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DEVELOPMENT OF AN IMPROVED INSTITUTION AUTOMOBILE SERVICE DELIVERY BASED ON INTEGRATED EQUIPMENT LAYOUT

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ABSTRACT

Effective Automobile layout is of paramount importance for setting up workshop facilities and equipment in attaining minimum turnaround time. It also brings about increment in productivity and profitability. The Federal polytechnic Ado-Ekiti Automobile workshop does not meet with the standard workshop layout; this implies the need to develop an improved integrated workshop layout. In achieving the improved layout, standard workshop within the country were visited (most especially Akure and Ado-Ekiti), literatures were consulted and questionnaires were administer and considered. A new layout model was developed in accordance with standard workshop which will give room for effective automobile service delivery. The management needs to invest more in the procurement of up to date machines and equipment, employment of more man power with different specializations regarding automobile services and implement the application of the developed layout model.

Keyword: Automobile, Effective, Layout, Profitability, Service and Workshop

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1. INTRODUCTION

Layout is the arrangement of departments and equipment in a plant to efficiently produce a product. Although a company should always consider facility layout to be top priority when the company first start its business or when it is moving to a new location, a new facility layout may sometimes be needed when a company decides to purchase new machinery or to develop a new product. A poorly designed layout could result in bottlenecks, increased overall production time per unit, increased transportation costs, increased number of accidents and decreased inventory space (Sherali *et. al.,* 2003; Ram and Prashant, 2012). Automobile workshop layout can be defined as follows: it is the arrangement of automobile workshop equipment such as crane, pit, etc. to allow free flow of both personnel and vehicle/tools in the workshop (Ejiko *et. al.,* 2009). It may be defined as a technique of locating machines, processes and plant services within the workshop so as to achieve the right quantity and quality of output at the lowest possible cost of manufacturing. It involves a judicious arrangement of production facilities for effective workflow.

Plant layout refers to the arrangement of physical facilities such as machinery, equipment and furniture. within the factory building in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of material to the shipment of the finished product **(**Tompkins, 1980; Abdullah and Lash, 2014).

Equipment layout optimization is a foundational question of floor improvement activities, its rationality affects directly the field of production capacity, work efficiency and production cost (Tompkins *et. al.,* 1996). Tompkins *et. al.,* (2010) pointed out that operation cost of unreasonable equipment layout account for 20 - 50% of the total manufacturing costs, and superior equipment layout can reduce the cost by 10 - 30%; Superior equipment layout can also speed up the materials handling efficiency, reduce the residence time of articles being processed, reduce the capacity of work piece buffer, reduce the occupied space of manufacturing system and reduce the manufacturing cost.

According to Riggs, (2014), "The overall objective of layout is to design a physical arrangement that most economically meets the required output - quantity and quality". Ram and Prashant (2012) stated that layout ideally involves allocation of space and arrangement of equipment in such a manner that overall operating costs are minimized. Maheer et al., (2015) stated that an ideal layout should provide the optimum relationship among output, floor area and manufacturing process. Layout facilitates the production process, minimizes material handling, time and cost, and allows flexibility of operations, easy production flow, makes economic use of the building, promotes effective utilization of manpower, provides employee's convenience, safety, comfort at work, maximum exposure to natural light and ventilation (Wiyaratn and Watanapa, 2010). This is also important because it affects the flow of material and processes, labour efficiency, supervision and control, use of space and expansion possibilities.

In modern days, the initial planning of a facility layout requires substantial investments. It involves long term commitment into planning the types of products to produce, the number of departments, the constraints of the company size and possibility of future expansion (Saif *et al.,* 2002). The decisions made during the planning could make a large impact on the operations. An optimized facility layout not only improves production

efficiency, but it also provides a safer environment for the workers. For examples, a shortened walking time between departments could reduce accidents, allow easier communication and even allow forklifts to travel less. Moreover, a better layout could help the company comply to changes in environmental and legal regulations. For example, realigning the production streamline could reduce the need of production transfer across departments and reduce emission of CO_2, also, different types of productions would have different types of layout. In general there are different types of layouts: process layout, product layout, and fixed position layout. These layouts all have their advantages and disadvantages. This report discusses how facilities decide on which layout to use and also analyze other integrated layouts. As mentioned before, planning a layout is a long term process. However, improved software technology has allowed companies to forecast outcomes of various possibilities and shorten the planning process. These software models allow users to simulate real time scenarios to better see the effect of the layout. Automobile can be described as a road vehicle, typically with four wheels, powered by an internal combustion engine or electric motor and able to carry a small number of people. A developed automobile workshop is required to have good floor space, ventilation, advanced technological equipment, proper lighting etc. The under study automobile workshop lacks properly arrangement of equipment, Roof leakages, pit too deep, water coming out from the pit, improper flow in and out of vehicles etc. which now calls for development of an improved integrated layout for effective service delivery.

The reason for developing improved equipment integrated layout for effective automobile service delivery is to meet new technological standard with improved automobile equipment and improve the service offered to customers. In this work an improved equipment integrated layout for effective automobile service delivery in the Federal Polytechnic Ado-Ekiti was developed. The specific objectives of this project work are to make general overview of the federal polytechnic Ado automobile workshop, develop questionnaire and administer, collect and analyze data obtained from questionnaire understudy, design an improved workshop layout for effective service delivery based on ii, and make recommendation for practical application of the findings in iii. It also seeks in the long run to correct defects in some existing motor vehicle repair workshop, proper and efficient utilization of available floor space and allow high machine or equipment in the workshop.

2. LITERATURE REVIEW

The present layout and the operation process of each section have been investigated. The problem in term of material flow of each operation section was identified. The result showed that disassembly surface finishing and inspection sections should be allocated to make the good material flow. The suitable of new plant layout can decrease the distance of material flow, which rises production (Anucha, *et. al.,* 2011). Saifallah and Mehdi (1997) present a formulation of plant layout problem where the objective is to minimize work-in-process by designing layout using a queuing-based model can be very different from those obtained using conventional layout procedures. Amine and Henri (2007) proposed various formations of the facility layout problem and the alogrithms for solving this problem as it known to have a significant impact upon manufacturing costs, work in process, lead times and productivity. A good placement of facilities contributes to the overall efficiency of

operations and can reduce until 50% the total operating expenses (Tompkins *et. al.*, 1996). Simulation studies are often used to measure the benefits and performance of given layout. Stefan and Kai, (2007) proposed an integrated approach which allows a more detailed layout planning by simultaneously determining machine arrangement and transportation paths. Facilities to be arranged as well as the entire layout may have irregular shapes and sizes. By assigning specific attributes to certain layout subareas, application-dependent barriers within the layout and making mathematical calculations new layout design made to improve transportation path.

In order to obtain a competitive level of productivity in a manufacturing system, efficient machine or department arrangements and appropriate transportation path structures are of considerable importance. By defining a production system's basic structure and material flows, the layout determines its operational performance over the long term. By design plant layout structures, gives integrated approach which allows a more detailed layout planning by simultaneously determining machine arrangement and transportation paths, this approach supports a detailed mapping of irregular, but fixed machine shapes. Laura *et. al.*, (2010) study the stability of a Virtual Layout (VL) along with an existing functional layout (FL) of an industry and a Classical Layout (CL), if considered for implementation. A Genetic Algorithm (GA) based on intra-cell formation procedure and cellular layout design.

Taho, (2007) explores the use of multiple-attribute decision making methods MADM approach in solving a layout design problem. The proposed methodology is illustrated through a practical application from an IC packaging company. Two methods are proposed in solving the case study problem: Techniques for order preference by similarity to ideal solution (TOPSIS) and fuzzy TOPSIS. Empirical results showed that the proposed methods are viable approaches in solving a layout design problem. TOPSIS is a viable approach for the case study problem and is suitable for precise value performance ratings.
The proposed model will enable the decision maker of a manufacturing enterprise to analyze a layout in three different aspects, based on which they can make decision towards productivity improvement. As with any other layout, the workshop area depends entirely on the work anticipated and in the case of an exciting service station, the work already being done, the volume and type of work to be done in the repairs workshop determines whether the layout should be Single-Speed Bay, Flow Line, Single- Speed Bay Service Layout or Flow Line Service Layout.

2.1 HISTORICAL BACKGROUND

Automobile workshop and its machinery are involved with the task of servicing and carrying out repair on vehicles. Workshop are set out to serve this purpose, and over the years, as technology have been on the high rise, so also has workshops evolved to meet the latest trend in vehicle technology. Technology has been on the high rise, an improved equipment integrated layout is very essential for free flow of vehicles and equipment's in the workshop. The smallest unit of the workshop can be seen in the individual garages in our homes. This is closely followed by the smaller roadside mechanics, whose scope of business is limited on-the-job experience. Modern motor vehicle maintenance workshops, both small and large are virtually capable of solving most vehicle problems, since they were designed for the just that purpose.

2.2 WORKSHOP LAYOUT

The layout of any workshop will depend upon the work anticipated. Smaller workshops usually have a bench at the closed end of a workshop with one pit to enable work to be carried out underneath a car. In this modern workshop, it demands sophisticated equipment to both rapidly diagnose faults as a means of quality control following repair. Firstly, to ensure a profitable workshop, floor space must be used to the utmost, thus all spaces offices, bays and other equipment must be such that at no time should they due to the design obstruct the movement of materials, cars and staff, so that time is fully utilized. The need to keep cars moving as repairs and servicing is completed is obvious. Apart from this, customers usually requires a car as quickly as possible as a car off the road means loss earning to them. A modern workshop, area with painted lines on a slope of 60^{o} makes it easier to run in and back out. Bench with steel tops and bench vices constitute the basic equipment for repair work. Repair jobs requiring use of a life will move into the work area where lifts are part of standard equipment in the repair bays. At this point it should be noted that wheel free lifts are to be preferred and pits are to be avoided. The reason is that many serious accidents have occurred with the pits when fumes have accumulated and caused serious poisoning. Other accident have occurred when petrol have spilled into the pits and have gone unnoticed until a naked flame eventually ignited the vapor with terrible results for mechanics working underneath vehicles. This leads to the aspect of why the body repair shop and spraying should be excluded from the main workshop. The operations involved with body repair i.e. panel beating, filling, grinding, and washing raises dust that can be harmful to fellow mechanics should it be done in an enclosed space like the workshop; besides this, there is also the danger of sparks welding operation igniting fuel vapor. For this reason, it is advisable that these operations be done in the courtyard with a provision of roofing to protect the workers from harsh weather conditions.

2.3 REPAIR BAYS

Repair bay must be so situated or arranged inside the workshop such that the job it is meant for is carried out without difficulties to the mechanics and also to ease supervision by the foreman. The workshop should be broadly divided into the mechanical and electrical sections for easy supervision and repair. This should be so, such that vehicles for each of these problems can be easily directed to the bay for work. The engine room should be close to the repair bay so that engines can be easily removed and taken there to work on. On the other hand, the battery charging room should be close to the electrical repair bay. Another important aspect of the workshop is the quick service bay, where routine servicing can be carried out. This should be situated on the court of the shop. Only vehicle with major repairs should be allowed into the interior of the shop. The repair bay required the provision of power plugs with 13Amp and 15Amp fuse, an airline connection, an inter-communications connection of the bench for speaking direct to the stores for spare parts. This later item enables a mechanic to order parts and have them brought to him without moving from the car. This speeds up a repair job and save the mechanic valuable time. Low powered 24 sockets are also required for pressurized safety inspection lamps. Alternatively, a bare head wire system with movable leads can be used as an inspection lighting method.

The bench is of steel with good size drawer capable of holding tools belonging to a mechanic. It should also have a second under space to hold units while repair are going on; for example gearbox housing or cylinder blocks. This helps in preventing accidents from tools and units that are left lying about. All general tools and equipment that is necessary for all repair bays should be kept in a centralized area so that a mechanic can use them and replace them immediately after use. These include portable cranes, hydraulic stands, wheel braces, special extractors, stock, dies, amongst others. Finally, a good workshop should have good lighting, ventilation, drainage system, easy access to special tools, plug points, inspection lamp point, intercommunication system to stores, airline point, ample working space, a cloak room for workers to change their cloths before and after work and above all, sufficient safety devices should be provided and kept at easily accessible places.

2.4 DIAGNOSTIC CENTRES

This is a center where faults are diagnosed and also used to check work done on a car as a means of quality control in the workshop; this latter aspect is often referred to as Pre-Delivery Inspection (PDI). Diagnosis is made by performing inspection to discover what parts of a vehicle will require adjustment or repair. This is necessary in obtaining customers goodwill. The usage of diagnosis equipment serves as a means of quality control, such that any repairs executed are tested to ensure that the finished job is satisfy and operation is within certain limits.

2.5 EQUIPMENT SELECTION

The equipment for any type of workshop (large or small) depends on the capita at hand, workshop size and the amount of work expected. No workshop can be efficiently managed without suitable tools and equipment. Therefore, the owner (The Federal Polytechnic Ado-Ekiti) has to decide on which equipment is necessary as an aid to efficiently and profitability in a workshop. Amongst the numerous equipment available, the following are very essential, which are Lifting jacks of various sizes, Portable cranes for lifting engines, Engine stands for suspension of engine, Oxygen, acetylene and metallic welding equipment, Gas soldering iron with bits, Soldering iron electrical repairs, Air compressor, Tyre pressure gauge, Tyre servicing and repair equipment, Brake servicing equipment, Bench vices, Portable grinding machines, Electrical testing equipment for starter, dynamo, local lamps, circuits and ignition timing, Wheel alignment gauges, Hand drilling machines, Bench drilling machines, Shock absorber extractor machines, Battery charging machine, Hydraulic puller, Electrical computation system unit (Diagnostic equipment) and Fire extinguishers for various grades (classes) of fire.

2.6 VEHICLE RECOVERY EQUIPMENT

One way of generating profit for the workshop is by providing a vehicle breakdown recovery equipment to assist in extending services to a customer with a problem on the highway. This is essential as vehicles do often breakdown on the road and have to be moved as quickly as possible so that obstructions on the road is reduced to a minimum either by towing or by prompt attention on the spot. Consequently, mechanics going out for a recovery of vehicle must be fully experienced and be able to use all the recovery equipment, and be

prepared to pull a vehicle of ditches, tow wrecked vehicles and complete a host of repairs to get the vehicles back to the workshop.

A recovery should be equipped with the following Winch, Crane, Slings, Shackles, Towing bar, Fire extinguishers, Sledge hammer, Ropes, Jack (of good capacity), Locking clamps for steering wheel (when a car is towed backwards), Flashing beacon to indicate a breakdown, A suitable "ON TOW" notice board for attaching to the vehicle, A spare holder for attaching to the breakdown vehicle for rear illumination and normal mechanic tool kit.

3. RESEARCH METHODOLOGY

The methods and procedures used in the conduct of this study. The objectives of this work were achieved by observing the federal polytechnic Ado-Ekiti automobile workshop and comparing it with standard workshop from literature and established ones within the country. Questionnaire was design, produce and administer to the populace for their contributions and assessment. The information gathered from the questionnaire coupled with the literature survey lead to the design of an improved workshop layout. the presentation and analysis of the data (findings) of this study. The analysis so made would also be discussed.

OBSERVATIONS

In the course of getting information from available standard set-up automobile companies within the suburb of Ado Ekiti and Akure, It was observed that few companies were willing to give out needed information, and the few companies that responded to the questionnaire were carried out by their bosses. These challenges created limitation in getting enough variety of devise view from workers or administrative officials. With this development the information gotten is what the result and discussion is based on. Information was collected from Automobile companies such as Autoprobe service limited, Laffbart innovation ltd and Loco Automechanic, located in Akure, Ondo State why some data were collected by visual inspection from other automobile outlets. The data collected bothered on company performance and not individual work performances. Also, the information gathered under the length of service signifies that 70% of the respondents have been established or been with the company from five years and above, while 30% shows that they have been established or been with the company for four years and below.

4. PRESENTATION OF RESULTS

In the presentation of result, there are 12 questions for respondents to answer, some of it are: response on company type of work/service carried out, type of vehicle worked on, workshop space, number of workers, available machine, machines working condition and location of the workshop.

4.1 CONCISE INTERPRETATION OF RAW DATA

Several tables were presented indicating the responses to the questions in Table 1, 2, and 3, to establish were modification are required. Table 1 shows that the highest percentage is servicing and maintenance with 28% compare to other types of services of 22% for body repairs and diagnosis. Table 2 shows that the highest percentage of vehicle worked on are Medium/light vehicle (SUV's, Van, Sedan etc.) which amounted for 56%, this implies that more services are required of the light and medium category of vehicles. Findings on the workshop floor area in Table 3 show that 80% of the respondents believe that the space is sufficient compare to 20% that disagree, which implies the area was manageable. Table 4, shows that the 70% of workers working in the workshop are of age 11-20 while 20% are less than 10 years and 10% amounting to over 20 years of age. This implies that most youth majorly teenager are plying the job, a motivational program and scheme will be required to build their skills in auto mechanics early in life. Table 5 shows that all the respondents believe that there is enough floor space for storage, the implication is that extra space will not be required during modification. Table 6, shows the analysis of access road to the workshop from outside, the findings implies there were no indirect route. The indirect route is important when there are cases of emergency. Table 7 shows that the numbers of machines in the workshop were sufficient and in case of less performance enlightenment on the machine application will be required for greater efficiency. Table 8 shows that the condition of machines available in the workshop was excellent which may not likely be the true state. Based on Table 9 the available tools in the workshop are sufficient. Table 10 reveal the evaluation of the jobs carried out per day in the workshop is good which can still be improved upon by modernizing and proper integration of the facilities. Table 11 shows that most of the work were carried out outside the workshop floor this either limits the workshop floor or implies the layout is not properly established. Based on the Table 12 shows that toyota brand of vehicle has the highest percentage of vehicle work upon, therefore piority should be given to training in the work men on Toyota vehicle repairs skill. Based on the analysis carried out on Table 13 using Relative Important Index (RII), it was observed that the highest rank is Work bench, Compressor pump, Store room, fire extinguisher, engine crain, floor jack and jack stands, rest room, offices, first aid kits, OBD scanner, laptop computer, battery charging machine engine diagnostic equipment's with 8.5 ranked value followed by hydraulic lift, grease pump tool box trolley, dust removal system, stand smoke detectors followed by transmission stand followed by wheel balancer (digital) and wheel alignment.

TABLE 1: TABLE ANALYSIS ACCORDING TO TYPE OF VEHICLE REPAIRS/SERVICES CARRIED OUT.

Types of Services	Frequency	Percentage (%)
Body repairs	8	22
Servicing	10	28
Maintenance	10	28
Diagnosis	8	22

TABLE 2: TYPE OF VEHICLE WORKED ON

Type of Vehicle Worked On	Frequency	Percentage (%)
Heavy duty vehicle (truck, articulated vehicle and lorry)	8	44
Medium/light vehicle (SUV's, van sedan etc.)	10	56

TABLE 3: WORKSHOP FLOOR SPACE

Workshop floor area space	Frequency	Percentage (%)
Enough	8	80
Manageable	2	20
Total	10	100

TABLE 4: NUMBER OF WORKERS/PEOPLE IN THE WORKSHOP

Number of Workers	Frequency	Percentage (%)
1-10	2	20
11-20	7	70
21-30	1	10
Total	10	100

TABLE 5: FLOOR SPACE FOR STORAGE

Is there floor space for storage	Frequency	Percentage (%)
Yes	10	100
No	0	0

TABLE 6: ACCESS TO THE WORKSHOP FROM THE OUTSIDE

Response	Frequency	Percentage (%)
Direct	10	100
Indirect	0	0

TABLE 7: NUMBER OF MACHINES IN THE WORKSHOP

Response	Frequency	Percentage (%)
Enough	10	100
Average	0	0
Fair	0	0

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TABLE 8: CONDITION OF MACHINES AVAILABLE IN THE WORKSHOP

Response	Frequency	Percentage (%)
Excellent	8	80
Good	2	20
Fair	0	0
Poor	0	0

TABLE 9: TOOLS AVAILABLE IN THE WORKSHOP

Response	Frequency	Percentage (%)
Enough	10	100
Average	0	0
Fair	0	0

TABLE 10: EVALUATION OF NUMBER OF JOBS CARRIED OUT PER DAY IN THE WORKSHOP

Response	Frequency	Percentage (%)
Excellent	2	20
Good	7	70
Fair	1	10
Poor	0	0

Table 11: WORK CARRIED OUT OUTSIDE THE WORKSHOP FLOOR

Response	Frequency	Percentage (%)
Yes	10	100
No	0	0

TABLE 12: VEHICLE BRANDS WORKED ON

Response	Frequency	Percentage (%)
Honda	6	15
Mercedes	5	12.5
Toyota	12	30
Peugeot	5	12.5
Lexus	2	5
All vehicle makers	10	25

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TABLE 13: AVAILABLE WORKSHOP EQUIPMENT/FACILITIES

Equipment/Facilities	Response				
	Yes	No	MEAN	RII	RANK
Hydraulic Lift	9	1	9.5	0.95	7
Work bench	10	0	10	1	8.5
Dust removal system	7	3	8.5	0.85	4.5
Compressor pump	10	0	10	1	8.5
Store room	10	0	10	1	8.5
fire extinguisher	10	0	10	1	8.5
stand smoke detectors	7	3	8.5	0.85	4.5
Transmission stand	6	4	8	0.8	3
Engine Crain	10	0	10	1	8.5
Floor jack and jack stands	10	0	10	1	8.5
Rest room	10	0	10	1	8.5
Offices	10	0	10	1	8.5
first aid kits	10	0	10	1	8.5
OBD scanner	10	0	10	1	8.5
Laptop computer	10	0	10	1	8.5
Wheel balancer (digital)	4	6	7	0.7	1.5
Wheel alignment	4	6	7	0.7	1.5
Grease pump tool box trolley	8	2	9	0.9	6
Battery charging machine engine diagnostic equipment's	10	0	10	1	8.5

Source: Field

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CURRENT AUTOMOBILE WORKSHOPOF THE POLYTECHNIC

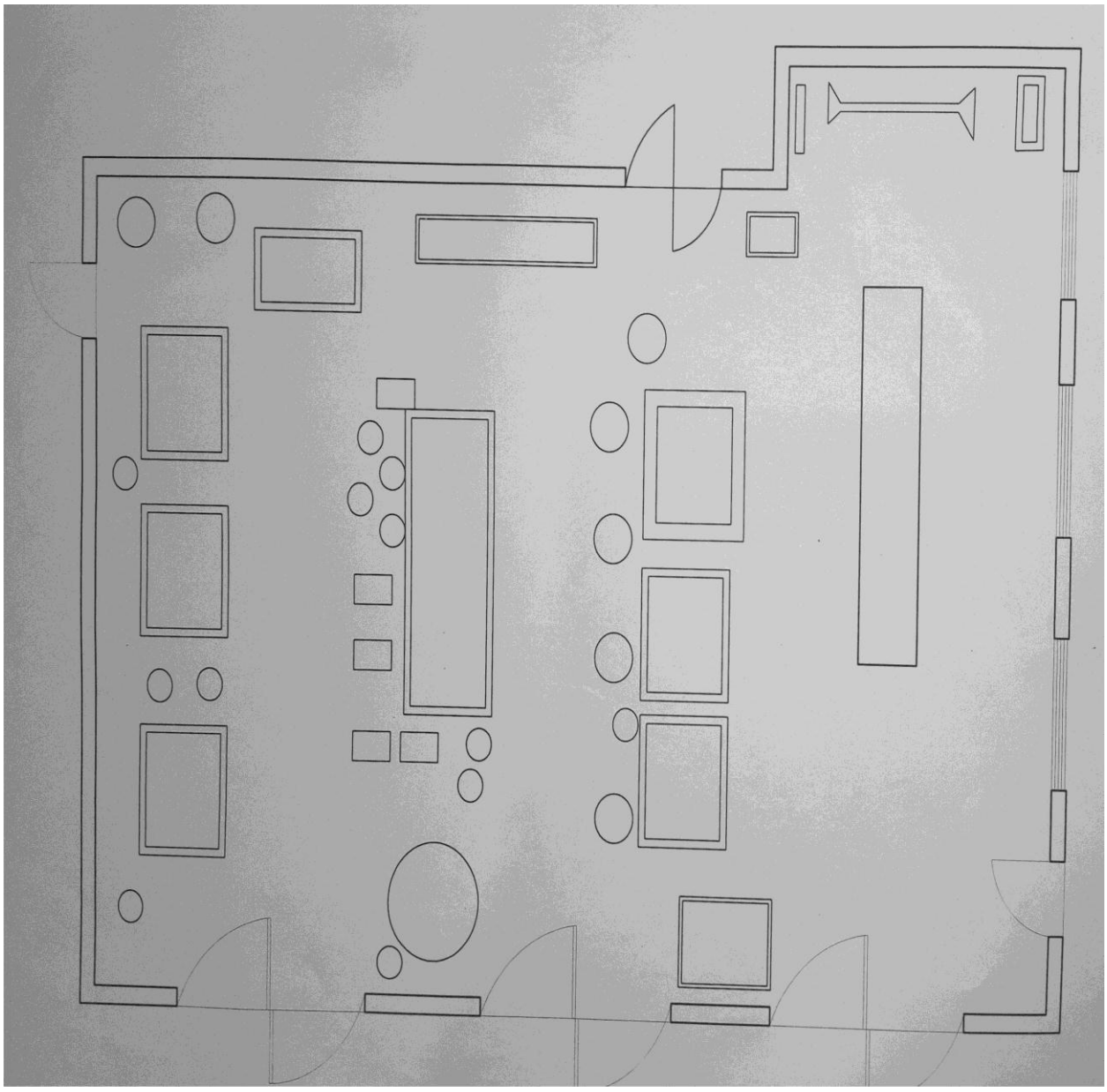

Fig. 1: Plan view of the existing workshop layout

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Plate 1: Capture of personnel and equipment in the current auto-workshop

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NEW PROPOSED AUTOMOBILE WORKSHOP PLAN FOR THE POLYTECHNIC

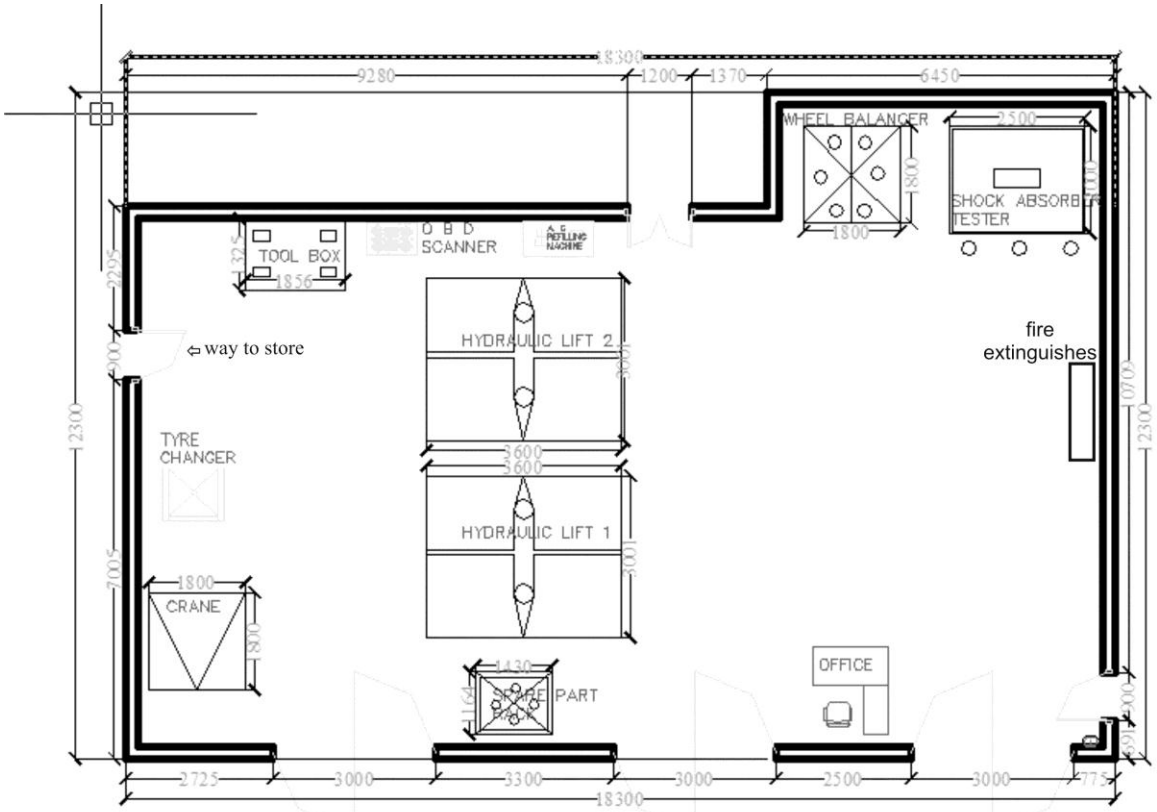

Fig. 2: The Proposed Automobile Workshop Layout

PROPOSED MODEL LAYOUT

The limitation experience in Fig 1 and Plate 1 shows an high restriction to movement of vehicles. The arrangement of the pit and route for passage implies that only a vehicle can be worked upon on the work floor at a time. The extra services done outside the wok floor area will come to an hold during the rainy and sun shine period. The work shop layout capture in Fig. 2 and 3 will give room for vehicle to work on in two routes, thereby allowing 4 vehicles to be worked upon at the same time that is two per route. The passage to the third door gives room for the repaired vehicle to be taken out been hinder by the vehicles being repaired behind. The vehicles behind when repairs are completed will easily be evacuated. Most facilities are positioned toward the wall to free the passage at the work floor. The equipment in used are expected to be mobile so as to applied them at any given point in time, this will go a long way to minimize the turn around and set up time thereby improving the render service efficiency.

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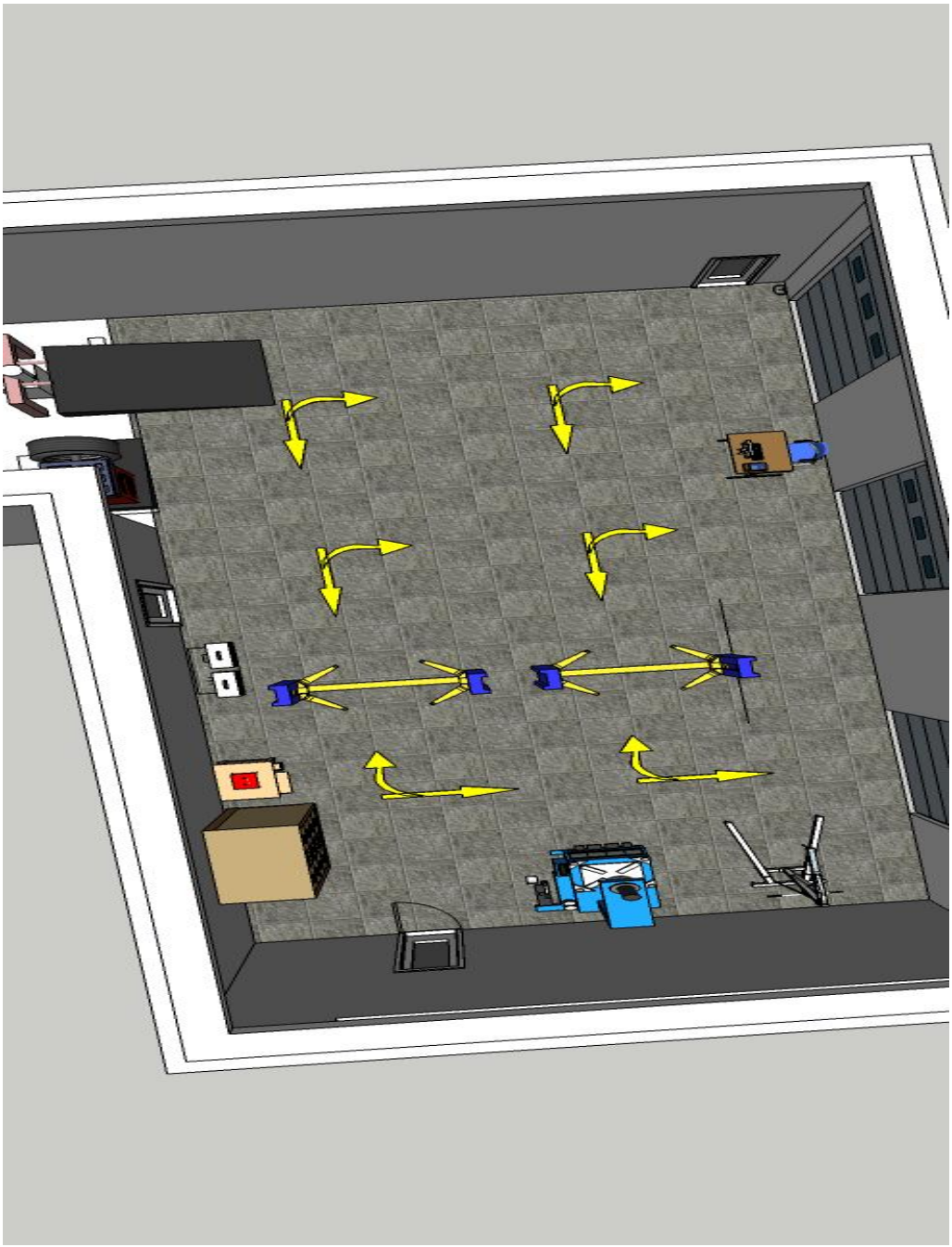

Fig 3: New Proposed Automobile Workshop Plan for the Polytechnic in 3D View

CONCLUSION

The Federal Polytechnic Ado Ekiti automobile workshop is a solution provider in automobile services and the satisfaction of customers can be maintain and improved through efficient service delivery with the aid of an integrated equipment layout, The automobile workshop needs improvement in workshop layout and man power investments. The Federal Polytechnic Ado Ekiti automobile workshop does not meet with the standard auto mobile workshop set up requirements, though it carries out servicing and maintenance but it lacks sufficient machine/equipment, man power, suitable working conditions and arrangement of machines. Consequently the development of an effective integrated equipment workshop

layout and addition qualitative man power will bring about staff encouragement, increase patronage and improved service delivery.

RECOMMENDATIONS

In order to attain quality an defective service delivery at The Federal Polytechnic Ado Ekiti automobile workshop, the management need to invest more in the procurement of up to date machines and equipment, employment of more man power with different specializations and applied the developed workshop layout model. Though the workshop has some workers, but there is a need to have well-structured personnel with a head of department at each units of service delivery, the available floor space area seems not enough which means its limited to one or two service delivery point at a time. This can be solved by proper utilization of the available space and there is need for proper illumination of the workshop. However, if these recommendations as suggested above can be implemented by the management of The Federal Polytechnic Ado Ekiti, the service delivery of the automobile workshop will be greatly improved.

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