İleri Teknoloji Bilimleri Dergisi
Journal of Advanced Technology Sciences
ISSN:2147-3455

CAPACITY CALCULATION APPROACH FOR FURNITURE COMPANIES AND APPLICATION OF A PROCESS EFFICIENCY ANALYSIS

Küçük Hüseyin KOÇ[1] Ender HAZIR[1] Sedanur ŞEKER[1]

[1] Istanbul University, Faculty of Forestry, Department of Forest Industrial Engineering
34473, Istanbul, TURKEY
hkoc@istanbul.edu.tr

Abstract- One of the most important decisions affecting the establishment process for a company is production capacity. Basic information such as the size of the enterprise, the establishment area, the qualifications of the machines, the number of the auxiliary facilities, the connections between the worker cells, the flexibility and the automation structure, the supply need, stock, energy and personnel need to be clarified in the process of establishment decision. However, such policies cannot be careful enough capacity in the process of organization in fast-growing countries such as Turkey after the new machines are also added as needed to the production line and the line re-balance is composed in a different way. From this point of view, furniture enterprises have a characteristic feature. Flexibility and automation in the furniture factories are two important critical concepts and directly affect production capacity in practice.. This study examined the capacity calculation in Turkey approaches and methods applied in the furniture industry, the process on the basis of existing practices, resources and capacity from the level of injury were analyzed. For this purpose, 55 furniture enterprises operating in Istanbul and the existing capacity reports are discussed. The machinery and installation structures, closed areas, number and quality of employees, product structures, installed power and production and consumption capacities of the companies were investigated and it was investigated whether there is a significant relation between these parameters. As a result of the research, it can be seen that there is not enough meaningful relations between the enterprises in terms of field use, installed power and production capacities. In the Turkish furniture companies, process efficiency are 61% for sizing process, % 64 for edge banding process and % 64 for sheathing process.

Key Words- Furniture Companies, Production Capacity, Capacity Calculation, Proses Efficiency.

1. INTRODUCTION

Capacity planning can be considered as a basic management technique based on its own managerial understanding of businesses in the narrow sense. Of course, the enterprises make capacity planning according to their demand and production conditions. However, this is not enough for firms to adequately explain themselves in the market environment. Particularly in the case of working in the public, the official capacity documents of the companies that the company defines according to its functioning are taken as basis for any product request. If the firm enters into a tender, the product range and production quantities of the officially identified capacity

certificate become important, not their own calculations and statements. In addition, the production and consumption information of firms can be seen as reference information in organizations such as finance, tax office, environment, energy and municipality in quantity and quality. For this reason, capacity information can sometimes be seen as a major problem for the firm or as a saving tool.

There are concepts such as theoretical capacity, normal capacity and actual capacity for the factory. Capacity reports usually focus on the capacity that the firm can do, not directly on the actual capacity. Actual capacity can only be used as an important indicator for a better understanding of the production and consumption relationship of the firm's product range.

The furniture industry in Turkey is among the five fastest-growing sector. Furniture foreign trade has been steadily positive in recent years [1-2]. However, in spite of the positive indicators that the furniture sector possesses, how effectively it can use its resources and how much added value it creates is also an important area of discussion [3-4]. Because the rapidly developing sector is changing the structure very rapidly and adding machines or work cells with advanced technology to the production line in order to get more out of the opportunities caught in the market.

In particular, such as computer-controlled machines, flexible work cells that may be of such a high capacity can be used as effective enough, in countries such as Turkey remains committed to running purely coincidental. For example, taking a product or part order that requires intensive work on that work cell can completely change the process efficiency.

The capacity report on The Union of Chambers and Commodity and Exchanges of Turkey (TOBB) Capacity Principles is defined as a document showing the production power of all public and private sector establishments manufacturing and valid for 2 years from the date of approval. Capacity reports must be registered in the trade register of the companies for which the capacity report is to be issued, and must be a member of the place where the workplace is located. Capacity reports; as well as company's contact information, annual production capacities, machine park, raw materials used, capacity calculations, capital and employment information. Capacity reports have a legal basis, such as Trade Law No. 6984, TOBB Law No. 5174. Capacity Report; Investment Incentive Certificate, Inward Processing Permit Certificate, Industry Register Certificate, various import and export transactions, Tenders, Credit supply, Preparation of Industry Data Base. In the Capacity Report Automation System, the products included in the Capacity Reports are coded by the PRODCOM 2010 coding system derived from the NACE coding system, main machines and main consumption items. Capacity Reports are the source of the industry database, which is the only database in which our country can be informed about the industry [5].

Criteria for the forest industry in the TOBB system are under the heading "3311 Tree and Mushroom Products". Here, there are five criteria for Timber, Particleboard, Fiberboard, Plywood, Wood Covering and Furniture.

In the Furniture Industry Capacity Calculation Criteria, the machine capacity and the labor capacity that can create a bottleneck depending on the product structure are evaluated together. The following main structures are considered in this framework.

a) Panel sizing, edge banding, panel coating (pressing) and assembly capacities are primarily considered for wood-based products (such as chipboard, chopping board, MDF board, MDF laminate board).
b) For solid wood (timber) products: Timber processing, profile drawing, installation capacities are taken into consideration.

c) Wooden processing capacities for framed - upholstered products (such as chairs, armchairs, sofas), installation and upholstery capacities are considered together.
d) Metal Goods Industry criteria shall be used for fully or partially metal based furniture (metal cabinets, tables, bunk beds, seats and chairs, etc.).

The processing capacity of the metalworking raw material is calculated, if necessary, the labor capacity for wood processing capacity, installation and flooring is evaluated. According to the capacity calculation criteria for furniture companies, processing capacities for machinery and labor are defined according to development level. For example, the capacity values that can be taken for panel sizing machines are given in table 2 and the work capacity in Table 1 are given in Table 2.

For example, the sizing capacity is calculated taking into account the following formula.

Kc = H x 8 x 300
H: Sizing speed (m^2/hour)(it can be used if the date available)

Table 1. sizing capacity values used in Capacity Calculation of Furniture Firms

Type of Machinery and installation	**With manuel loading and unloading sytem (m^2/h)**	**With otomated loading and unloading system (m^2/h)**
CNC wooden panel sizing machines	150	200
Horizontal wooden panel sizing machines	50	75
Vertical wooden panel sizing machines	30	50
Circular sawing machine with drawing	10	10
CNC wooden panel machining center(if the table size can be us for sizing)	30	50
Other machines	Determined by the chronometer in the examination process.	

Table 2. Panel processing capacity values used in Capacity Calculation of Furniture Firms

Type of Machinery and installation	**B(min, m^2 / person x hour)**	**B(max, m^2 / person x hour)**
The firm has only traditional machines	1	2
The firm has either traditional and developed machines(NC, CNC)	3	5
The firm generally has developed machines(CNC,NC)	5	10
The firm has developed machines and works as fason (only sizing, edging, etc)	10	20
The		
The firm has different machines	Determined by the chronometer in the examination process	

$\mathbf{K_{ig}}$ = Capacity of panel machining per year (m^2/year)
$\mathbf{K_{ig}}$ = B x N x 8 x 300
B: the quantity of panel machining per a person X hour
N: Numbers of workers

The capacity for edge banding application is calculated according to the following formula.

$\mathbf{K_b} = H_b \times 60 \times 8 \times 300 \times D$
$\mathbf{K_b}$: Capacity of edge banding per year
$\mathbf{H_b}$: Speed of edge banding (m/minute)
CNC edge banding machines: 15-20 meter/minute
Traditional edge bending machines : 8-12 meter/minute
D: Loading percentage (% 60-80)

In the capacity calculation for products such as chair seats, labor time to be needed for each product is taken in bar 3 and calculated according to the following formula.

$\mathbf{K_{ü(n)}}$: Production capacity of the product
$\mathbf{K_{ü(n)}} : K_{ig} \times p_n / B$
$\mathbf{K_{ig}}$: Labour capacity per year
$\mathbf{p_n}$: Percantage of labour used for the product
B: Required labour for per product (person x hour / number of piece)

Table 3. Values of occupancy in seating group products such as chair seats

Type of Product	**B(min) Person xhour/number of piece)**	**B(max) personxhour/number of piece)**
Wooden chair	1	3
Wooden armchair (for a person)	2,5	6
Wooden armchair set (for a products grup)	12	32
Soffa (triple)	4	10
Wooden lounge suite	15	30
Other products	Determined by the chronometer in the examination process	

The transaction capacities determined by identifying the bottleneck points are distributed to the products taking into account the structure of the production schedule of the operator. In particular, how much of each of the products defined in the database will be generated is determined, and the consumption capacities are calculated taking into account the codes in the code system, taking production capacity and input structure into account.

2. MATERIALS AND METHOD

This study examined the capacity calculation in Turkey approaches and methods applied in the furniture industry, the injury levels were analyzed from the current process for existing applications based on furniture firms. For this purpose, existing capacity reports of 55 furniture operations operating in Istanbul and renewed capacity reports in the last 1 year have been handled. The machinery and installation structures, closed areas, number and quality of employees, product structures, installed power and production and consumption capacities of the companies were examined and it was researched whether there is a significant relation between these parameters. MS Excel and Minitab software are used for this purpose.

As the data collection area, the TOBB data base covers the activity area code 31.09.12. The purpose of this limitation is to increase the efficiency of the evaluation based on companies with similar production structure. In the TOBB database, the presence of a total of 307 firms with capacity reports in the Istanbul region was identified in the 31.09.12 field. These companies are

generally companies that produce wooden or board products (bedrooms, dining rooms, young room sets, decoration products) or semi-finished products. A total of 150 of these companies have been renewed in the last year. The evaluations were carried out by transferring the information defined in the report of 55 companies to the excel environment.

The information on the approved capacity reports of Firms was transferred to the excel environment and evaluated.

3. FINDINGS

3.1. General Information on Furniture Firms

The general overview of companies operating in the area of 31.09.12 in the Istanbul region is summarized in table 4. The average number of employees of 55 firms with a total of 2,724 employees is 50 in average. The average engineer employment of the firms is 1.5 per firm, while the closed area is 4.195 m^2. There are significant differences between firms in terms of number of employees. As Figure 12 shows, the number of employees can range from 10 to 250. This difference can be seen in almost every area from the number of engineers to the number of CNC machines. B in Figure 2 shows the number of engineers working and the situation regarding the existence of CNC machines.

Table 4. General Information on Furniture Companies Covered by Research

Total number of employees	**2.724 number**
Average number of employees	49,5 person/company
Number of Average Engineers	1,5 number/company
Average Forest Industry Eng. Woodworking End. Eng	0,6 number/company
Average Closed Area	4.195 m^2/company
Average machine equipment value (year 2018)	1.121.184 TL/company
Average number of CNC machines	3 number/company
Most common CNC; CNC machining center	1,1 number/company
Most common 2nd place CNC: CNC wood panel sizing	1,0 number/year
Most common 3rd place CNC: CNC edge banding machine	0,7 number/company
The average installed power of the companies	233,9 kW/company
Average panel processing capacity	122.018 m^2/company
Process efficiency in panel sizing	61,1 %
Process efficiency in edge banding	64,64 %
Process activity in panel cover	58,74 %

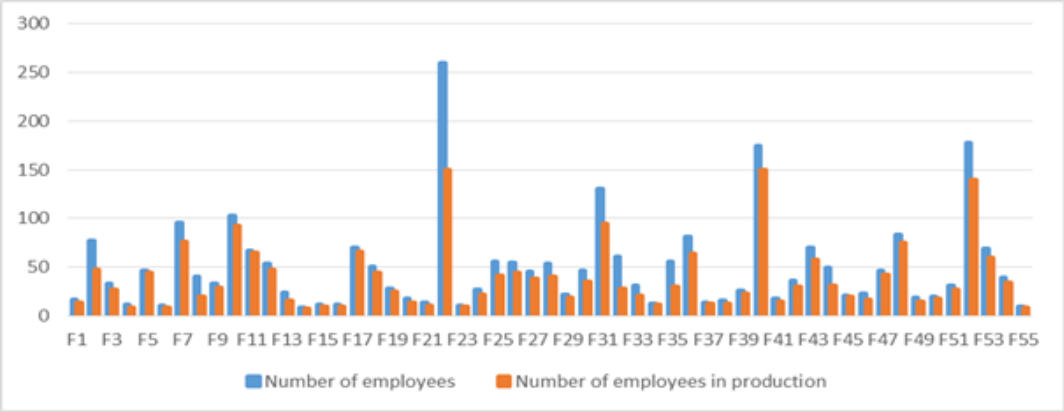

Figure 1. Numbers of Workers in the Turkish Furniture Companies

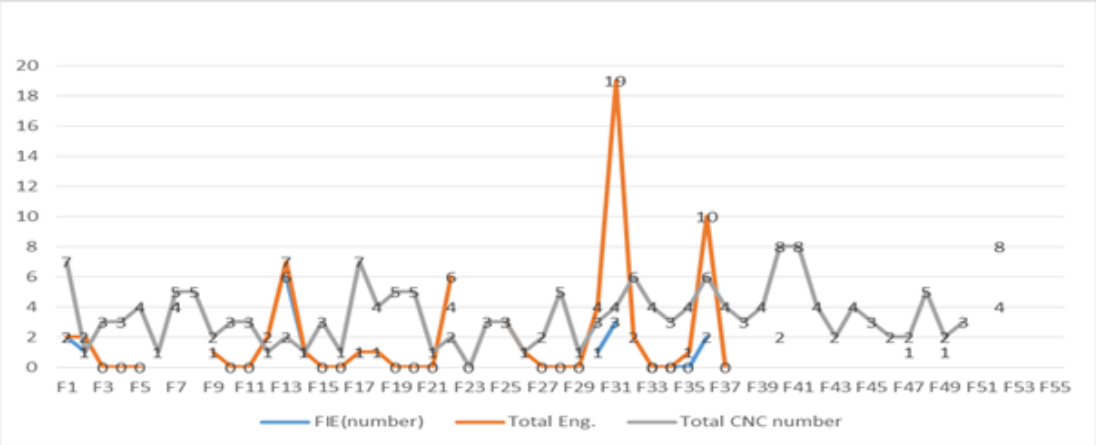

Figure 2. Numbers of Engineers and CNC in the Turkish Furniture Industry

3.2. Process Efficiency in Furniture Firms

Process efficiency has been examined for three sub-processes in furniture production. If we define furniture production as the main process, its sub-processes are panel sizing, edge banding and panel coating processes. These sub-basic process steps are often seen as a bottleneck in capacity calculations. Panel sizing usually indicates the first basic process step. All generic entrances pass through the sizing process at least once. The sizing process has been a highly planned, controllable and manageable process with technological advances. Especially CNC machines are a process in which machine capabilities are fully known, process, waste time, and operational pressure can be managed to a great extent. However, the average efficiency value for the sizing process in the current conditions was 61%. That means 40% of the capacity remains idle.

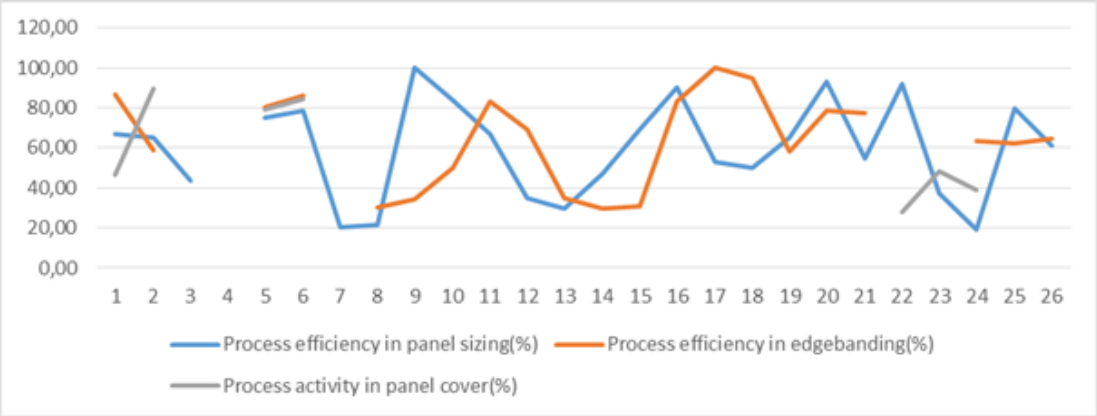

Figure 3. Process Effectiveness in the Turkish Furniture Industry

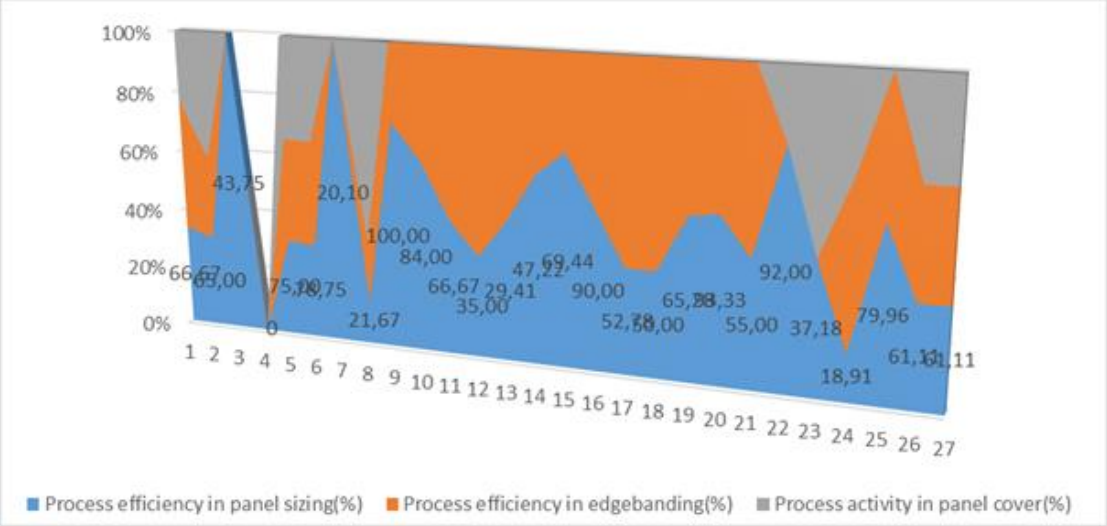

Figure 4. Process Effectiveness in the Turkish Furniture Industry

3.3. Relations Analysis Between Parameters of Furniture Companies

The relationship between the parameters is given in Table 1. These values were obtained by using Pearson correlation analysis. According to results, the relationship between machine value and number of person, number of CNC and number of person, number of CNC and machine value, power and machine value, processing capacity and machine value, power and number of CNC, processing capacity and number of CNC, processing capacity and power were found significant factors. Because Table 5 displayed the -value is less than 0.05 showing the model is significant at 95% confidence level. Moreover, the matrix plot (relations matrix) is shown figure 5. In this figure, the directions and structure of relations can be evaluated.

Table 5. Relationship between the parameters

Parameters	Number of person	Area	Machine Value	Number of CNC	Power
Area	0.180				
Machine Value	0.001	0.638			
Number of CNC	0.042	0.150	0.000		
Power	0.129	0.778	0.008	0.018	
Processing Capacitiy	0.154	0.346	0.000	0.000	0.002

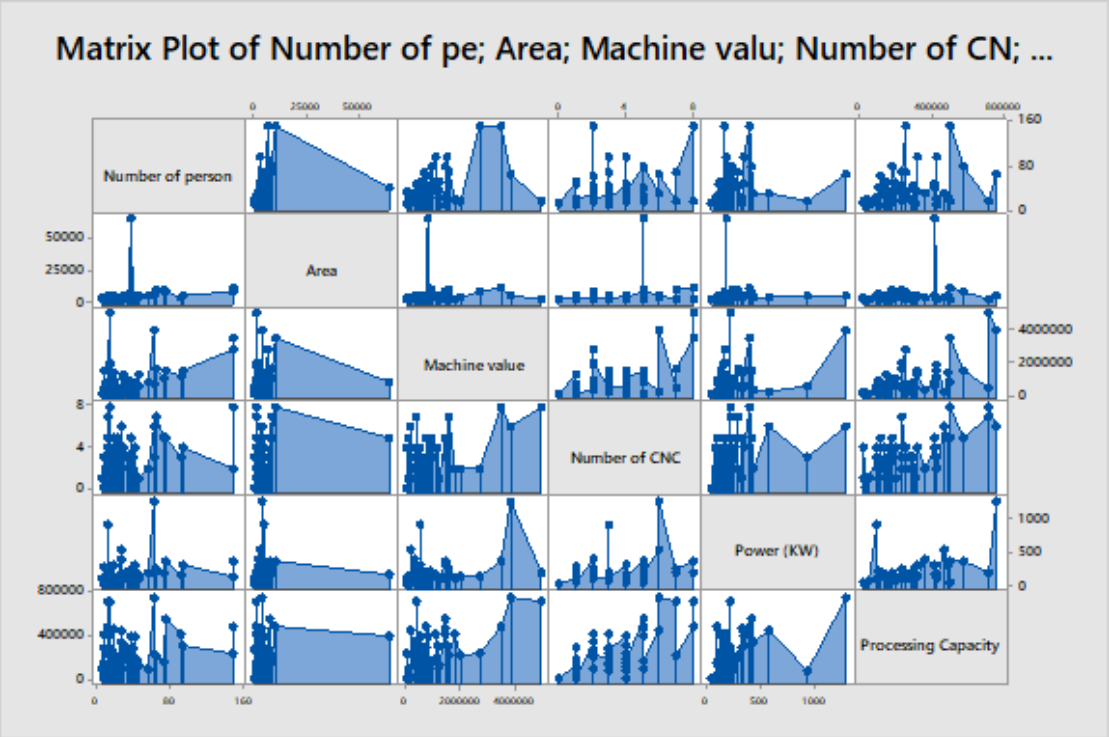

Figure 5. Matrix Plot of the capacity parameters

4. CONCLUSIONS

The furniture industry in Turkey is rapidly developing key sectors. The production value of the sector is increasing rapidly; export and import are continuously developing. From time to time, the wave of domestic demand for furniture shows a dynamic structure, and firms are turning to new demand areas and deepening in foreign markets. Despite these positive developments, research shows that the furniture sector also carries significant structural problems and those significant inefficiencies in resource utilization, productivity and profitability continue to develop together.

By understanding the causes of failure of one of Turkey's most important tools to guarantee the development of the furniture industry is rapidly starting to improve application. One of the important areas to be focused on in this respect is process competence studies. Turkey Furniture Company in process efficiency ranges between 58-64%. If companies want to reduce their costs in the long run and work with higher profits, they have to master every detail of their processes and increase their level of process competence. In the short term, sales-driven high profits are not enough to secure long-term firm future. It is also seen that furniture companies frequently increase production capacity and skills with advanced machines (such as CNC machining, CNC sizing, CNC edge banding) at critical production stages depending on the students they particularly catch. Having an average of 3 CNC machines in furniture firms is an important indicator of this change.

However, the value of the process efficiency at the level of 40% is a serious consideration. As firms develop in terms of machine installation, personnel, and all physical conditions, it is expected that the relationship between the parameters affecting each other is higher. Monitoring this relationship will not improve capacity, it will be an important tool to guide the factory planning. In this sense, capacity reports should be seen as important issues for companies.

Capacity reports also provide an important contribution in terms of market balances in the market, even if they represent the actual theoretical capacity. It can also be seen as a guiding tool in balancing companies' lines.

5. REFERENCES

[1]. Koç, K.H., Kurtoğlu, A., Erdinler, E.S. ve Hazir, E., (2016). Türkiye Mobilya Endüstrisine Stratejik Bir Bakış. *Selçuk Üniversitesi Teknik Online Dergisi,* 1150-1171.

[2]. Koç, K.H., Dilik, T. ve Kurtoğlu, A., (2017). Türkiye Orman Ürünleri Endüstrisine Stratejik Bir Bakış. *IV. Ulusal Ormancılık Kongresi,* ANTALYA, TÜRKIYE, 15-16 Kasım, cilt.1, 483-495.

[3]. Öztürk, E. ve Koç, K.H., (2017). Endüstri 4.0 ve Mobilya Endüstrisi. *Düzce Üniversitesi İleri Teknoloji Bilimleri Dergisi*, 6, 786-794,.

[4]. Tunçel, S. ve Koç, K.H., (2017). Orman Ürünleri Endüstrisinde Verimlilik Paradoksu. *IV. Ulusal Ormancılık Kongresi,* ANTALYA, TÜRKIYE, 15-16 Kasım, cilt.1, 523-529

[5]. TOBB, (2018). Kapasite Raporlarının Düzenlenmesi Usul ve Esasları, Türkiye Odalar Ve Borsalar Birliği, https://tobb.org.tr/SanayiMudurlugu/Sayfalar/KapasiteEsaslari.php, ET: 11.07.2018.