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Gym Layout Modeling and Optimization

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The purpose of the loop layout problem is to determine the optimal sequence for operations by giving a cyclical arrangement of the machines along a given route. Calculating the initial cost of processes is critical in general. Additionally, these expenses can be reduced by proposing an alternate flow for the system's components. It has been observed that machines at gyms are utilized in accordance with a certain program, and so they require the optimal arrangement to accommodate these programs. In this study, the best cyclical arrangement of the machines in a gym was determined using an intuitive method. Customers enrolled in various training programs will be required to change machines in accordance with the sequence of the machines in their training program. The purpose of this study is to determine the optimal layout of these machines in order to alleviate gym traffic congestion and provide a more intuitive movement plan for consumers. The purpose is to build a layout plan that minimizes backward movement using an objective function created from the positions of the machines in the training programs, the number of customers who use these programs, and the frequency with which the machines appear in multiple programs. For the first time in gyms, an effective solution to the machine layout problem has been proposed using an optimization approach.

1. Introduction

The optimal arrangement of facilities in product or service systems is known as the "facility layout problem." Maximizing the benefits of the facility's layout is closely tied to the operations that occur from the time the product or service enters the system until it exits. The amount of time spent in the system and the distances traversed are important considerations in determining the facility layout. In general, to be cost effective, a facility's equipment, materials, employees, storage, transportation, and energy must be efficiently located (Picard and Queyranne, 1981). This layout problem is an industrial one that has long-term consequences, is quite costly to address afterwards, and is extremely effective at ensuring the facility operates efficiently. The facility's ineffective arrangement has an impact on the business, time, space, and staff, among other things. It is estimated that with a good facility layout, around 30% of the costs associated with these resources can be avoided. In this sense, one could argue that facility layout is a strategic endeavor for enterprises. As a result, the issue at hand has been thoroughly investigated both in industrial settings and within the academic community (Baki, 2014). Tompkins et al. (2003) stated that the costs associated with transporting inputs and intermediate products between manufacturing sites account for between 20% and 50% of the enterprise's overall production costs. Additionally, an ineffective facility layout has major negative consequences for occupational health and safety, disruption of maintenance and repair activities, increased system wait times, and increased intermediate stock levels. Eventually, production suffers, and employee unhappiness grows.

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Loop layout, one of the facility layout types, is the placement of equipment in a virtual circle. Numerous research studies have been conducted on the cyclic facility layout problem. Particularly in light of Afentakis's (1989) study, in which the advantages of considering in-plant layouts as loop layouts are demonstrated using a graph model, it is clear that cyclic layout studies are more prevalent in the literature. According to the model, it is intended to distribute n cells (machine, equipment, workstation, station, table, etc.) circularly throughout the facility, ensuring an optimal arrangement. According to this approach, materials enter the system at a single loading/unloading station and exit the system via a one-way transit system that connects the cells. The literature typically asserts that the loop topology in question offers extremely efficient results for flexible manufacturing systems. Indeed, it has been stated that cyclical facility layout results in cost reductions of between 20% and 70% for any industrial system (Saravanan & Kumar, 2013). Gyms in the service sector have machines and equipment. These machines are utilized by customers who visit the facility to exercise for a specific reason and in accordance with a predetermined training program. Gym machines are typically extremely heavy, difficult to transport and/or relocate, and may require assembly and disassembly prior to reinstallation. The machine arrangement is determined during the facility's installation, and its replacement will result in a greater cost afterwards. As a result, the machine lineup is critical during the facility's establishment phase. Currently, machines are placed regionally based on their intended usage. Modeling and optimization of gym layout have not been studied in the literature yet. The purpose of this work was to identify the loop layout problem and propose a strategy for the optimal placement of machines in gyms by modeling the loop layout problem. It is well-known that the gym has a large number of machines, that transportation and initial setup expenses are expensive, and that the facility operates on a closed loop. There are no scientific studies in the literature that address the issue of machine placement in gyms. A layout model concept was built and presented in this context for the first time. The objective function was built by picking the most effective parameters for the problem in order to decide the machine sequences. The problem of facility layout is resolved in an intuitive manner. Each of the effective factors for machine sequencing has been evaluated using gym customer programs. The objective function keeps track of the distances between the machines' positions within predefined training programs and attempts to locate the machines based on their overall positional weight within these programs. The quantity of clients at each training program has an effect on the machines' distance calculations, acting as a weight factor. The overall objective function attempts to find the optimal layout in which the machine sequence is as one-way forward as possible for each training program. Congestion is intended to be minimized by factoring in the client proportion for each training program and the machine's frequency of use during the training programs.

2. Gym Layout Problem

The loop plant layout places the machines in a virtual circle throughout the process, from material entry to system departure, and the flow between the machines is either uni-directional or bi-directional. When examined in general, it is seen that one-way circular placement techniques are preferred more frequently. A unidirectional circular layout is shown in Fig. 1. As can be seen from the figure, in this arrangement, the parts move only in one direction. During the processing process, each part is directed to the next cell. Once a part has been processed at one of the workstations in the cell, the part is transported unidirectionally via the material handling system to the next workstation specified in the processing plan. If the workstation is busy, the part is kept in the queue until the workstation becomes available (Altınel and Öncan, 2005).

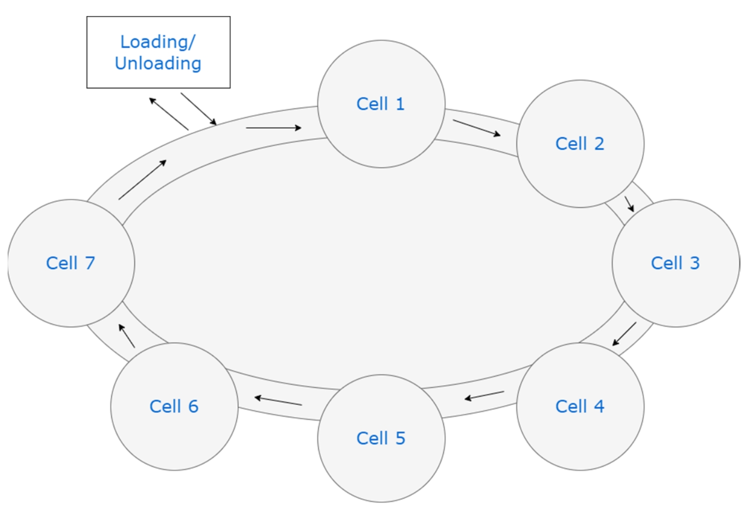

Fig. 1. Unidirectional loop Layout with 7 Machines with a Single Loading / Unloading Point

Each workstation is capable of retrieving material from the material handling system, processing it, and then returning it to the material handling system. The most commonly used operational approach for these systems is for all components to enter and exit via loading (entry) and unloading (exit) stations. Stations for loading and unloading are specialized in handling. At these stations, materials are transferred from the outside of the loop into the loop without any changes to it. The primary objective of this settlement is to build *n* cells in *n* candidate zones. While designing this structure, the objective is to reduce the total transportation cost and production time for the components generated in the cells. According to Afentakis (1989), unidirectional circular layouts are chosen due to their lower initial investment costs, increased material handling flexibility, and capacity to adapt to future new parts and process changes (Özçelik & Isler, 2011). Using conveyor belts to move between cells in a cyclic structure is not always practicable or necessary. For example, organizations in the service industry are less likely to need a conveyor belt system than those in manufacturing. An example of this is the optimum placement of the sports stations to be placed in the gyms. Service desks in public sector offices that require more than one stage of service can also be used as an example of this. Yang et al. (2005) suggest that the block layout-based method can be used in such cases. Cells are placed in conjunction with each other using the space filling curve method and annealing simulation methods to reduce flow costs. In the examples presented within the scope of the study, the situation of placing several stations of different sizes in a facility with a square area has been examined. The objective function of this layout was determined to be minimizing the cost of transitions between stations. Gyms are service-sector establishments that provide clients with the chance to participate in sports. The placement of gym machines is a decision that can be made during the initial installation phase, and subsequent adjustments are improbable. It has been observed that the machines in the gyms are categorized and arranged according to the body parts being worked. The layout of the machines in the gym was designed using an intuitive algorithm in this study. The established gym facility layout problem considers the customers' training programs, the machine order within these programs, the number of arriving customers, the ratio of males to females using the training programs, and the frequency of the machines within the programs as elements impacting the machine order. Customers enrolled in various training programs will be required to switch machines in accordance with the sequence of the machines in their training program. The purpose of this study is to determine the optimal layout of these machines in order to alleviate gym traffic congestion and provide a more intuitive movement plan for consumers. The purpose is to build a layout plan that minimizes backward movement using an objective function created from the positions of the machines in the training programs, the number of customers who use these programs, and the frequency with which the machines appear in multiple programs. One of the criteria examined when developing the objective function is the unit distances between the machines, which are determined by the trainers' training plans. Another parameter is the overall frequency with which machines occur in programs. Finally, the rate at which machines were used was computed and appraised.

2.1 The mathematical model

The following notation is used in the algorithm solution.

$X_{i,j} \begin{cases} 1, \text{if machine } j \text{ is next to machine } i \\ 0, \text{if machine } j \text{ is not next to machine } i \end{cases}$

l: Number of machines

k: Number of training programs

P_k: Training program *k*

M_i: Machine *i*

C_{ij}^k: Unit distance between machines *i* and *j* in the training program *k*

T_k: % of customers enrolled in a training program *k*

$N_{i,j}$: The frequency with which machine *i* and *j* coexist in training programs

In the problem, the order of the machines are referred to as $X_{i,j}$. For example, if $X_{3,5} = 1$ then machine 5 is next to machine 3. There are *l* machines in the system. Sports trainers divide training programs for men and women based on their intended application. There is a specific sequence to these training programs that are followed. P_k stands for the training plans devised by the trainers. Depending on the training program, the number of machines will vary. The order of machines in each program is also unique. To evaluate the algorithm's performance, the distance between the machines along the route indicated in the training programs is employed as a parameter. This parameter is denoted by the symbol C_{ij}^k. The distance between two machines is regarded as one unit. The value of the unit distance for machines that are not used in the training program is set to zero. For each training program, an inter-machine unit distance matrix was built to assist in the algorithm's solution.

T_k is the ratio of people who use gym machines according to their intended purpose. To build the objective function, the machine listings, training program routes, and the rate at which individuals use the training programs were determined. The frequency of machines in the training programs was then computed as a parameter that affects the objective function. $N_{i,j}$ is the number of times the machines are utilized in training programs. All variables and factors that are effective in the layout and contribute to the system have been determined during the solution of the gym facility layout problem. The following is the mathematical model for gym facility layout optimization.

2.2 Objective Function:

$$\min Z = \sum_{i=1}^{l} \sum_{j=1}^{l} \sum_{k=1}^{p} \frac{X_{i,j} C_{ij}^k * T_k}{N_{i,j}} \quad (1)$$

$$X_{i,j} \in \{0,1\} \quad (2)$$

Eq. (1) aims to place the machines that are frequently used and that are heavily sequential in the training programs close to each other. This equation's value is directly related to the training program density and the sequential use of machines in the training programs. The goal is to develop a layout plan that minimizes backward movement by utilizing the locations of the machines in the training programs, the number of customers who use these programs, and the frequency with which the machines appear in multiple programs.

3. Experimental Study

To evaluate the suggested model's findings in practice, the arrangement of 50 machines in a gym was evaluated. The problem was created by studying the variables affecting the layout of a gym facility. The gym has a total of 50 machines. This machine data was gathered from a 1,000-square-meter gym. The gym's lineup was evaluated.
Table 1 contains the list of machines.

Table 1
Machine List

Machine Name	Code	Machine Name	Code
Treadmill	M_1	T-Bar Rowing	M_{26}
Elliptical	M_2	Triceps Curl	M_{27}
Horizontal-Bike	M_3	Lower Back	M_{28}
Vertical-Bike	M_4	Biceps Curl	M_{29}
Bench Press	M_5	Abdominal Machine	M_{30}
Incline Bench Press	M_6	Seated Horizontal Pully	M_{31}
Decline Bench Press	M_7	Roman Chair	M_{32}
Seated Chest Press	M_8	Crunch	M_{33}
Incline Chest Press	M_9	Total Abdominal	M_{34}
Decline Chest Press	M_{10}	Twist	M_{35}
Butterfly	M_{11}	Squat	M_{36}
Seated straight Arm Clip Chest	M_{12}	Hack Squat	M_{37}
Dips	M_{13}	Seated Leg Curl	M_{38}
Cable Cross	M_{14}	Horizontal Leg Curl	M_{39}
Shoulder Press	M_{15}	Leg Extension	M_{40}
Front Shoulder Press	M_{16}	Leg Press	M_{41}
Dumbbell Press	M_{17}	Seated Calf	M_{42}
Deltoid Machine	M_{18}	Abductor In	M_{43}
Seated Row	M_{19}	Abductor Out	M_{44}
Row	M_{20}	Total Hip	M_{45}
Pulldown	M_{21}	Calf	M_{46}
Pulldown Front	M_{22}	Glute	M_{47}
Lat Pulldown	M_{23}	4 Station	M_{48}
Lat Pulldown Front	M_{24}	Multi Press	M_{49}
Horizontal Bar	M_{25}	Dumbbell Station	M_{50}

In order to better serve their clients, sports trainers differentiate their workout plans into male and female versions. The sequencing of these programs is well-defined. On average, sports trainers recommend exercising three days a week. As a result, the programs were organized into three distinct schedules for each participant, each lasting three days. P_k stands for the training programs devised by the trainers. The layout problem was created by considering 18 different programs ($k = 18$). There are a variety of reasons why people go to the gym, from gaining weight to losing weight. The training programs are $P_1, P_2, P_{3,}$female 3-day slimming; P_4, P_5, P_6male 3-day slimming; P_7, P_8, P_9 women 3-day weight gain; P_{10}, P_{11}, P_{12} e male 3-day weight gain; P_{13}, P_{14}, P_{15}female 3-day fitness; P_{16}, P_{17}, P_{18} is defined as male 3-day fitness program. The programs are shown in Table 2 below.

Table 2
Program List

Code	Training Program	Code	Training Program
P_1	Female Slimming - I	P_{10}	Male Weight Gain - I
P_2	Female Slimming - II	P_{11}	Male Weight Gain – II
P_3	Female Slimming - III	P_{12}	Male Weight Gain - III
P_4	Male Slimming - I	P_{13}	Female Fitness - I
P_5	Male Slimming - II	P_{14}	Female Fitness – II
P_6	Male Slimming - III	P_{15}	Female Fitness – III
P_7	Female Weight Gain - I	P_{16}	Male Fitness – I
P_8	Female Weight Gain – II	P_{17}	Male Fitness – II
P_9	Female Weight Gain - III	P_{18}	Male Fitness - III

Each training program utilizes a unique set of machines. Additionally, each training program features a unique arrangement of machines. The training programs' routes are detailed in Table 3 below. As an illustration, P_6depicts the path taken on the third day of the male slimming program as the sixth workout session. The Decline Chest Press (M_{10}) appears to be the route's fifth machine.

Table 3
The Training Programs' Route

Order	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
1	M_1	M_3	M_1	M_1	M_3	M_1	M_5	M_5	M_5
2	M_2	M_4	M_3	M_2	M_4	M_3	M_6	M_8	M_9
3	M_{30}	M_8	M_{30}	M_5	M_{13}	M_4	M_{11}	M_{11}	M_{10}
4	M_{31}	M_9	M_{32}	M_6	M_{14}	M_9	M_{21}	M_{20}	M_{20}
5	M_{32}	M_{10}	M_{33}	M_7	M_{30}	M_{10}	M_{22}	M_{23}	M_{23}
6	M_{33}	M_{11}	M_{35}	M_8	M_{31}	M_5	M_{25}	M_{24}	M_{24}
7	M_5	M_{13}	M_5	M_9	M_{32}	M_6	M_{15}	M_{15}	M_{15}
8	M_6	M_{23}	M_7	M_{10}	M_{33}	M_7	M_{16}	M_{17}	M_{19}
9	M_8	M_{24}	M_9	M_{11}	M_{34}	M_{20}	M_{19}	M_{27}	M_{30}
10	M_9	M_{25}	M_{11}	M_{13}	M_{35}	M_{21}	M_{27}	M_{28}	M_{33}
11	M_{11}	M_{15}	M_{23}	M_{14}	M_{23}	M_{22}	M_{29}	M_{48}	M_{37}
12	M_{23}	M_{16}	M_{24}	M_{21}	M_{24}	M_{23}	M_{50}	M_{36}	M_{40}
13	M_{24}	M_{17}	M_{25}	M_{22}	M_{37}	M_{24}	M_{37}	M_{40}	M_{41}
14	M_{25}	M_{37}	M_{15}	M_{23}	M_{38}	M_{15}	M_{40}	M_{41}	M_{47}
15	M_{15}	M_{40}	M_{27}	M_{24}	M_{40}	M_{16}	M_{41}	M_{32}	M_{48}
16	M_{16}	M_{41}	M_{29}	M_{25}	M_{41}	M_{19}	M_{30}	M_{34}	M_{50}
17	M_{18}	M_{43}	M_{28}	M_{15}	M_{46}	M_{27}	M_{33}		
18	M_{27}	M_{44}	M_{36}	M_{16}	M_{47}	M_{28}			
19	M_{29}	M_{45}	M_{38}	M_{17}	M_{48}	M_{29}			
20	M_{28}	M_{30}	M_{40}	M_{18}	M_{50}	M_{48}			
21	M_{36}	M_{31}	M_{41}	M_{19}		M_{49}			
22	M_{38}	M_{34}	M_{43}	M_{27}					
23	M_{40}	M_{35}	M_{44}	M_{28}					
24	M_{41}	M_{50}	M_{50}	M_{29}					
25	M_{43}								
26	M_{44}								

Table 3 (cont.)
The Training Programs' Route

Order	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}
1	M_5	M_9	M_5	M_1	M_3	M_1	M_2	M_1	M_2
2	M_7	M_{10}	M_6	M_3	M_4	M_2	M_4	M_3	M_3
3	M_{11}	M_{11}	M_9	M_5	M_5	M_5	M_5	M_5	M_5
4	M_{23}	M_{20}	M_{10}	M_8	M_9	M_8	M_8	M_6	M_{11}
5	M_{25}	M_{21}	M_7	M_{11}	M_{10}	M_{11}	M_{11}	M_7	M_{12}
6	M_{24}	M_{22}	M_{14}	M_{12}	M_{11}	M_{21}	M_{13}	M_9	M_{20}
7	M_{26}	M_{25}	M_{23}	M_{21}	M_{25}	M_{22}	M_{14}	M_{10}	M_{21}
8	M_{15}	M_{17}	M_{24}	M_{22}	M_{26}	M_{24}	M_{21}	M_{12}	M_{22}
9	M_{16}	M_{18}	M_{25}	M_{23}	M_{15}	M_{25}	M_{22}	M_{13}	M_{26}
10	M_{17}	M_{19}	M_{26}	M_{24}	M_{18}	M_{17}	M_{23}	M_{16}	M_{17}
11	M_{27}	M_{48}	M_{49}	M_{25}	M_{50}	M_{15}	M_{24}	M_{18}	M_{18}
12	M_{28}	M_{49}	M_{50}	M_{15}	M_{27}	M_{19}	M_{25}	M_{19}	M_{19}
13	M_{29}	M_{37}	M_{39}	M_{49}	M_{28}	M_{48}	M_{26}	M_{50}	M_{48}
14	M_{50}	M_{40}	M_{40}	M_{16}	M_{29}	M_{50}	M_{15}	M_{28}	M_{27}
15	M_{36}	M_{41}	M_{41}	M_{18}	M_{49}	M_{37}	M_{49}	M_{37}	M_{29}
16	M_{37}	M_{43}	M_{31}	M_{27}	M_{36}	M_{38}	M_{16}	M_{38}	M_{38}
17	M_{41}	M_{44}	M_{32}	M_{28}	M_{38}	M_{39}	M_{17}	M_{40}	M_{39}
18	M_{30}	M_{30}	M_{34}	M_{50}	M_{39}	M_{40}	M_{19}	M_{41}	M_{40}
19	M_{32}	M_{33}		M_{37}	M_{45}	M_{41}	M_{27}	M_{42}	M_{41}
20	M_{33}	M_{34}		M_{39}	M_{46}	M_{47}	M_{48}	M_{46}	M_{42}
21				M_{43}	M_{30}	M_{31}	M_{28}	M_{30}	M_{47}
22				M_{44}	M_{32}	M_{32}	M_{29}	M_{32}	M_{31}
23				M_{45}	M_{33}	M_{35}	M_{50}	M_{33}	M_{32}
24				M_{31}			M_{36}	M_{35}	M_{33}
25				M_{34}			M_{38}		
26				M_{35}			M_{40}		
27							M_{31}		
28							M_{32}		
29							M_{34}		
30							M_{35}		

The distance between the machines on the path provided in the training programs is used as a parameter to analyze the performance of the algorithm. This parameter is denoted by the letter C_{ij}^{k}. The mathematical notation $C_{4,23}^{2}$, for example, relates to the distance between the 4th and 23rd machines in the 2nd training program. $C_{4,23}^{2} = 6$. The distance between a machine and the next machine in line is measured as 1 unit. For each training program, an inter-machine unit distance matrix was built to aid in the algorithm solution. During the creation of the objective function, the average number of people utilizing the gym's machines was measured using the customers' monthly registration information. Table 4 shows the purpose of utilizing the equipment and the percentage of people who use the program based on information received from gymnasium records.

Table 4
Percentage of People Who Participate in Training Programs

P_k	Percentage
P_1	0.1
P_2	0.09
P_3	0.08
P_4	0.04
P_5	0.03
P_6	0.04
P_7	0.02
P_8	0.01
P_9	0.02
P_{10}	0.06
P_{11}	0.05
P_{12}	0.06
P_{13}	0.03
P_{14}	0.03
P_{15}	0.02
P_{16}	0.11
P_{17}	0.11
P_{18}	0.1
Total	1

According to the data in Table 4, on average, 27% of gym customers are female ($P_1, P_2, P_{3,}$) and use the facility for weight loss goals. 32% of consumers are male (P_{16}, P_{17}, P_{18}) and they utilize the facility for fitness training. As indicated in table, 60% of gym customers are men, while 40% are women. Table 5 further shows that the number of times the machines are utilized in the programs which is specified as $N_{i,j}$. For example, in the matrix developed, the total number of the 5th and 20th machines in the program is $N_{5,20} = 5$.

Table 5
Machine Frequency in Training Programs

Machine	Frequency	Machine	Frequency
M_1	7	M_{26}	5
M_2	5	M_{27}	11
M_3	8	M_{28}	10
M_4	5	M_{29}	9
M_5	15	M_{30}	10
M_6	6	M_{31}	8
M_7	6	M_{32}	11
M_8	7	M_{33}	10
M_9	10	M_{34}	7
M_{10}	8	M_{35}	7
M_{11}	13	M_{36}	6
M_{12}	3	M_{37}	9
M_{13}	5	M_{38}	8
M_{14}	4	M_{39}	5
M_{15}	13	M_{40}	13
M_{16}	9	M_{41}	13
M_{17}	8	M_{42}	2
M_{18}	7	M_{43}	5
M_{19}	9	M_{44}	5
M_{20}	5	M_{45}	3
M_{21}	8	M_{46}	3
M_{22}	8	M_{47}	4
M_{23}	12	M_{48}	8
M_{24}	13	M_{49}	6
M_{25}	12	M_{50}	12

The following is the mathematical model for the experimental study:

$$\min Z = \sum_{i=1}^{50} \sum_{j=1}^{50} \sum_{k=1}^{18} \frac{X_{i,j} C_{ij}^{k} * T_k}{N_{i,j}} \tag{3}$$

$$X_{i,j} \in \{0,1\} \tag{4}$$

Genetic algorithms are employed to determine the optimal layout of machines in the gym. The result of the genetic algorithm solution is shown in Table 6.

Table 6
Results of the Best Machine Ranking

Order	M_i	Result	Order	M_i	Result
1	M_{22}	0.02	26	M_{14}	0.00
2	M_{23}	0.04	27	M_{43}	0.00
3	M_{21}	0.04	28	M_{46}	0.00
4	M_{13}	0.05	29	M_{17}	0.07
5	M_{11}	0.02	30	M_{27}	0.04
6	M_{10}	0.06	31	M_{19}	0.03
7	M_9	0.06	32	M_{18}	0.06
8	M_7	0.01	33	M_{25}	0.01
9	M_8	0.03	34	M_{20}	0.02
10	M_3	0.05	35	M_{50}	0.03
11	M_1	0.00	36	M_{48}	0.03
12	M_{26}	0.00	37	M_{28}	0.05
13	M_{44}	0.00	38	M_{29}	0.02
14	M_{42}	0.00	39	M_{37}	0.02
15	M_2	0.01	40	M_{38}	0.04
16	M_{30}	0.05	41	M_{36}	0.01
17	M_{32}	0.04	42	M_{39}	0.01
18	M_{31}	0.08	43	M_{40}	0.05
19	M_{34}	0.04	44	M_{41}	0.07
20	M_{35}	0.04	45	M_{49}	0.00
21	M_{33}	0.08	46	M_{47}	0.00
22	M_4	0.02	47	M_{16}	0.07
23	M_5	0.06	48	M_{15}	0.01
24	M_6	0.00	49	M_{12}	0.01
25	M_{45}	0.00	50	M_{24}	0.14

Fig. 2 depicts the circular layout of the machines based on the results of the gym facility layout optimization.

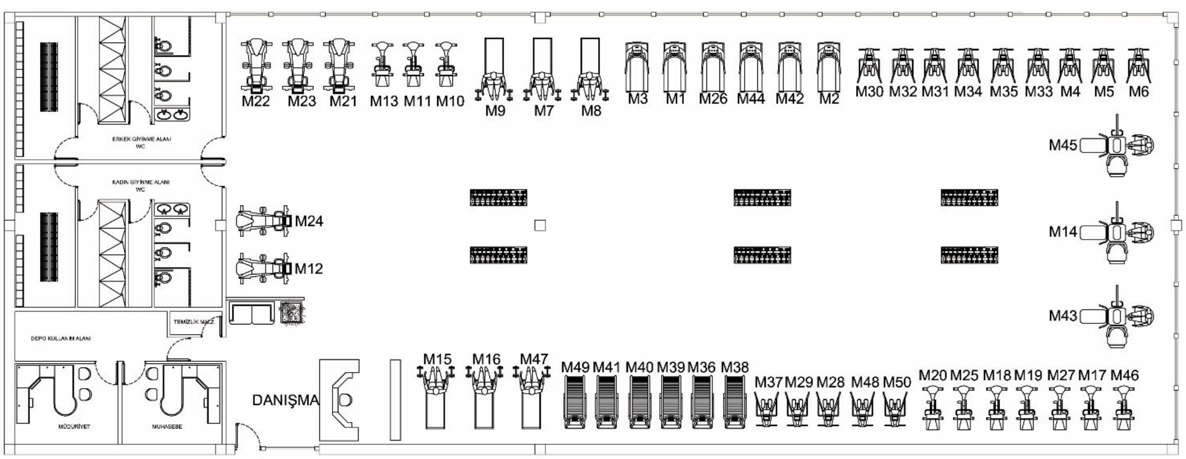

Fig. 2. Final layout of the gym

2. Conclusion

Facilities are areas in the manufacturing and service industries where goods and services are prepared and offered to customers at various stages. Today, it is critical to design processes holistically and to optimally locate physical elements within the facility in order to maximize efficiency and minimize costs. The primary reason for this is the necessity of locating the extremely expensive in-plant equipment in the most efficient and cost-effective manner possible. The facility layout problem, which arose in order to accomplish these goals, is a well-studied type of problem in the literature. It has been demonstrated that choosing the loop facility layout provides significant benefits in terms of low settlement costs, ease of flexibility in production and processes, significant cost savings on machinery and equipment expansion, and ease of resolving system bottlenecks, thereby increasing system reliability and reducing system delay times. The retail sector benefits the most from the loop layout strategy. Customers are encouraged to browse the system and are exposed to a variety of products.

The purpose of this study was to determine the optimal way to organize training equipment in a gym. The loop layout model designed aims to minimize backward movements in the gym in accordance with the training programs, in order to allow customers to travel intuitively between the machines while also reducing traffic congestion in the gym. The model, which was examined in an experimental study, was solved by genetic algorithms, and the optimal solution was found in a gym consisting of 50 machines.

To our knowledge, this is the first time such a solution for machine placement in gyms has been introduced. Also, for the first time, the loop layout problem was applied to gyms. The model's findings are applicable to gyms and lead to a layout that both minimizes traffic congestion and improves customer flow.

This study has highlighted the possibility of future major studies on gym layout problems. Further research will be useful in evaluating different models for gym layouts and comparing the results of established models using various optimization methods.

Compliance with Ethical Standards

The authors report no conflicts of interest in this work.

Data Availability Statement

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

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