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Redesign of Water Filter Workshop Using SLP

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K E Y W O R D S

Existed layout, plant layout, procedural approach, proposed layout, SLP.

A B S T R A C T

Workshop and factory design is one of the most important problems facing companies to enhance their performance and productivity. Facility layout issue is a fundamental fragment of accommodations planning which have a target of organize all manufacturing entities to be located as a facility having the objective to improve manufacturing processes for an organization. The aim of this paper is to study, evaluate and then creating an improved water filter workshop adopting Muther's (SLP) Systematic Layout Planning Procedure for increasing production and utilizing spaces. The case study in this paper is a practical one for the existing layout in Al-Faris Company in the water filter workshop. The excited layout is studied and manufacturing processes are explored with flow investigation. Activity relationship graph is molded to develop a novel layout alternative. Analyzing by using SLP technique showed that the results for the proposed layout got 341score; while the current layout got only 281 score based on the manufacturing and facility relations. The results show that, the proposed layout is much better than the existing layout of the workshop as significant reduction in the space of material handling and workflow drive and lead to increase the unit production.

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1. INTRODUCTION

The most vital element that affects proficiency of a production process is the facilities layout. To get an appropriate layout, the following goals and principles must be taken into design consideration, for example, safety factors, space necessities, budget, and communication. Layout improvement raises utilization of machines that increases machining capability for the workshop. Relatively, the organization often feels the necessity of redesigning plant layout even though it looks that work is running well in the company. One of the causes for designing a new plant may be improving the performance of the present plant [1]. The facility of design layout controls the virtual position of sections and machineries in the workshop aiming to maximize effectiveness and facility organization to decrease material handling budgets [2]. Long distance travelled from department to department causes the worker to take more time to complete a product. From the material flow of several products, the worker has to walk from one department to another several times before getting the finished goods. The repetition of long-distance movement from a department to another is a sign of poor layout planning. Therefore, a better solution for the layout planning could minimize waste caused by poor layout problem should be proposed [3]. Facility layout design includes a regular physical arrangement of different sections, workplaces, machines, tool, storage areas and common areas in a manufacturing industry [4]. Facility arrangement is highly important in industrial process because of their effect on accomplishing an efficient product produce. Suitable examination of Facility Design Layout might develop performance of manufacture shop and reduce bottleneck amount; reduce handling of material price, decreases time idleness, increase productivity and employment utilization, tool and area. Basic manufacturing Layout Planning is implemented to a systematic layout planning (SLP) technique that presented step-to-step of workshop design starting with inputs and actions to be evaluated for workshop layout. This technique offers proposed layout which develops product production within the workshop. Traditionally, facilities layout problem FLP structures two procedures; quantitative and qualitative. Qualitative procedure intends for maximization of nearness scores rating among the work centers or sections constructed to the nearness task resulting from the relationship chart whereas quantitative procedures intends to minimization of overall handling of material budgets among sections created on the distance task [5].
So, the goal of this research is to study water filter workshop based on qualitative systematic layout planning technique (SLP), to reduce distance and increase production.

2. LITERATURE REVIEW

The most related studies to the redesign layout subject are as follows:
Shewale et al. [6], work on the goal of their research to evaluate workshop layout of compressor production adopting (SLP) Systematic Layout Planning technique for growing efficiency. Their problem under study performs calculation of quantity of apparatus's and tools in compressor manufacture in details for studying the workshop layout. Designing for a novel layout is performed and compared with the current layout. The SLP technique presented that the novel workshop layout expressively reduces the space of the movement of material from supplies till send [6]. Singh and Manderas (, in their paper study the manufacture workshop layout of Can production and the implementation of SLP steps as a technique for solving the production workshop layout problem. (SLP) technique is adopted to propose two alternative manufacturing layouts for workshops and to compare the proposed layout with the current layout in their performance taking into consideration the flow distance of material, moving time, and moving budget. The suggested approach is showed to be an applicable for determining manufacturing workshop layout design within a practical example. Results displayed that the manufacturing flow distance is reduced from 389.7 meter to 311.2 meter and 360.6 meter. The moving period can be decreased from 901 sec. to 750 sec. and moving budget is decreased to 2.98 and 2.19 Birr from 3.17 Birr for every movement resulting growing in the productivity [7]. Chen et al (2016), in their paper adopt the (SLP) technique for improving design

layout for H Firm, and comparing non optimized layout structure with an optimized one for quantitative and qualitative investigation aspect adopting Analytic Hierarchy Process technique. Results display that applying SLP technique in H firm, might improve its workshop capability layout and efficiency [8]. Wen and Bai (2015), in their paper introduces an investigation of logistics abilities layout of Production Company with the implementation of Intuitionistic Fuzzy Sets (IFSs) to make an assessment to improve abilities of layout problem logistics. For their work, (SLP) is used to design the best position of warehouses and determine the logistics facilities. However, the full valuation of manufacturing logistics abilities layout is good (g), an ideal spatial to enhance logistics productivity is existed. Consequently, they suggested a novel enhanced logistics abilities layout. Applying production company, an enhanced logistics abilities layout is gained, the carriage become more free, waiting period is decreased and cost of logistics is reduced thus [9].

3. THEORETICAL BACKGROUND

The theoretical background conducted in this research is explaining the concept of plant and work shop layout as well as explaining the concept of systematic layout planning and how to be applied in this research

I. Plant and Work Shop Layout, purposes and principles

In a production institution, a manufactured work occupies maximum time for traveling and waiting. It is essential to have appropriate layout and appropriate scheduling technique, to decrease this traveling and waiting time of works/items. Workshop layout starts with design workshop structure location to go up to the position and machine work table movement [10]. Plant layout of a manufacturing institution plays a vital character in logical management which is defined as "Plant layout is a systematic and effective well-designed organization for different sections, machineries, tools, apparatus with other supports services of an industrial association that may enable horizontal processing of the proposed and assumed product for best efficiency, most effectiveness and greatest economical style within minimum possible period" [11]. Bottlenecks and topics of overcrowdings must be removed, to enable raw-material and semi-finished products to be transferred faster from a workplace to another [12]. Major objectives of well plant layout are [13]: 1) Facilitate manufacturing process, 2) Minimize material handling, 3) Active use of employers, machine and area, 4) Stream line the flow of material through divisions of plants, 5) Flexibility of manufacturing operations and arrangements, 6) To provide employee convenience, safety and comfort, 7) To make supervision easier and efficient and 8) Provide satisfaction to all concerned .The main criteria for assessing any layout will be the: minimizing of material handling (MH) prices. MH price components: decrease of MH equipment, flexible operating prices, and employment expenditures. As well, MH prices are typically directly proportional to: (a) The regularity of movement of material, and (b) The distance over which material is moving. The main principles of plant layout are [14]

1. The norm of merger: Well layout joins employment, material, machineries and auxiliary facilities with others for getting best use of resources and most efficiency.

2. The norm of least distance: Aims to disturb for the lowest travel of employment and materials. Services are organized to enable the employment and materials to move the whole distance as lowest and as far as probable straight line.

٣.The norm of plant utilization: Well layout uses all vertical and horizontal space effectively. The height as a third dimension is also to be used effectively.

٤. The norm of smooth stream: Well layout makes the materials to transfer in frontward path towards the accomplishment step without any interrupted.

٥. The norm of high flexibility: Well layout can be changed with minimum time. And cost.
6. The norm of safety, security and confidence: Well layout gives due attention to labors care, gratification and protections to the workshop and machinery in contradiction of fire, robbery… etc.
7. The norm of least handling: Well layout decreases handling of material to the lowest.

II. Systematic Layout Planning (SLP)

SLP is a procedure used to organize any workshop in a company by spotting two zones having high rate with logical relations closeness. This procedure licenses fastest material stream in producing the product in its least price with minimum quantity of movement [15]. SLP is a systematized technique to plan a layout. SLP includes steps; depend on classifying conventions, score, then imagining the fundamentals of layout planning [16]. The procedure combines numerical dimension for materials handling with nonflow contemplations like sound, smokes, temperature, administration, transport network, staff's relief and traveling. Its main benefit is obviously documenting layout logic and to simply permit staff input [17].

The Steps of SLP technique are described in Figure 1 which shows that the analyzing of a layout using SLP should pass through five steps [18]. SLP procedures as illustrates in Figure 1, is a procedural layout design approach developed by Murther, Ricard in 1961. The procedure is a planning process allows identifying, visualizing, assessing different events, relations, and alternatives for capability layout. SLP is also adopted to raise production by matching the facility layout designed with the present facility layout [19]. This technique can be successfully applied for both production and service facilities [20]. Activity association diagram results from the investigation of altered actions and their relationship. It is founded in the input information like products, amount, path, provision, time and understanding the characters with relations between each activity and others. Inputs help in generating a material flow examination diagram typically stated to as a (From to Diagram). Analyzing the (from to diagram) and action relation diagram, a relationship chart is advanced. Determining the extent of space essential for each action and allocating each action then the unfilled space, space forms are prepared for every sector to find the space relationship chart. Next step includes developing and valuing a number of alternative layouts depend on adjustment considerations and real-world boundaries. Established alternatives are then assessed based on designers' criteria facility with the aim of choosing the most appropriate alternative [21].

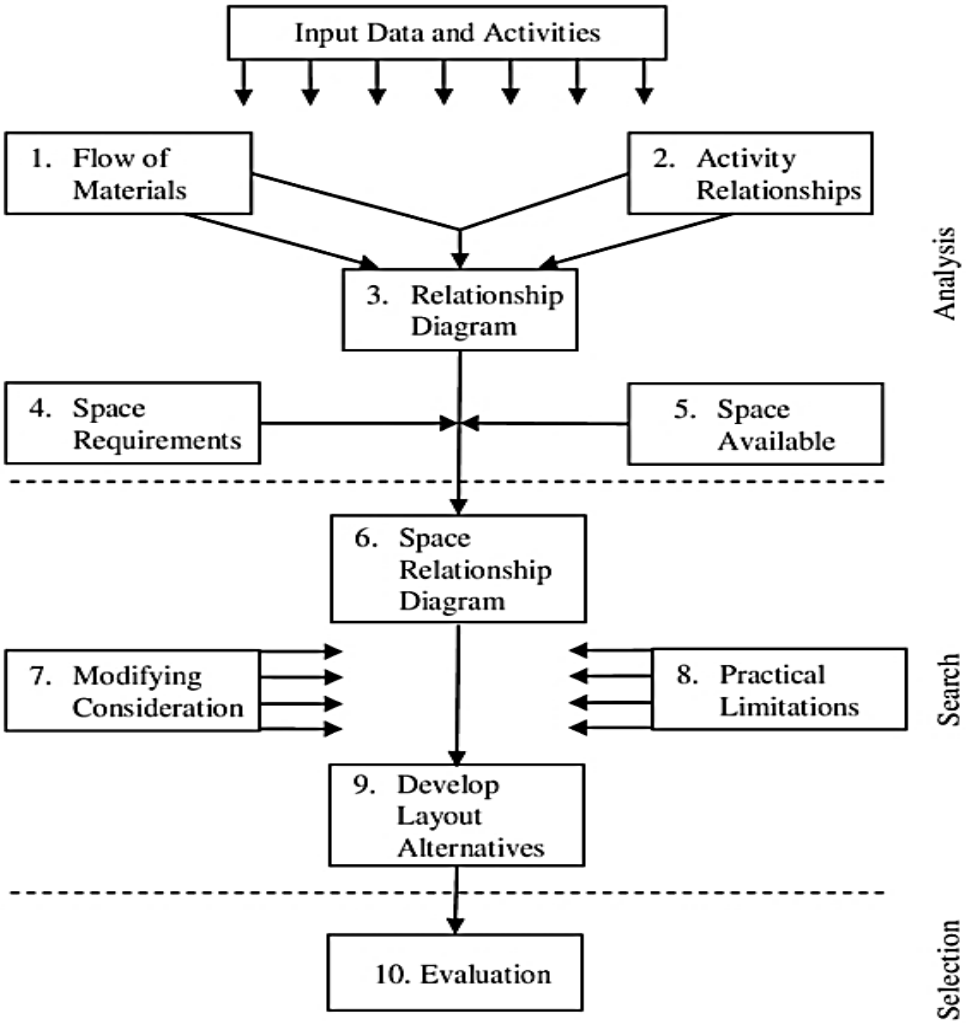

Figure 1: Systematic layout planning implementation diagram [20]

4. Systematic Layout Planning Implementation

I. Implementation Overview

SLP is applied in Al-Faris General Company as a case study where the water filter workshop is chosen for applying the steps previously mentioned in Figure 1. Al –Faris state company is one of the formations of Ministry of Industry and Minerals. It is specialized in the field of manufacturing heavy engineering equipment and water treatment units of various capacities. Water filter workshop consists of four departments these are preparations, assembly, structure, mechanical operation and drying, each department includes many machines and tools. These departments are shown in Figure 2 that illustrate existing or current layout of water filter.

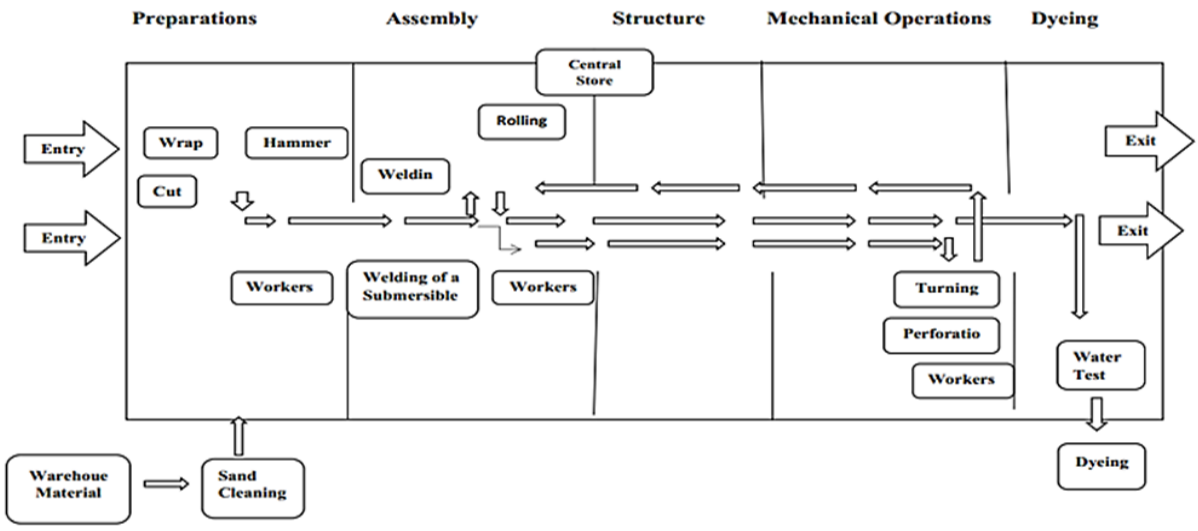

Figure 2: Current layout

II. Applying SLP technique

The SLP CS includes the flowing steps**:**

i. ***Flow process of filter*:**

To go through the manufacturing processes diagram for the product under study (the filter), a flow process diagram is drawn to illustrate the sequence of manufacturing process. These sequential processes are shown in Figure 3 starts with drawing raw materials from the stores to be cleaned by sand blasting, then cutting process according to the routing sheet for predefined dimensions is performed…. and so on up to testing and painting operations to get the final product. The symbols specification in Figure 3 is defined as shown in Figure 4.

ii. ***SLP analysis***

Adopting the investigation of the manufacturing process for filter product, it is noticed that extended handling of raw material can be decreased to solve the problem of unused area. To improve the plant layout applying SLP is adopted, for continuous work flow. Based on the most related manufacturing processes, relationship of each activity to improve handling is considered as illustrated in Table I. The nearness value is defined according to similar case studies in literature as: A=Absolutely necessary = 16, E = Especially important = 8, I= important = 4 O= Ordinary closeness = 1 and U= Unimportant = 0.

These values are used to illustrate the relationship between each two departments, this evaluation shows the importance of the two departments being close to each other, for example the relationship between material drawing and sand cleaning (SC) is A this means that the degree of their closeness with each other is necessary.

iii. Current layout scores

The current layout is studied and many observation and discussion with professionals from the company was performed. Relationship between processes is checked to apply their scores and then

relationship score matrix of the manufacturing activities is gained as illustrated in Table II, which displays the aggregate scores for current situation depend the importance relationship scores mentioned previously. The scores gained of relationship calculation are 281.

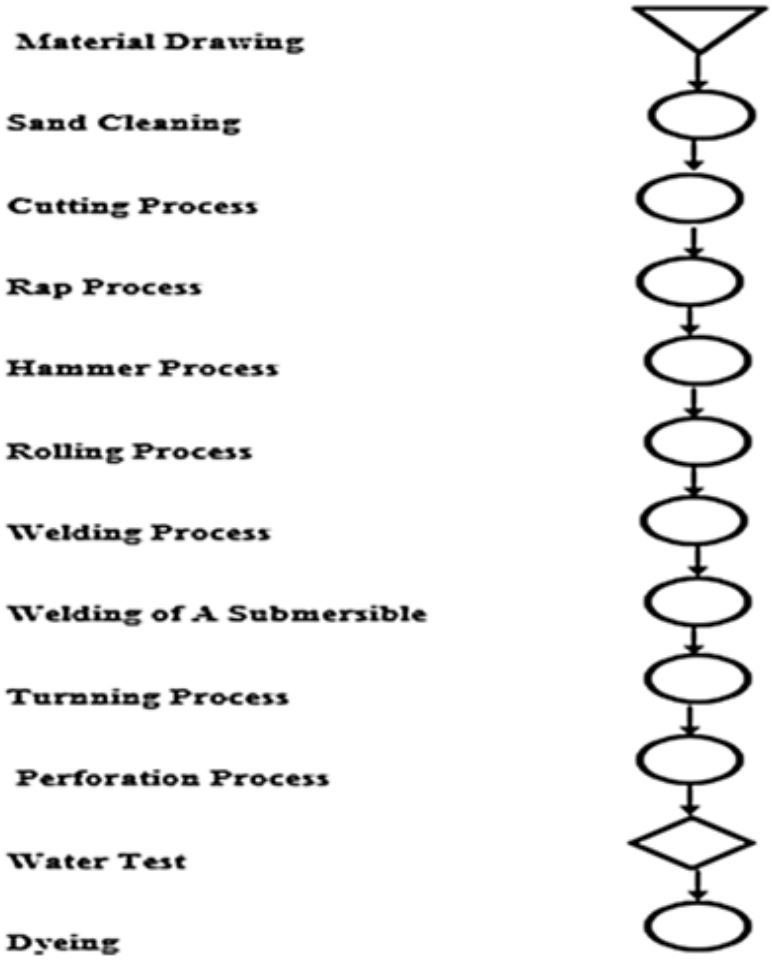

Figure 3: Flow process of filter

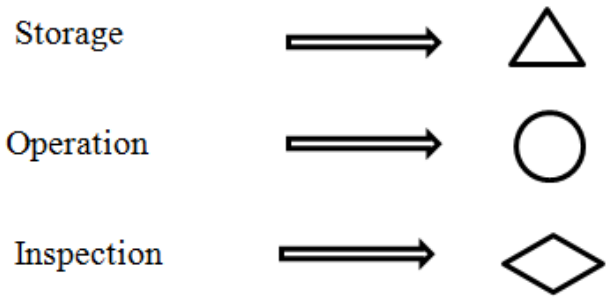

Figure 4: Symbols specification

TABLE I: Activity relationship matrix

	DY	WT	PP	TP	WS	WP	RP	HP	WP	CP	SC	MD
Materials Drawing	U	U	U	U	O	O	O	I	I	I	A	
Sand cleaning	U	U	U	U	O	O	O	I	I	I		
Cutting process	U	U	I	I	E	E	E	A	A			
Wrap process	U	U	I	I	E	E	E	A				
Hammer process	U	U	O	O	E	E	E					
Rolling process	U	I	I	I	A	A						
Welding process	U	O	I	I	A							
Welding of a submersible	U	O	I	I								
Turning process	O	I	A									
Perforation process	O	I										
Water test	E											

TABLE II: Current layout scores

	Total	DY	WT	PP	TP	WS	WP	RP	HP	WP	CP	SC	MD
Materials Drawing	31	0	0	0	0	1	1	1	4	4	4	16	
Sand cleaning	15	0	0	0	0	1	1	1	4	4	4		
Cutting process	58	0	0	1	1	8	8	8	16	16			
Wrap process	42	0	0	1	1	8	8	8	16				
Hammer process	26	0	0	1	1	8	8	8					
Rolling process	41	0	1	4	4	16	16						
Welding process	25	0	1	4	4	16							
Welding of a submersible	9	0	1	4	4								
Turning process	21	1	4	16									
Perforation process	5	1	4										
Water test	8	8											
Total	281												

iv. *Proposed layout*

As shown in Figure 5, an alternative design has been proposed based on manufacturing processes relations, machines utilization and work flow.

In the proposed layout, two additional stations are added; these are a waste store and a waiting station. The purpose of adding the waste store is to collect excess waste from the parts in the production stages as soon as possible, so it is suggested to be inside the factory for increasing transportation speed. Adding the waiting station due to not impede the movement of workers and the transport tools used inside the factory, where the finished parts are placed in a waiting station to complete the manufacturing process smoothly and for easy arrangement. The proposed is to rearrange the relationship between the sections of the workshop and to apply the scores that were suggested; this proposal achieved 341 scores as shown in the Table III.

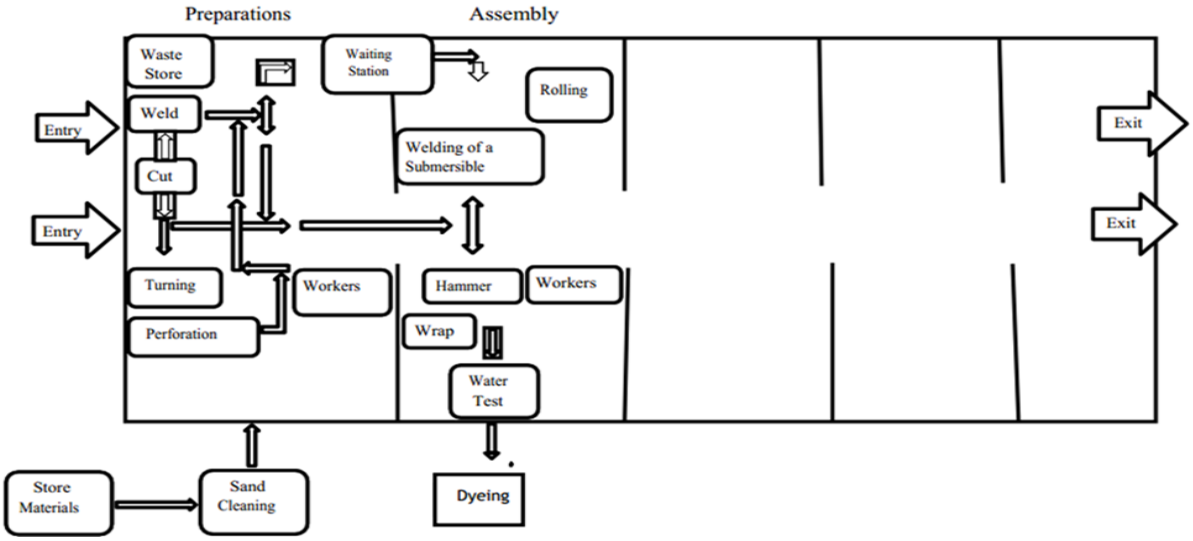

Figure 5: Proposed layout

TABLE III: Proposed layout scores

	Total	DY	WT	PP	TP	WS	WP	RP	HP	WP	CP	SC	MD
Materials Drawing	34	8	0	4	4	0	1	0	0	0	1	16	
Sand cleaning	18	8	0	4	4	0	1	0	0	0	1		
Cutting process	68	0	4	16	16	4	16	4	4	4			
Wrap process	64	4	16	4	4	8	4	8	16				
Hammer process	48	4	16	4	4	8	4	8					
Rolling process	37	1	8	4	4	16	4						
Welding process	24	0	4	8	8	4							
Welding of a submersible	16	0	8	4	4								
Turning process	20	0	4	16									
Perforation process	4	0	4										
Water test	8	8											
Total	341												

V. Proposed Layout Evaluation

After analyzing present layout and the suggested layout, it is found that the proposed layout got higher score and this means that it is better than the current state through which will reduce the time of handling and movement between departments. Increasing the score means that the proposed layout is better than the current layout, by relying on the applied mechanism, which is an evaluation of the relation-ship between each of the two parts through the degree of their closeness to each other. In the proposed layout, the waste distances during the movement between the departments within the factory are reduced, so reducing the distance is a time gain. This increases the safety for the present layout of the workshop, offers flexibility, increases material and workers flow, besides utilizes space efficiently as presented in able IV.

TABLE IV: Comparison of the current layout with proposed alternative

Facility layout	Current layout	Proposed layout
Scores Evaluation	281	341

5. CONCLUSIONS

In this paper a real world problem is considered aiming to redesign the current layout of filter manufacturing work shop in AL-Faris state company. The current layout suffers from long transportation which causes extra manufacturing time. For improving performance and productivity in this workshop, SLP is used for improving the current layout. The main objective of the study is determining the current bottlenecks in the existing layout of the company to develop a better layout and minimize the total distance travelled. The main problem identified is the long distance travelled caused by poor facility planning in the company. Throughout many observation and discussion with the experts of the company, it is found that there are bottlenecks between the departments and random in the organization of machine sites in the production line. Therefore, SLP is adopted and a new layout for the production line followed is suggested and compared with the current layout. Analyzing by using systematic layout planning technique showed that the results for the proposed layout got 341score; while the current layout got only 281 score based on the manufacturing and facility relations. This result means that the proposed layout is better than the current layout. Reorganization of the water filter production lines has a significant role in increasing productivity and reducing the waste distances, consequently using SLP for new plant layout suggestion may significantly decreases the distance of material flow from raw material storage to packing department. For future work another product and other layout rearrangement could be compared with the current state layout. Optimization techniques could be adopted too for the best solution.

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