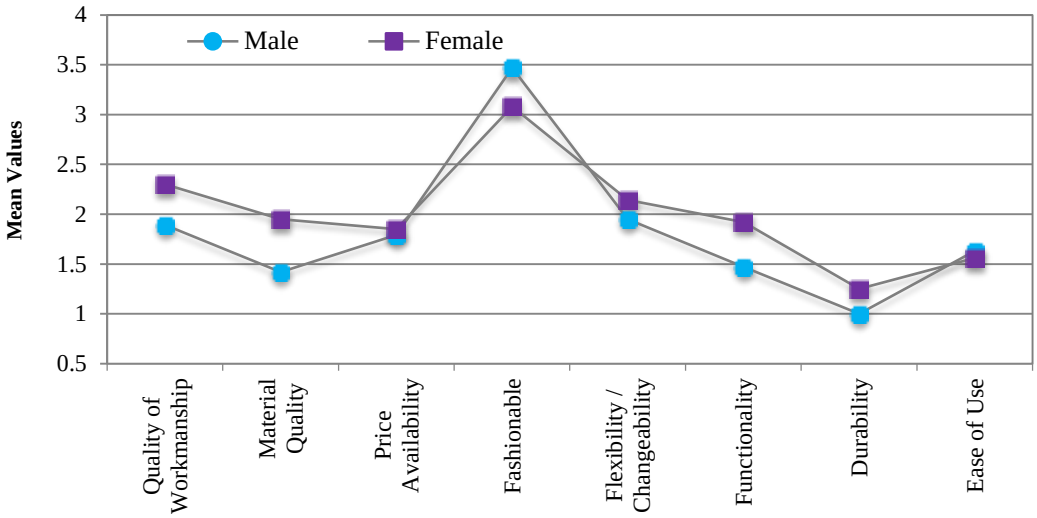
Table 1 shows the categorical averages, standard deviation values and ANOVA test results of the data that the participants take into consideration when purchasing children's room furniture by gender.

Table 1. *Preference of children's room furniture according to gender of the participants*

Preference of Children's Room Furniture	**Gender**						**ANOVA Results**		
	Male		**Female**		**Total**				
	M	SD	M	SD	M	SD	F	df	Sig.
Quality of Workmanship	1.89[a]	0.66	2.30	0.72	2.22	0.73	4.947	1	0.028*
Material Quality	1.42	0.51	1.95	0.56	1.85	0.58	14.514	1	0.000*
Price Availability	1.79	0.92	1.85	0.94	1.84	0.93	0.055	1	0.815[ns]
Fashionable	3.47	0.96	3.08	1.28	3.16	1.23	1.557	1	0.215[ns]
Flexibility / Changeability	1.95	0.40	2.14	0.60	2.11	0.58	1.800	1	0.183[ns]
Functionality	1.47	0.51	1.92	0.56	1.84	0.58	9.858	1	0.002*
Durability	1	0	1.25	0.44	1.20	0.40	6.210	1	0.014*
Ease of Use	1.63	0.76	1.56	0.50	1.57	0.55	0.261	1	0.611[ns]

Notes*: M: Mean, S: Std. Deviation, df: Degree of freedom, *: P < .05 level is significant, ns: Not significant.*
a: Variable averages ranked from 1 to 5 (1: Very important, 5: Not important). Higher values are negative answers.

When the average values given in Table 1 are considered, it is found that there is a statistically significant difference between the evaluations of the participants regarding the "quality of workmanship", "material quality", "functionality" and "durability" which are taken into consideration when buying furniture according to their gender. The graphical expression of these differences is given in Figure 1.



***Note**: Higher variable means show more negative responses.*

***Figure 1.** Considerations of the participants when buying furniture according to their gender*

In general, Figure 1 shows that when purchasing children's room furniture, participants give an importance to quality of workmanship, material quality, flexibility / changeability, functionality, durability and ease of use. This result shows that participants consider the hypothesis (*H1*) when buying child furniture. In addition, it is seen that male give more importance to "workmanship quality", "material quality", "flexibility / changeability", "functionality" and "durability" of the furniture when buying children's room furniture compared to female. On the other hand, it is seen that female give more importance to the fashionability of furniture than male. However, there was no statistically significant difference between "price availability", "fashionable", "flexibility / changeability" and "ease of use" with gender at $p < 0.05$.

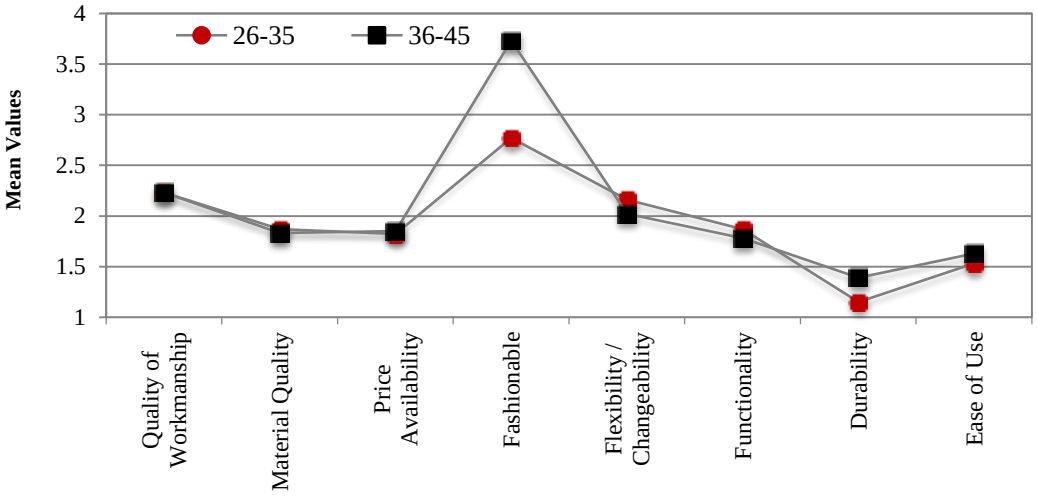
Table 2 shows the categorical averages and standard deviation values and ANOVA test results of the data that the participants take into consideration when buying children's room furniture according to their age.

***Table 2.** Preference of children's room furniture according to age of the participants*

Preference of Children's Room Furniture	**Age**						**ANOVA Results**		
	26-35 Age		**36-45 Age**		**Total**				
	M	SD	M	SD	M	SD	F	df	Sig.
Quality of Workmanship	2.23[a]	0.76	2.23	0.69	2.22	0.73	0.002	1	0.966[ns]
Material Quality	1.87	0.56	1.83	0.63	1.85	0.58	0.125	1	0.725[ns]
Price Availability	1.82	0.98	1.85	0.85	1.84	0.93	0.027	1	0.869[ns]
Fashionable	2.77	1.25	3.73	0.98	3.16	1.23	17.198	1	0.000*
Flexibility / Changeability	2.16	0.61	2.02	0.52	2.12	0.58	1.400	1	0.239[ns]
Functionality	1.87	0.59	1.78	0.57	1.84	0.58	0.600	1	0.440[ns]
Durability	1.15	0.36	1.29	0.46	1.20	0.40	3.352	1	0.070**
Ease of Use	1.53	0.50	1.63	0.62	1.57	0.55	0.836	1	0.363[ns]

***Notes**: M: Mean, S: Std. Deviation, df: Degree of freedom, *: P < .05 level is significant, ns: Not significant.*
a: Variable averages ranked from 1 to 5 (1: Very important, 5: Not important). Higher values are negative answers.

When the average values given in Table 2 are considered, it is found that there are statistically significant differences in the levels of "fashionability" and "durability" that the participants take into consideration when buying furniture according to their age. The graphical expression of these differences is given in Figure 2.



***Note**: Higher variable means show more negative responses.*

Figure 2. Considerations of participants when buying furniture according to their age

According to Figure 2, it is seen that the participants between the ages of 26-35 give more importance to "fashionability" and "durability" features when buying baby / child room furniture compared to the age range of 36-45.

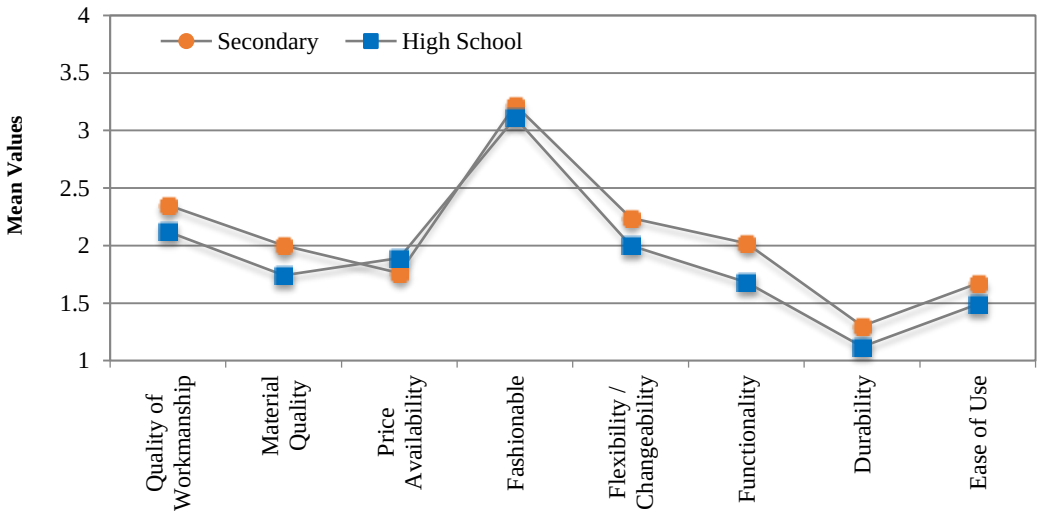
Table 3 shows the categorical averages, standard deviation values and ANOVA test results of the data that the participants take into consideration when buying baby / child room furniture according to their educational level.

***Table 3.** Preference of children's room furniture according to educational level of the participants*

Preference of Children's Room Furniture	**Educational Level**						**ANOVA Results**		
	Secondary		**High School**		**Total**				
	M	SD	M	SD	M	SD	F	df	Sig.
Quality of Workmanship	2.35[a]	0.77	2.12	0.68	2.22	0.73	2.476	1	0.119[ns]
Material Quality	2	0.60	1.74	0.55	1.85	0.58	5.387	1	0.022*
Price Availability	1.76	0.79	1.89	1.03	1.84	0.93	0.525	1	0.470[ns]
Fashionable	3.22	1.32	3.11	1.18	3.16	1.23	0.208	1	0.649[ns]
Flexibility / Changeability	2.24	0.67	2	0.46	2.11	0.58	4.542	1	0.035*
Functionality	2.02	0.54	1.68	0.57	1.84	0.58	9.360	1	0.003*
Durability	1.30	0.47	1.12	0.33	1.20	0.40	5.336	1	0.023*
Ease of Use	1.67	0.60	1.49	0.50	1.57	0.55	2.827	1	0.096**

***Notes**: M: Mean, S: Std. Deviation, df: Degree of freedom, *: P < .05 level is significant, ns: Not significant.*
a: Variable averages ranked from 1 to 5 (1: Very important, 5: Not important). Higher values are negative answers.

When the average values given in Table 3 are considered, it is seen that the participants considered the "material quality", "flexibility / changeability", "functionality", "durability" and "ease of use" that they considered when buying furniture according to their educational level $p < 0.05$ / $p < 0,10$ levels were found to be statistically significant differences. The graphical representation of these differences is given in Figure 3.



***Note**: Higher variable means show more negative responses.*

***Figure 3**. Considerations of participants when buying furniture according to their educational level*

According to Figure 3, participants who graduated from university gave more importance to ”workmanship quality”, “material quality”, “fashionable”, “flexibility / changeability”, “functionality”, “durability” and “ease of use” than the participants who graduated from high school. However, an opposite result has emerged for price availability.

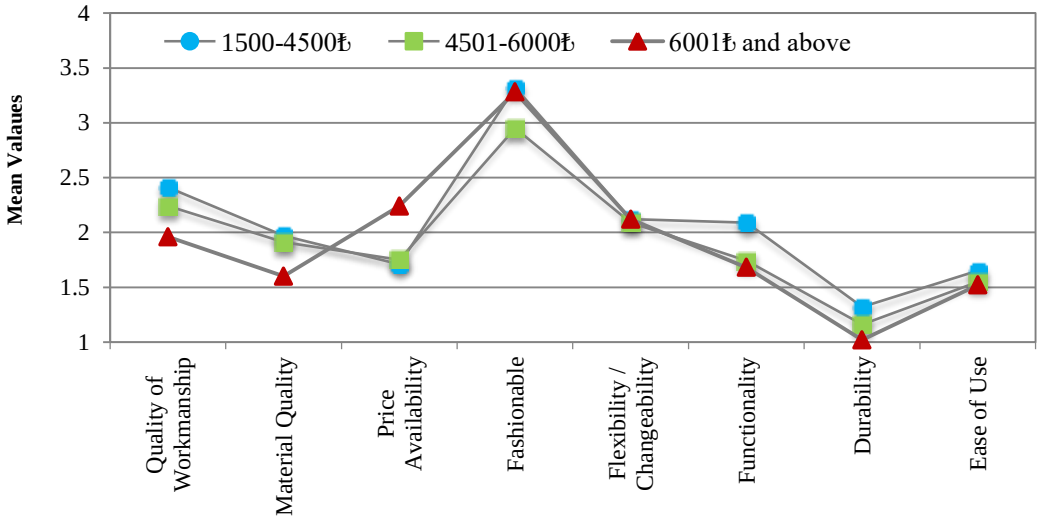
Table 4 shows the categorical averages, standard deviation values and ANOVA test results of the data that the participants take into consideration when buying children's room furniture according to their income level.

***Table 4.** Preference of children's room furniture according to income level of the participants*

Preference of Children's Room Furniture	**Income Level**						**ANOVA Results**		
	1500-4500 ₺		**4501-6000 ₺**		**6001 ₺ and above**				
	M	SD	M	SD	M	SD	F	df	Sig.
Quality of Workmanship	2,41[a]	0,66	2,24	0,71	1,96	0,79	2,888	2	0,060**
Material Quality	1,97	0,46	1,91	0,56	1,6	0,71	3,387	2	0,038*
Price Availability	1,71	0,76	1,75	0,79	2,24	1,23	3,272	2	0,042*
Fashionable	3,32	1,15	2,95	1,24	3,28	1,34	1,025	2	0,363[ns]
Flexibility / Changeability	2,12	0,59	2,09	0,60	2,12	0,53	0,029	2	0,972[ns]
Functionality	2,09	0,57	1,74	0,49	1,68	0,63	5,326	2	0,006*
Durability	1,32	0,47	1,16	0,370	1,12	0,33	2,351	2	0,100**
Ease of Use	1,65	0,49	1,55	0,503	1,52	0,71	0,469	2	0,627[ns]

***Notes**: M: Mean, S: Std. Deviation, df: Degree of freedom, *: P < .05 level is significant, ns: Not significant.*
a: Variable averages ranked from 1 to 5 (1: Very important, 5: Not important). Higher values are negative answers.

When the average values given in Table 4 are taken into consideration, it is seen that there is a strong relationship between “workmanship quality”, “material quality”, “price suitability”, “functionality” and “durability” with income level. There was a statistically significant difference between $p < 0.05$ / $p < 0.10$ levels. However, no statistically significant difference was found between “fashionable” and “flexibility / changeability” with income level at $p < 0.05$ level. The graphical representation of these differences is given in Figure 4.



***Note**: Higher variable means show more negative responses.*

***Figure 4.** Considerations of participants when buying furniture according to their income level*

According to Figure 4, when purchasing children's furniture, participants with income 6000₺ and more pay more attention to "workmanship quality", "material quality", "functionality" and "durability" characteristics when purchasing baby / child room furniture compared to participants with income of 1500-4500₺. On the other hand, it is seen that participants with income between 1500-4500₺ and 4501-6000₺ pay less attention to the "price suitability" feature compared to participants with income of 6000₺ and above.

Finally, Table 5 shows the categorical mean and standard deviation values and ANOVA test results of the data that the participants want to have in the children's room furniture in terms of flexibility and changeability.

***Table 5.** Features of children's room furniture in terms of flexibility and changeability*

Flexibility and Changeability Features	**Bed**		**Commode**		**Dresser**		**Wardrobe**		**Diaper Changer Unit**	
	n	%	n	%	n	%	n	%	n	%
Extensibility	86	83.5	8	24.2	77	86.5	40	76.9	6	33.3
Summability	63	61.2	18	54.5	41	46.1	30	57.7	14	77.8
Changeability	22	21.4	17	51.5	10	11.2	27	51.9	8	44.4
Functionality	54	52.4	16	48.5	49	55.1	35	67.3	5	27.8
Storability	96	93.2	29	87.9	84	94.4	49	94.2	13	72.2
Partitionability	45	43.7	23	69.7	81	91.0	37	71.2	11	61.1

n: Number of frequencies, %: Percentage values

Table 5 shows the characteristics that the participants want in the children's room furniture in terms of flexibility and changeability. Accordingly, extensibility in the bed, storage in the commode, storage in the dresser and partitionability, storage in the wardrobe and summability in the changing unit are prominent. These results show that the "Participants will require extensibility, storability, partitionability and summability in children's room furniture." (*H2*) hypothesis is generally supported.

4. CONCLUSIONS

In this study, the points that participants take into consideration when purchasing children's room furniture such as workmanship quality, material quality, flexibility/changeability, functionality, durability and ease of use have been determined and the results obtained are given in a systematic order below.

It was found that the participants gave importance to the quality of workmanship, material quality, flexibility / changeability, functionality, durability and ease of use while purchasing children's room furniture. This result was previously reported by Yıldırım et al. [17] as indicated in the study by the interior equipment elements of workmanship and material quality, size and storage capacity that supports the conclusion that shows the importance.

Another result shows that men give more importance to “workmanship quality”, “material quality”, “flexibility / changeability”, “functionality” and “durability when buying children's room furniture compared to women. Women, on the other hand, give more importance to the “fashionability” of furniture than men. In addition, it is noteworthy that the participants in the 26-35 age range declare that they attach more importance to the “fashionability” feature when purchasing children's room furniture compared to the 36-45 age range.

Another result is that the university graduate participants give more importance to ”workmanship quality”, “material quality”, “flexibility / changeability”, “functionality”, “durability” and “ease of use” when purchasing children's room furniture compared to high school graduates. This result shows that the quality expectation in furniture also increases due to the increase in education level.

Another result is that participants with income of 6000₺ and above pay more attention to “workmanship quality“, “material quality”, “functionality” and “durability ken characteristics when purchasing children's room furniture compared to participants with 1500-4500₺ income. On the other hand, it is seen that participants with income between 1500-4500₺ and 4501-6000₺ pay less attention to the “price suitability” feature compared to participants with income of 6000₺ and above. This result supports the conclusion that the increase in the income level leads to a decrease in the importance of the price as stated in the study conducted by Akyüz [18].

Finally, it is seen that the participants want to have extensibility in the bed, storage in the commode, storage in the dresser and partitionability, storage in the wardrobe and summability in the changing unit in terms of flexibility and changeability. If these results are taken into consideration in the design of children's room furniture, the satisfaction levels of the users will increase.

These results show that parents take into consideration when buying and replacing children's room furniture according to their demographic characteristics. Based on these results, designers and furniture firms can determine design characteristics that are appropriate to users' preferences, develop marketing strategies and prepare new presentation concepts.

CONFLICT OF INTEREST

No conflict of interest was declared by the authors

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GU J Sci, Part A, 6(4): 93-103 (2019)

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PART A: ENGINEERING AND INNOVATION

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Automatic Dough Draw Robot System Design

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Article Info

Research Article
Received: 22/11/2019
Accepted: 13/12/2019

Keywords

Dough draw,
Image processing,
Robot systems

Abstract

This robot system was designed to eliminate the human factor in the factories where bread production is provided and to enable the establishment of faster and sterile bread production lines. How the robot system works; doughs placed on bread baking boards machine. The automatic dough drawing robot takes these boards on to the machine. The doughs on the machine are drawn to the doughs for good cooking.

1. INTRODUCTION

Automatic dough drawing robot will enable the production of bread in series. Speed and time are the most important elements in bread production facilities. This robot system will increase the productivity in bread production. Bread consumption in our country is quite high compared to other countries. Robotic systems are essential to meet this need quickly. In many European countries, bread is produced with automatic systems. robotic systems are essential for production without human factor. Turkey is among the countries that consume more bread. Among the types of bread consumed, there is at most 250 gr bread. Human factor is in the foreground in these productions. Human factor will be eliminated with hhis machine system. Production will be made according to European standarts. 3- axis motion robot and image processing technology will be used in this robot system. The doughs on top of the machine will be rendered 3D by image processing. The coordinates of the doughs scanned in 3D will be determined. 3-axis robot will move according to the doughs whose coordinates are determined. The 3-axis robot will make the movement of the system according to the parabolic curve we have determined. Dough on the machine will be drawn on top. 3-axis robot system will make dough drawing process. As seen in Fig. 1.

Solak and Altınışık worked on image processing using clustering methods to identify and classify hazelnut fruit. In this study, images of hazelnuts were created by image processing and their shapes were also extracted. They also used the clustering method while performing these operations [1].

Eldem and Palalı, developed image processing techniques and face recognition system. In this study, face recognition was performed with image processing technique. Only the face detection process was performed in 2D [2].

Çankaya, Arslan and Ceylan, in this study, image processing is provided by following the neural networks on the photographed part. In the determination of the concrete strength, the phonograph of the

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cross-sectional surface of the existing concrete is taken and the value is determined on the phonograph. In other words, no direct image processing was performed in this study [3].

Çevik and Çakır, in this study, plates of vehicles were defined. Plate registration of the vehicles made by image processing method. İmage processing only as a picture made. The image was scanned and the text was determined. One size image scanning was applied [4].

Perihanoğlu, in this study, only details were extracted from the pictures. One-dimensional study was done on the scanned images. Matlab software and pictures are examined in electronic environment [5].

Gökçe, in this study, automatic storage process was performed. The positions of the parts in the warehouse are determined. The center mark to be recognized by the camera is affixed on the part. The parts are stocked after the positions are determined. One - dimensional image processing method [6].

2. AUTOMATIC DOUGH DRAW ROBOT SYSTEM DESIGN

The process of drawing the pulp is a very important part. For the dough to be cooked well, it must be scratched. The reason for drawing the dough is to cook the inside of the bread. The carbon dioxide gas comes out with the drawing of the dough. The dough is cooked in a better and larger way with the gas coming out. They are drawn to cook the whole dough. Dough drawing process is done with human. Worker draws on the doughs with the help of a knife. Speed is very important in the boot process. With human these speeds remain low. In this project, doughs are drawn with the robot system without human. this is done with the robot shown in the Fig. 1.

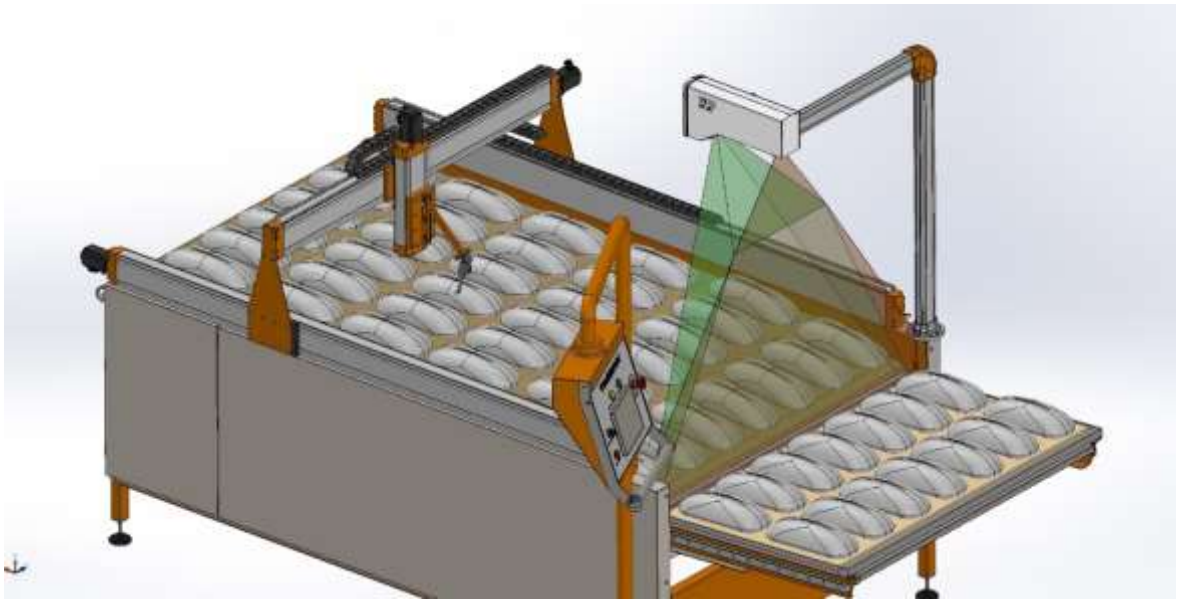

Figure 1. *Automatic Dough Draw Robot System Design*

2.1. Design Criteria

The most important part of the dimensioning of the robot system is the oven where the doughs will be cooked. Doughs are determined according to the oven size. İn Turkey production until dough bread are placed on board. The dimensions of these boards are 70x120 mm. 14 pieces of dough are stacked on one piece of wood. The design of the robot system is based on this 120 mm width. The depth of the robot system is determined according to the depth of the oven to bake bread. These ovens take 2 planks according to their size and max 5 planks. The working range capacity of the furnaces is such. These

parameters were taken into consideration when designing this robot system. As shown in Fig. 2, the doughs are transported onto the robot system. Robotic system length is determined according to oven size.

Figure 2. *Dough boot tip*

2.2. Automatic Dough Drawing Robot Working Principle

Automatic dough drawing robot system consists of 3 parts in itself. These parts;

1. Dough conveying belt system
2. Dough boot axial robot system
3. Control unit

In the operation of the robot system, as a result of these 3 parts working in conjugate with each other, it performs the process of drawing on the doughs.

2.2.1. Dough conveying belt system

The working principle of dough conveyor belt system is the same as conveyor belt systems. Dough from point a to point b transport. Dough is designed to get over the board. Boards with dimensions of 70x120 mm are placed in the machine. The robot system automatically takes the placed boards. The board remains at the bottom as a result of the import. The doughs are taken to the top of the tape. Dough removal process is made with a single axis mechanism. 0,75 kw 1400 rpm 3 phase electric motor is given to the system. This movement is drawn to the low speed by means of the reducer. The movement of the band on the robot system provides a drive shaft.

The drive shaft is covered with rubber. This shaft is rotated by means of a gear. The gear part takes its movement from the electric motor connected to the reducer. This band movement is provided by 3-phase 1,1 kw 1400 rpm electric motor. Roller bearings are used throughout this system. Axial movement of the table is made linear bearing. There are 2 sensors on the system, these sensors are the stop sensor and the deceleration sensor. 2 electric motors and 2 sensors are controlled by PLC. the detailed view of this system is shown in Fig. 3 below.

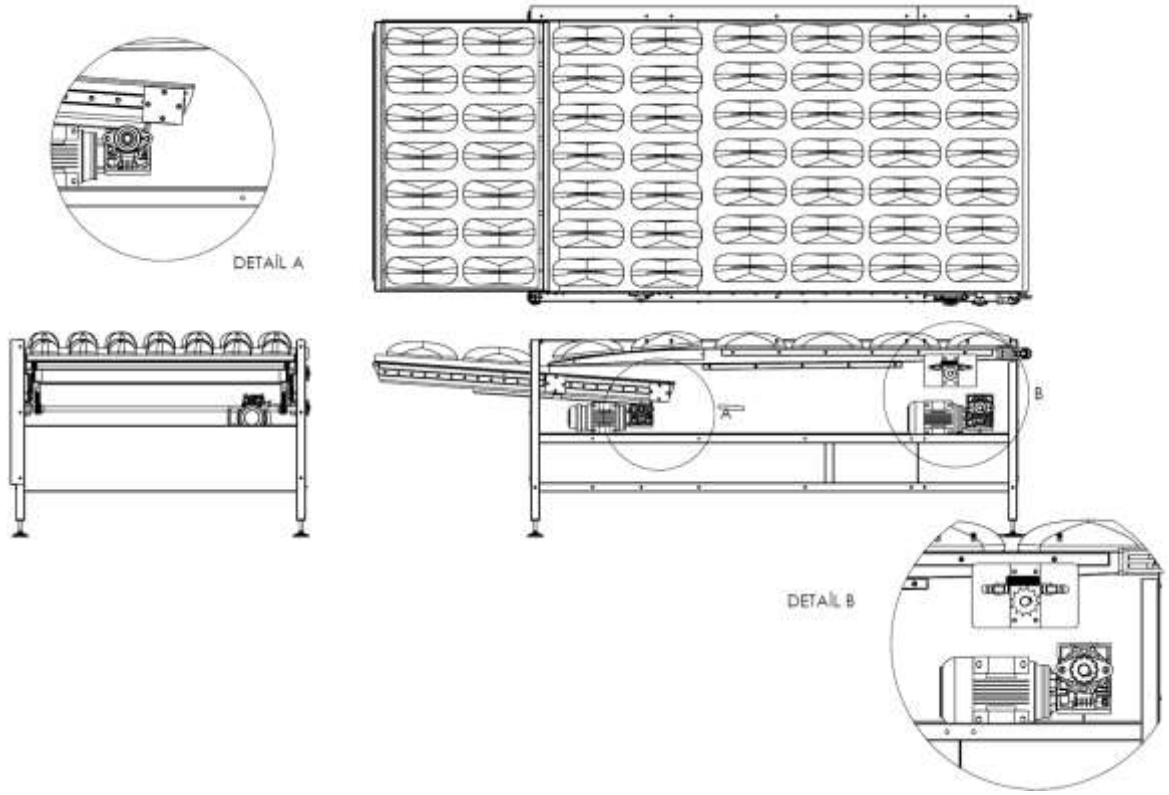

Figure 3. *Dough Conveying Belt System*

2.2.2 Dough boot axial robot system

The working principle of dough drawing axial robot system is to perform dough drawing by moving 3 axis. The design of this system is as shown in Fig. 4. These movements are to perform x and x ', y and y', z and z 'movements. The main purpose of these movements is to provide the cutter blade with access to all points of the dough conveyor belt system. The operation of the system; 3 servo motors are provided on the conjugate movement. The motion points of the servo motors move according to the technical data obtained from the image processing sensor which performs 3D field scanning. The doughs loaded on the dough conveyor belt are passed under the 3-D sensor and the positions of the doughs are determined. These positions are defined as x and y axis. According to these bread positions, 2 servo motors move to those points by positioning itself. The image processing sensor also measures the height at the same time and positions itself in the z axis according to the measured height value. These values are determined in the light of the parabolic movement of the dough is drawn on top. The movement elements in the system are coupled bearing elements in the squeezed profiles, in which the shaft and other pulley sets to be connected to the servo motor are ready.

The bearing elements which are ready for this three-way movement are preferred. Only the dough drawing knife and the degree of adjustment of this knife are mechanically designed. In this design, the maximum movement points of the system were determined and the knife clamping apparatus was designed by placing extra tolerances in this determination.

In the control of the system, PLC was also used, and the drives that enabled the servo motors to operate were preferred. These drives are determined by the motor power and the number of motor steps. Many

servo motors are operated as a team with drives. In our design, servo motor and driver are preferred as a team.

Figure 4. *Dough boot axial robot system*

2.2.3. Control unit

Automatic dough drawing robot system is controlled by PLC. The elements in which the control is provided in the system are given below.

• 1 piece three-phase 0,75 kW electric motor
• 0.55 kW three-phase electric motor
• 2 deceleration sensors
• 2 stop sensors
• 0.1 mm minimum pitch servo motor with 3 0.55 kW drives
• 1 SICK sensor with 3D scanning

The above parts need to be checked for the system to work. In the written program, the running speed of the motors is controlled and at the same time the reading sensitivity of the 3-D sensor can be adjusted. The mounting location and position of the control system in the automatic dough drawing robot are as shown in Fig. 5.

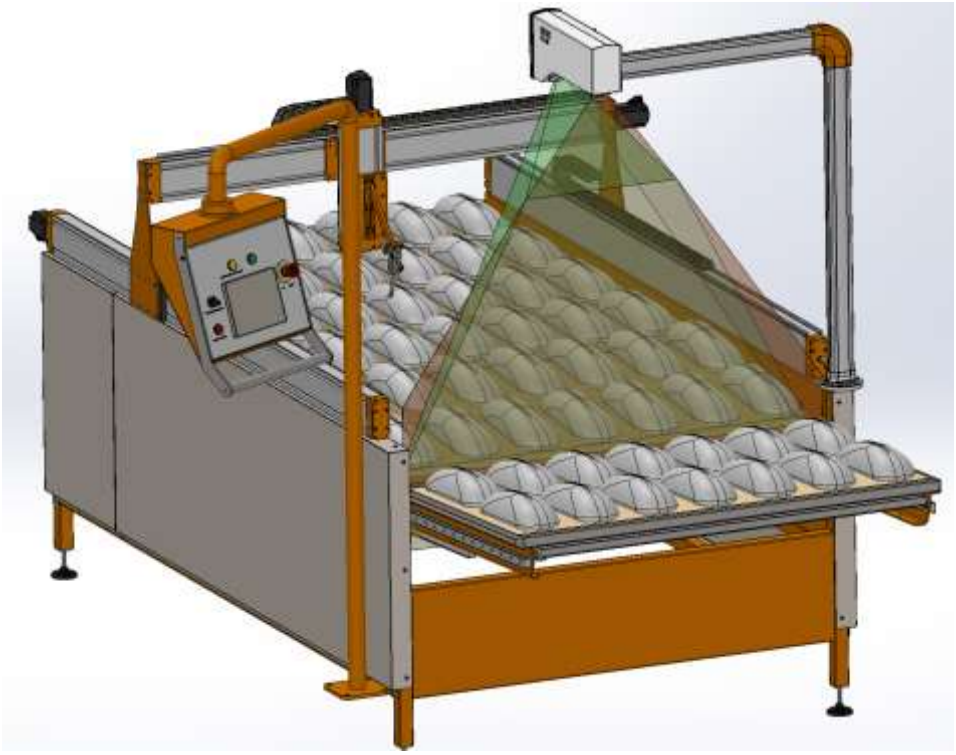

Figure 5. *Control Unit*

2.3. PLC and Image Processing

Automatic dough drawing robot can be provided by operating the PLC and image processing without any error in order to work as desired.

2.3.1. PLC

Automatic dough drawing robot system is controlled by PLC. Control of 2 three-phase electric motors, 3 servo motors and 1 deceleration and 1 stop sensor in the system are provided by gmt brand PLC. PLC system operates with 24 volt DC supply. 9-channel input 6-channel protected transistor output. 3 channels with 100 kHz 3 axis servo motor provides the opportunity to drive this system in our system of 3 servo motors is provided the opportunity to operate as a conjugate. The programming language of the PLC we use is the graphical ladder editor. In programming PLC, it is programmed with GMTSoft ladder editor software specially developed. Generally in the command system within the program; logic, mathematical, communication, fast counter and pulse outputs, time and counting relays are special purpose function blocks. In the PLC system, there is one main counter, in addition, expansion modules are used to increase and convert the inputs to the system. With this module, the desired inputs are transferred to the main PLC body [7].

The technical features of the PLC (Fig. 6) system to be used in automatic dough drawing robot system are given below.

• 24VDC supply
• 9 channels 24V DC PNP / NPN input
• 6 channel 24V DC 300mA short circuit protected transistor output
• 3 channels 100kHz with 3 axis servo / stepping possibility
• Modular structure, support up to 273 points with the possibility of connecting up to 16 expansion modules
• Network access via 100MB ethernet port
• MODBUS TCP Master / Slave support
• RS232 and RS485 communication ports

• MODBUS RTU protocol support
• Decimal operation support
• 12ns command processing speed
• DIN RAIL mounting
• 1 channel 0-10VDC / 0-20mADC selectable analog input (12 bit resolution)
• 1 channel 0-20mADC analog output (14 bit resolution)
• RTC (Real Time Clock) real time clock
• PLC internet connection service (WMI)
• E-mail sending function
• Possibility to connect 3 dual-phase (A, B, Z) encoders or 3 speed counters (50kHz)[8]

Figure 6. *GMT PLC*

2.3.2. Image processing

Automatic dough drawing robot is provided with the image processing sensor to identify the doughs in 3D. With this sensor, all details of the doughs are scanned in 3D. The system is moved according to the points obtained from this scan.

These sensors have emerged with industry 4.0 and have become the most frequently used tools in mass production. The characteristics of these sensors are given below.

• High speed and quality 3D measurement
• Provides reliable 3D control even in different colors, positions and heights of parts.
• Fast commissioning and control system thanks to intuitive user interface
• Integrated image analysis for fast parameterization.
• Fast instrument change thanks to guaranteed visibility and re-use of saved settings.
• Resistant to the harsh environment and harsh conditions of food processing
• Company calibrated data simplifies installation and saves time and expense
• High sensitivity to ambient light, accurate measurement and increased output in industrial environments.

• Industrial design with integrated laser light source guarantees trouble-free operation.
• High resolution 3D picture with density overlay.
• Material is not affected by the color and contrast
• Integrate with PLC systems
• Humidity, temperature, operating under severe conditions.
• 3D contours of moving parts
• Calibrated with software
• It works with laser triangulation method.
• Rugged IP67 metal housing with plastic glass.
• Usage areas; quality control of consumer goods: volume and thickness measurement, counting and positioning of objects, integrity check of boxes, content, completeness and void control, product sizing in food processing [9].

Sensor selection is based on the working area. According to this working area, the sensor system is positioned on the machine. If the sensor is not placed at the desired points, it cannot perform the reading process in a healthy way. The reading accuracy of the sensor is also determined by the location where it will be placed. For example Fig. 7 should be placed as is.

Figure 7. *Image processing sensor*

It is used in all areas where 3D scanning will be performed in Uygumala areas. Although it is often used in quality control units, it is also used in facilities established for full automation. It is used in 3-dimensional dimensioning of dough in food sector, detecting surface defects and counting pieces. The scanning of a 3 dimensional dough made by this sensor is shown in Fig. 8.

Figure 8. *Image processing sensor applications*

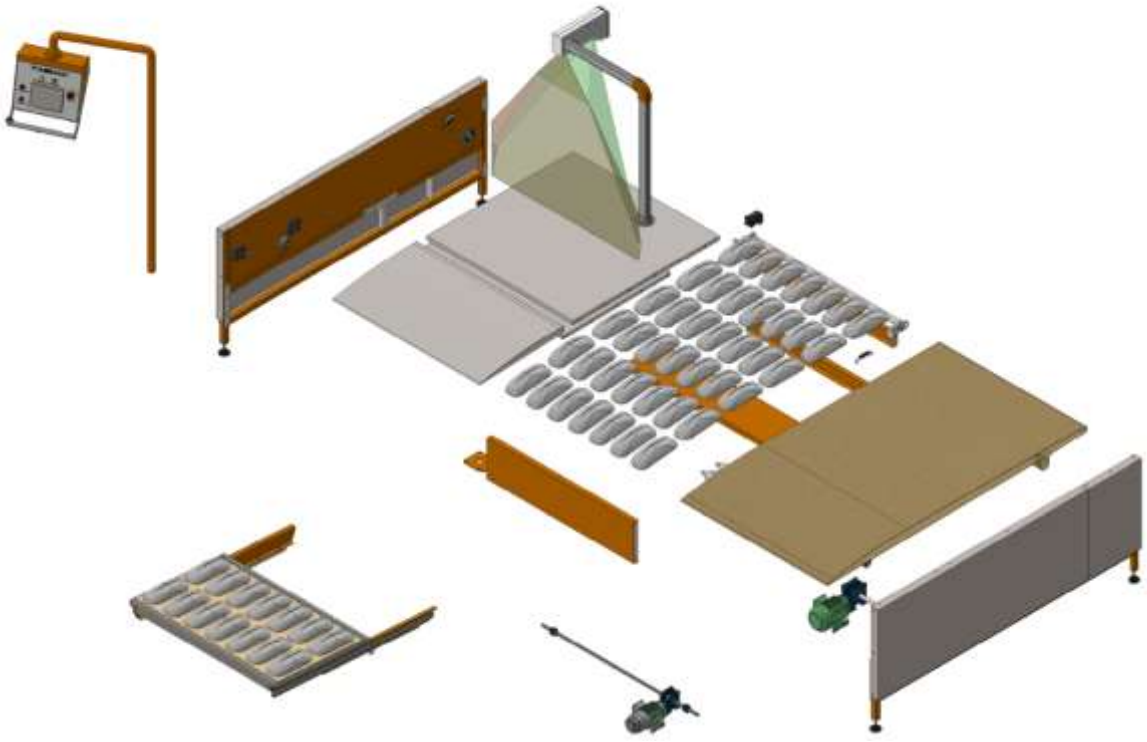

Figure 9. *Dough conveyor belt assembly parts*

The assembly elements and parts of the automatic dough drawing robot system are as in Fig. 9.

3. CONCLUSIONS AND RECOMMENDATIONS

Automatic dough drawing robot system in our research about any patent, utility model, name right, etc. studies have not been encountered. Automatic dough will be a robotic system boots made in Turkey and the world for the first time. So far the studies have been quite limited and the reason for this is limited by the human factor. The fact that they do these operations with the personnel in the production facilities is not a situation that affects their production and the fact that they cannot get the required efficiency from the mechanical systems made so far is the factor. Fixed mechanical systems which make line drawing process on doughs are made because these systems do not work efficiently because the dough is not fixed. Due to the different reactions during the fermentation process (deformation of the dough, differences in the amount of swelling, different physical dimensions of each dough, etc.), a system operating at full efficiency could not be constructed. Turkey is also not included in the product range of companies operating in this sector. The companies that make production abroad do not make this system because of different bread consumption and consumption types. In the automatic dough drawing robot system, the dough will work with full efficiency no matter which shape it enters. The working principle of the robot system is that it will scan the shape of the dough and perform the movements that we have determined through that shape.

Many methods will be applied in the application of automatic dough drawing robot;

• Field scanning
• Image processing
• Data transfer
• Value creation through data
• Ensuring system movement according to the result obtained by image processing
• Electric motor, servo motor, 3D sensor, deceleration sensor, stop sensor, etc. it will allow a plurality of parts to be operated concomitantly.

Fully automatic bread production facilities will be established with automatic dough drawing robot. It will enable mass production in bread production and facilitate product production under sterile conditions.

ACKNOWLEDGMENT

We have benefited from the knowledge and experience in the design and R & D process of the automatic dough drawing robot project, and also my project consultant, Prof.Dr. Dr. Thank you to İhsan KORKUT. I would like to thank Ahmet MAVİ for his support during the design process of the project, material selection, automation and software.

CONFLICT OF INTEREST

Automatic dough drawing robot project is a project that belongs entirely to us. It is not related to a different institution or person. No conflict of interest was declared by the authors.

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