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RESEARCH ARTICLE

IMPROVEMENT OF PRODUCTIVITY AND WORK MEASUREMENT IN A TYPICAL SYRINGE PLANT

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ABSTRACT

In this research work an attempt has been made to improve the productivity by using time and motion study in a syringe plant. First Medical & Sterile Product value stream is facing low productivity and how best they can use their available resources, i.e. Man, material, machinery and money. Every organization tries to achieve best quality production in minimum time. Therefore, optimization of the current production layout and resources using time study is necessary to improve quality and increase productivity of workers in a section of the company in order to stay competitive in the global context. A method study used to design optimized resources utilization is outlined. The stop watch time study technique and man machine chart helped in improving the efficiency of the manufacturing process thus saving a lot of rework cost and valuable time. Work measurement also reduced the number of personnel, delay and fatigue allowances of the workers. The proposedlayout redesign can provide the benefits of higher production output and improved resource utilization since improvement in productivity is competently placed at 23.45%.Based on the financial analysis, the company has a longer break-even period and the internal rate of return of this company is 18.56% indicating the viability of the company.

INTRODUCTION

Productivity is measured by evaluating the amount of items produced with time taken or raw materials utilized in the process of producing a given quantity of an item. It is the life of any economy and the base for standard of living particularly in evolving countries and the success to trade and industryand increase in affluence (1). Industrial development is forcefully believed to be one of the most suitable means of improving standard of living (2). This explains why less developed nations are slow to achieve industrialization with determination and single mindedness. (3) noted that to improve productivity, manufacturing is vital. Therefore, manufacturing is one of the current activitiescontributing to the increase of national income and general growth. Despite the vast cooperate jobs that ignite the manufacturing system into higher position, the significance to ascertain productivity in manufacturing industries as a foundation for its improvement is very important. Productivity describes various measures of the efficiency of production. Often (yet not always), a productivity measure is expressed as the ratio of an aggregate output to a single input or an aggregate input used in a production process, i.e. output per unit of input. Most common example is the (aggregate) labour productivity measure, e.g., such as GDP per worker.

There are many different definitions of productivity (including those that are not defined as ratios of output to input) and the choice among them depends on the purpose of the productivity measurement and/or data availability. The key source of difference between various productivity measures is also usually related (directly or indirectly) to how the outputs and the inputs are aggregated into scalars to obtain such a ratio-type measure of productivity. Productivity is a crucial factor in production performance of firms and nations. Increasing national productivity can raise living standards because more real income improves people's ability to purchase goods and services, enjoy leisure, improve housing and education and contribute to social and environmental programs. Productivity growth is a crucial source of growth in living standards. Productivity growth means more value is added in production and this means more income is available to be distributed. At a firm or industry level, the benefits of productivity growth can be distributed in a number of different ways to the workforce through better wages and conditions; to shareholders and superannuation funds through increased profits and dividend distributions; to customers through lower prices; to the environment through more stringent environmental protection; andto governments through increases in tax payments (which can be used to fund social and environmental programs).

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Productivity growth is important to the firm because it means that it can meet its (perhaps growing) obligations to workers, shareholders, and governments (taxes and regulation), and still remain competitive or even improve its competitiveness in the market place. Adding more inputs will not increase the income earned per unit of input (unless there are increasing returns to scale). In fact, it is likely to mean lower average wages and lower rates of profit. But, when there is productivity growth, even the existing commitment of resources generates more output and income. Income generated per unit of input increases. Additional resources are also attracted into production and can be profitably employed. Productivity is very, very important to the economy, because it's closely correlated with the standard of living. The higher the ratio of human capital to labor, the more output per worker is likely to be produced. The productivity and work study in this research is directed to case study is company involved with production of syringe tubes. The rupture mechanism of the syringe tube would be evaluated by mathematical model development to keep it safe in operation.

LITERATURE REVIEW

Manufacturing is one of the modern sector activities which are contributing to increasing national income (2). This explains why less developed countries pursue the goal of industrialization with determination and single mindedness (4, 3). The greater the productivity of the manufacturing establishments, the greater are the opportunities of producing various products abundantly and cheaply in quantities and at prices which will meet the requirements of consumers (5). There are many agents hindering the productivity of each sectors and they are not contingent from each other (1). Productivity describes various measures of the efficiency of production. A productivity measure is expressed as the ratio of output to inputs used in a production process, i.e. output per unit of input. Productivity is a crucial factor in production performance of firms and nations. Increasing national productivity can raise living standards because more real income improves people's ability to purchase goods and services, enjoy leisure, improve housing and education and contribute to social and environmental programs. Productivity growth also helps businesses to be more profitable.

Some major goals of a developing society, as well as a developed society contingent upon growth of productivity, are: maximum freedom and dignity, full employment, sufficient and equal distribution of income, adequate shelter and food, good health and decent environment, equal opportunity and enjoyable life, democratic structure of society, industry, and community. All of these above mentioned factors contribute to a better quality of life and standard of living which are achieved by the process of industrialization, with the net result of growth in productivity. Commercial administrators, on different view, see manufacturing not only as a tool of effectiveness, but also imply efficiency and achievement of single sectors. For them, productivity will include quality of production, craftsmanship, adherence to quality, absence of difficulty, customer gratification, etc(6).

A Productivity Improvement: The productivity of a definite set of raw materials (effort) remains according to the total of product or services rendered (production) that is manufactured by them. Land and structure equipment, automobiles, workforce (work), expertise are the raw materialsnext to the reach of a producingfirm. Therefore, greater (enhanced) productivity denotes that additional good are manufactured with the equivalentamount of raw material, at the similar amount in relationsto land, resources, facility and machine or work periods. Improve productivity simply denotes that extra items of good are produced by the similar expenditure of assets i.e. at equal or lesser costs in relation to land, materials, machine time and labor (7).

B Measurement of Productivity: Productivity have remaineddistinct as fraction of the output to input. A rise in productionmeans an increaseof the outputso that now it is proportionatelylarger than rise in input. Production might be checked either on atotalfoundation or specific basis. Considering aggregate terms, yield is evaluatedthrough all inputs being use together. It is termedtotal productivity. Individually,yield is measuredasindividual input factor and it is termed partial productivity. Until the current position of the system has been measured, productivity cannot be evaluated. Therefore, productivity measurement is a prior condition for increasing the system output. In a productionsystem, productivity can be determined in form of materials,labour, materials, capital, machines and capital, land and building.

C Work Measurement: Work measurement or time study originated with the scientific of management movement at the turning of the century (9). While the instance of the application of work measurement was recorded in 1760, it was not widely taking into consideration until this century. Its introduction into the manufacturing sector was largely entitled to the publications of (8). The technique was particularly change in the late 1920s when Lowry, (10); brought the phase of rating – adjusting observed times to the observer's concept of what the times would be if they had been performed at a normal pace. Various means such as the SAM (Society for the Advancement of Management) rating films have been developed. They are utilized to train observers to determine rating judgment that are in line with those made by right ratings of the processes. The system of predetermined time – tabulated times for basic motions such as MTM (Method Time Measurements) began appearing in 1930s, but these were not totally used until after the World War II. In the late 1940s, interest was directed to the limits of time study by the research work of William Gomberg. This brought about development steps in using new statistical techniques.

DWork Measurement as a Tool to Improve Productivity: A work measurement system has three components: preferred methods, time values, and reporting. Preferred methods are not always the most efficient or fastest way to do a task. They should enhance safety, quality, and productivity. Safety for the employee and for the product should be considered. Quality is equally important; it has been proven that good performance and good quality go hand in hand. People who are trained in the proper method and follow that method will produce high-quality work and perform at an acceptable performance level. Time values and

reporting should also be considered. The time that a job should take is determined not on the basis of speeding up the motions a worker normally makes but on the normal pace of the average worker, taking into consideration allowances for rest periods, coffee breaks, and fatigue. A reporting system is important to the success of any work measurement method. Supervisors and managers must have access to labor-management information that is both timely and complete. Timely information can be used to manage and shift labor hours to areas where they are needed and to correct problems or at least prevent them from becoming a crisis. Personal computers help to apply work measurement more effectively and more cheaply and provide immediate feedback to the workers, supervisors, and managers. Businesses need data toset targets, assesscapacity, plan output, set budget costs, predict completion times, establish staffing levels, justifying investment and confidently compare performances of people doing similar and different tasks. All these activities help in the process of identifying, making, monitoring and maintaining improvements in productivity.It states that a standard time that a capable worker, at work in a normal rating of speediness, will need to do a specified task (11).

RESEARCH SIGNIFICANCE

In the past, Nigeria Government and manufacturing sector did not pay much attention to productivity measurement. However, presently, the ugly trend is reversed as the government and industries are realizing that productivity measurement is an excellent way to evaluate a nation's ability to provide an improved standard of living. The greater are the productivity of Nigerian manufacturing firms the greater chances for manufacturing the goods profusely and economically in quantities and on prices which every family in the country can meet. Therefore, for economic development work measurement becomes a very important technique for establishing standards of performance which is needed for productivity measurement and effective work force management. This research will be helpfultoward all manufacturing industries particularly in Nigeria, as it stressed the improvement of productivity besides utilizing effective work method. It will aid industrialist of severalmanufacturing sector to createconcepts and answer to difficultiescentered on the paramount way to run productivity improvement in their business in order to attainwanted goals and purposes.In this research, the work measurement technique is used to establish capacity utilization of different machine and worker and assure effective resource utilization in First Medical & Sterile Product, Port Harcourt, Rivers State. .

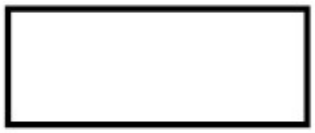
MATERIALS AND METHODS

A Data Collection: For accurate data realization, several visitations to the firm were made to study the production process. The several work centers and sequences of production processes were recorded in consultation with production engineers, workshop supervisors, line supervisors and operatives. Jobs were selected and broken down into elements. The actual work measurement or the timing of the elements was carried out with fly back stop watch and the element times recorded. The stop watch technique was adopted and manufacturing operation are repetitive. The fly back stop watch has two controls for operating the action of the hands. The start action is controlled by a button. Continuous and repetitive timing methods were used in the timing process.

Figure 1. A typical mechanical analogue stopwatch

B Charts for Man and Machine: Both man and machinein a production plantcarry out many operations independently. To measure and analyse thelevel of performance of several operations, activity charts are important.These charts givevalued information regarding equipment utilization and present the lengthy and haphazardly given data into a precise and presentable form. The busy and idle time both for man and machines can be simply found with the aid of these charts. The charts provide a background for work measurement and operational analysis. The notification about busy and the idle periods of man and machine can be utilized for rescheduling in order to make efficient use of resources. An activity chart is a graphical representation of the combined activities of man and machine in a system. These portray the situations where both are working independently or together, and the status when either one or both of them are idle. Independent activity is any activity where work can be done without using machine or a machine can run without interference of man. Loading, unloading and clean-up activities are joint activities of man and machines.

D Symbols Used in Activity Charts: Blank rectangle denote that one of the two i.e. man or machine is idle.



Dark coloured rectangular space depicts position/period of independent activity intended for man/machine is demanding.
Stripped space displays as soon as both man and machine are working collectively i.e. combined activity

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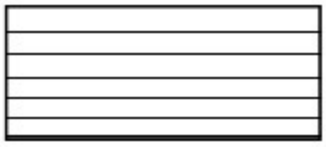


E Standard Time and Allowances

Standard Time: Standard time is the total time in which a job should be completed at standard performance i.e. work content, contingency allowance for delay, unoccupied time and interference allowance, where applicable.

Normal time: Normal time is the time needed to complete an operation by an employee working at 100% efficiency having no delays.

Allowances: An amount of extra time added to the normal time for personal delays, unavoidable delays and fatigue of the operator. An allowance when added to the normal time, it results in standard time. Different Type of allowances provided for workers

Personal Allowance: A personal allowance considers time for a worker to take care of personal needs, such as trips to the rest room and drinking water.

Fatigue Allowance: A fatigue allowance considers the time required to recuperate from fatigue.

Delay Allowance: A delay allowance covers unavoidable, predictable and unpredictable delays for such activities as replenishing materials, rejecting nonstandard parts, making minor equipment repairs, and receiving instructions.

Contingency allowance: A contingency allowance is a small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays, the precise measurement of which is uneconomical because of their infrequent or irregular occurrence.

Relaxation allowance: A relaxation allowance is an addition to the basic time to provide the worker with the opportunity to recover from physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of the allowance will depend on the nature of the job.

Other allowances: Other allowances include process allowance which is to cover when an operator is prevented from continuing with their work, although ready and waiting, by the process or machine requiring further time to complete its part of the job. It is now possible to obtain a complete picture of the standard time for a straight forward manual operation.
For this study various allowances considered are as follows:

- Personal need allowance- 5% of NT
- Basic fatigue allowance- 4% of NT
- Standing allowance- 2% of NT
- Contingency allowance - 2% of NT

Total allowance= 13 % of normal time, NT= Normal time

F: Utilization and Efficiency

Efficiency is the ratio of the actual output produced to the standard output that should have been produced, at a given amount of time with fewer resources.Thus, efficiency percentage is set as:

$$\int = \frac{Qa}{Qb} \quad (1)$$

Where ∫ -- Efficiency Percentage,
Qa --Output from a system
Qb --Resources used to produce output
Similarly, utilization percentage is given as:

$$\varepsilon_{\cdot} = \frac{Ta}{Tb} \quad (2)$$

Where$\varepsilon_{\cdot}$--Utilization efficiency percentage
Ta --Effective time expended through a period
Tb --Total duration of a period

The top of the utilization ratio can be gotten by recording the lapsed time using a watch. The worker may be asked to clock off and on. The actual time expended can only be gotten using measurement,then given the additional consistent results. Consequently, the periodthat ought to have been used by aworker working efficiently could be measured.

Performance Rating: Throughout the time study, careful observation was carried out by the operator. This act seldom followsthe precisedescription of usual way or standard. Consequently, it becomes arequirement to put onmodification to the mean experimental time to reach the period the regularworkerdesired to take to carry out awork when operational atthe average stage. This change is termed Performance Rating. It can be termed to be stated astechniquethat time study engineer equates output performance of worker(s) under the observations of Normal Performance and defines a element or factortermed Rating Factor.

$$Rating\ factor = \frac{observed\ performance}{Normal\ performance} \quad (3)$$

Time Study is found by recording of experimental times for performing a task composed with theevaluation by observer on the speed rate and efficacyfor the operator relative to observer's perception for Standard Rating. The rating conforming to the middlingamount at which capablepersonnel will certainly work, on condition that they followthe statedtechnique and are encouraged to relate themselves to the pattern of their work. When standard evaluation is reliablysustained and the suitable rest is observed, a qualifiedemployee will attain standard or normal performance during the on worktime or shift.

System Description: The processes flow of syringe production are as outlined:

Process 1: Injection molding produces plastic parts. There are two types of plastic parts being molded: barrels and plungers. Every barrel molding machine is designated to a specific barrel size. Barrels of different tips can be produced by changing the mould. The changeover of different tips can typically take up to 2 hours. There is only one type of plunger for each size of syringe, so there is no changeover for the plunger molding machines.

Process 2: The next stage of the process is to print the scale and label on the molded barrels. The molded barrels are first transferred from the molding machines, through air vents into the hoppers. These barrels are then channeled into a Machine for printing.

Process 3: Syringe assembly is performed by a complex assembly machine, which assembles the printed barrel, molded plunger, stopper and needle together into an assembled syringe. The printed barrels are channeled from the printing machine via conveyor, while plungers are transferred from the molding machine via air vent. The stoppers and needles are manually replenished into their respective hoppers. The assembly process starts by attaching the stopper to the plunger. This is followed by having the plunger

sub-assembly push-fit into the barrel. Finally, the needle is attached to the tip of the barrel to complete the assembly. A changeover is required between assemblies with different needle options.

Process 4: The assembled syringes are packed in blisters in primary packaging machines. A blister consists of top and bottom web. The top web is a piece of paper that carries the label and information of the syringe. The bottom web is a nylon pocket that contains the syringe. The process begins by thermal heating of the bottom web to form pockets in the gage. The assembled syringes are then picked and placed into each gage. The gage runs through a computerized vision system to detect any missing parts of the syringes. Finally, the bottom web is sealed with the top web to form blister packs. A changeover is required for different product sizes as well as batch number.

Process 5: The blisters of syringes are transferred out into the secondary packaging machines. They are then packed in cartons and labeled before sending for sterilization and quarantine.

Flow chart symbols and descriptions: All actions can be categorized into five simple types of events and individually is represented using a symbol. The Following are the five typical symbols used in process charting.

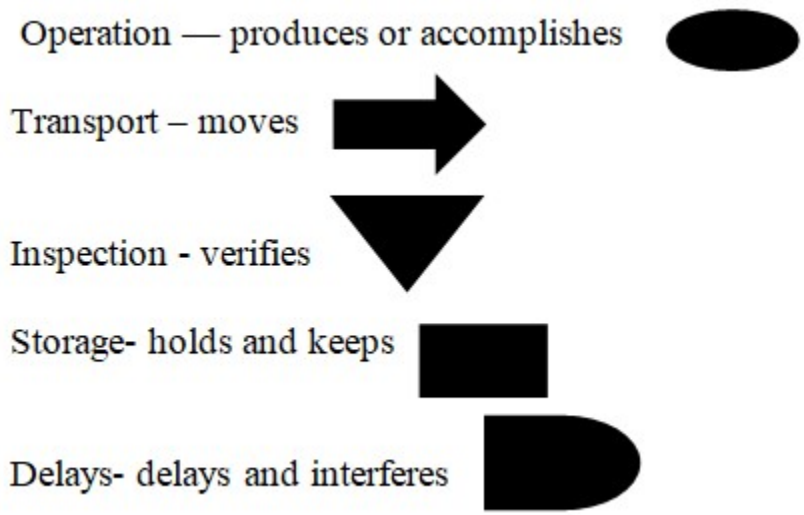


Figure 2. Flow chart symbols

- **An operation** happensonce there is an alteration in the outer or biologicalfeatures of an object or material. Assembling and disassembling, creatingset of actions or hitting away, extra activity are also categorized as operation. Psychologicalevents such as giving or getting information or manipulating, are regarded as operation. Connectionof two mechanisms by welding, position in a ledger, a chemical reaction, pull to pieces of a steam pipe are operations.
- **An inspection**when checking an object for quantity or quality an inspection occurs. Activity such as examination by counting, dimensional check, optical inspection of welded joint, etc are categorized as inspection.
- **Transport occurs**when there is any movement of material by machine or man. This might entail movement of material on a trolley or manually by man.
- **A delay**when the performance of the next action is not carried out immediately.A delay has a symbol. For instance a worker waiting close to machine for a tool to loosen certain machine part and to couple such parts.
- **Storage**happensonce an object is reserved and protected against pull out authorization.

Analysis of Existing Method

Molding Machine:A molding machine was observed to be too far from the assembly which results in unneeded movement of the workers in the production plant and this reduces productivity. According to the specification given by the technical department molding machine should be positioned5metres near the stores where raw materials are kept because of their heavy weight.

Assembly Machine: The barrel/plunger passes through a hot stamping die process for graduation and immediately lubricated by silicon oil only for AD (Auto Disable) syringes. At a set time, the gasket lining releases rubber stopper to the plunger head through a mechanical design press device. The work of operator is to operate the assembly machine at a fixed angle. The target set down by the production department is minimum 64,800 syringe per day for three machine units. The challenges here are that the assembly machine is far from the molding machine (10 meters), thus taking more to time to convey barrel/plunger to the assembly machine.

The flow process chart of the company is as shown in Figure 3.

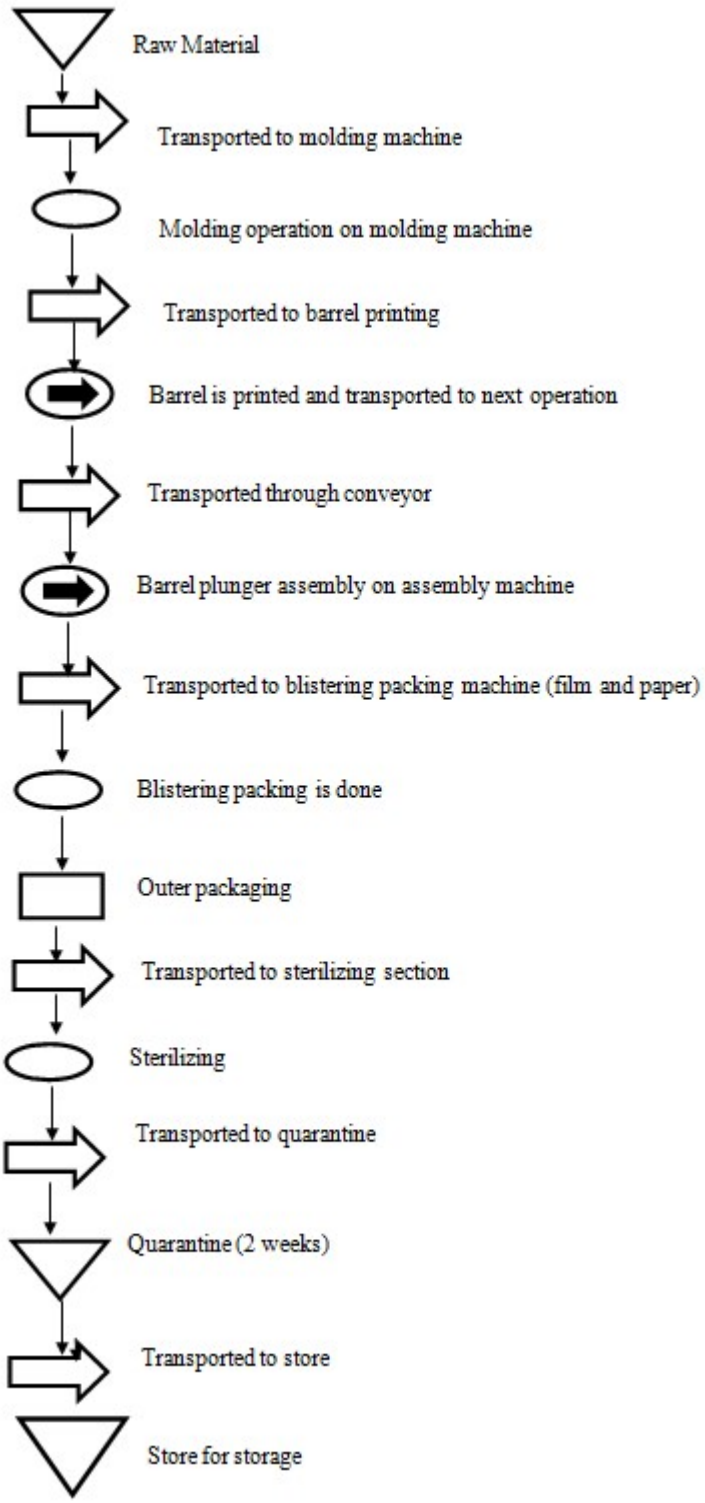


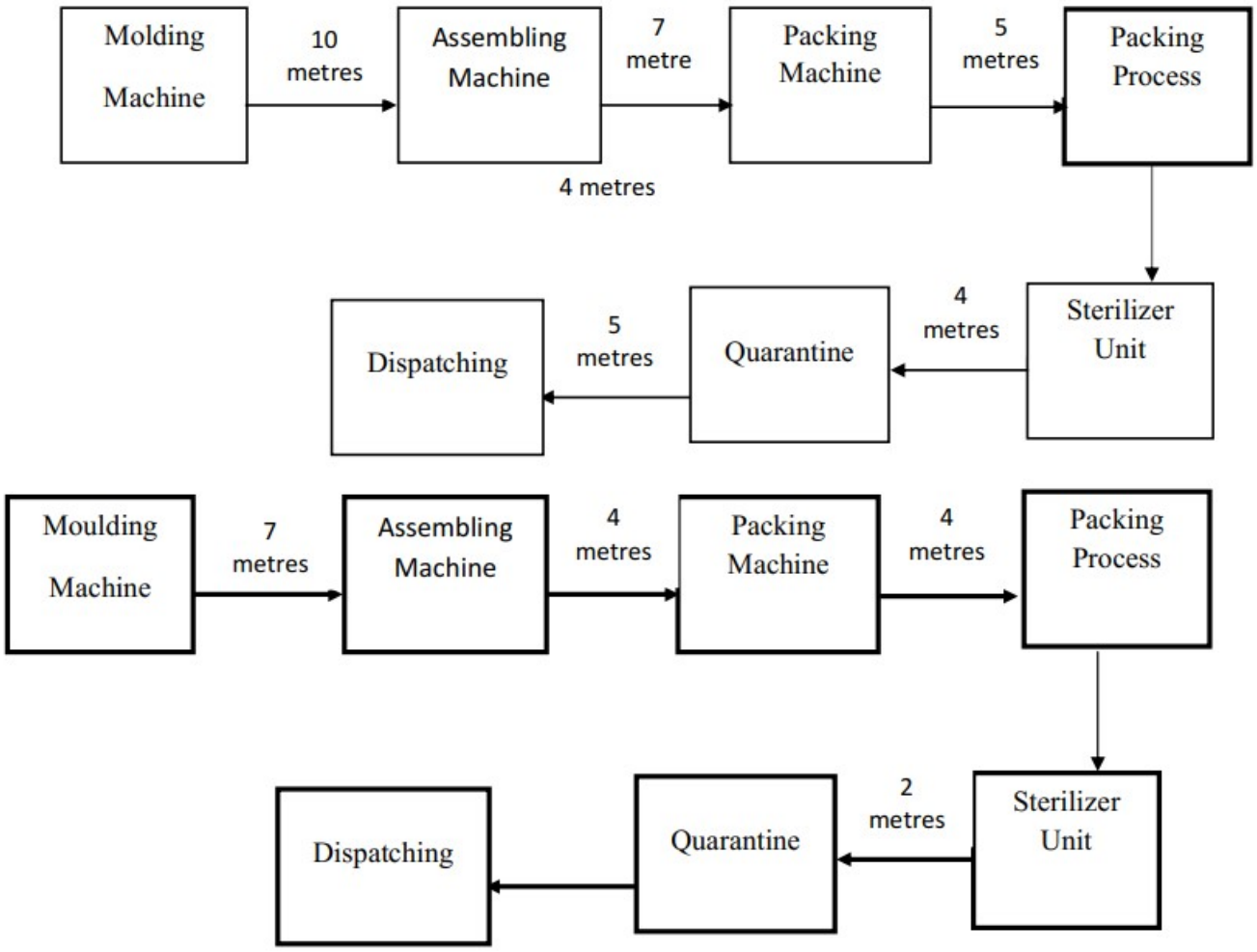
Figure 3. Flow Process Chart of Syringe plant at First Med & Sterile Product.

As analyzed in the existing plant layout the distance between molding machine and assembly is 10 meters which is reduced to 7 meters. The motive behind this is to reduce minimally distance between the stations so as to reduce the unnecessary movement of worker due to too expanse of space between the stations. Some other distance is also modified between other stations which are given below in Table 1.

Table 1. Distance between machine before and after modification

Name of the station of which the distance is calculated	Earlier distance	Distance after modification
Moulding and Assembly Machine	10	7
Assembly and Packing Machine	7	4
Packing Machine and Packing Process	5	4
Packing Process and Sterilising Unit	6	5
Sterilising Unit and Quarantine	4	2
Inspection Section and Dispatch	4	4

The reason for the existing distance is for Line or Product Layoutwhich is very popular in mass production. In this layout only one product or one type of product is produced in an operating area. In order to justify the line layout, the product must be standardised and manufactured in huge quantities. The machines in such layout are arranged in the order in which they are to be used.The operations are performed in a sequence. All parts, sub-assemblies etc. are started at right time so as to be ready at the required time and kept moving until the finished product is available at the end of the assembly line. This arrangement is also known as the "synthetic system" of manufacture.



Experimental Analysis of Proposed Plant Layout

According to the study of the manufacturing process, the details for plant design layout and flow of material from machine centre like molding machine, assembly machine, packing machine,Packing process, sterilizer unit and quarantine section are described in Table 1. After critical assessment of the existing as earlier reviewed, the new plant layout design was created by reducing the distance between molding machine, assembly machine, packing machine, packing process, sterilizer unit and quarantine section are shown in Figure 5. By rearranging the plant layout the following changes are made in slack time, distance moved and material handling cost. Distance moved: It is the distance travelled by the product for processing from one machine to another machine which can be reduced by rearranging the plant layout. So the distance move is reduces in new layout 7m between moulding and assembling machine, 4m between assembly and packing machine, 4m between packing machine and packing process, 5m between packing process and sterilising unit, 2m between sterilizing unit and quarantine and 4m between Inspection section and Dispatch. Slack time: It is the time taken by the product to move from one machine to next machine.

Material handling cost: It is the cost of man and machine which is required to convey the material from one machine to another. The material handling cost is reduced because of reduction in distance travel.

Capacity utilization for different machine and worker is calculated as:

$$\text{Capacity Utilization} = \frac{\text{total working time}}{\text{total cycle time}} \times 100 \qquad (4)$$

Total working time = Total cycle time - idle time (5)

Average normal time gotten from different operators working on different machines for making one piece of complete syringe = 0.016 man - min

Standard time = NT + % allowance of NT (6)

Total number of pieces gotten on all the 3 machines units in one shift

(8 hours) = Total output per machine $= \frac{\text{No of hours used per day}}{\text{Standard time}}$ (7)

The percentage improvement in productivity of machine at (100% capacity) is expressed as:

$$\frac{\text{Proposed Standard output} - \text{Existing Output}}{\text{Existing Output}} \times 100 \quad (8)$$

Financial Evaluation

Financial expectation conditions are as follows

- No variation in plant size.
- Revenue and costs will be uniform in all the years under review.
- Cost of capital is 18 %.
- Being a company located in Export Processing Zone the company is exempted from Company Income Tax.
- Depreciation is at 10% on cost of Plant and machinery.₦ 110,000,000 at full capacity of 90 million syringes per year (3 shifts). Thirty million syringes per shift (30 million per shift) is the stipulated production target.
- The production capacity of the factory is 90 million syringes per annum. It has been difficult to achieve a 3 shift production. What had been feasible is a 2 shift production which translates to 60 million syringes in a year.
- Cost of capital is 18%. This is the negotiated interest of bank funds.
- The company manufactures the following sizes of Syringes:
- 0.5 ml
- 2 ml
- 5 ml
- It has been assumed that 20 million units of each of the three sizes will be manufactured. This will bring the total syringes manufactured in a year to 60 million.

Standard Cost: Standard cost is based on the manufactured output of 1 million syringes. The Standard costs of each of the syringe sizes per 1 million units is shown in Appendices D.Since it is assumed that 20 million units of each size will be manufactured in a year, total cost of production in a year per 20 Million Units is shown in Appendices D.

The current price per syringe of each size is as follows:

- 0.5 ml = ₦ 17.50
- 2 ml = ₦ 17.50
- 5 ml = ₦ 18.50

Investment Appraisal: The investment as appraised to determine if it would provide adequate returns for investors and as well improve the wealth of the shareholders.The investment appraisal methods are as outlined.

Net Present Value: The expression for future value of investment in addition to the accumulated interest after n time periods is given as:

$$FV = PV(1 + r)^{n} \quad (9)$$

Internal Rate of Return: The exact Discounting Factor rate of return that would yield Net Present Value (NPV) of zero expression in Equation 10 is applied.

$$\text{Rate of return} = A + \left[\frac{P}{P+N} \times (B - A)\right]\% \quad (10)$$

Where,

A = 18%
B = 20%

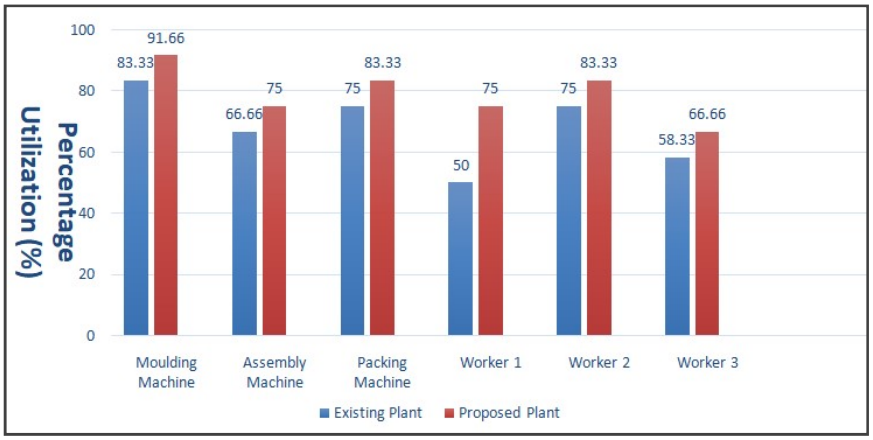
P = ₦ 26,059,534 (from the NPV above)
N = ₦ 66,640,221 (Negative NPV when discounted at 20 % for 11 years)

Man –Machine Utilization: In First Medical & Sterile product, syringe barrel and plunger are manufactured with various diameters and number of operations are involved in existing manufacturing method. It is attempted to find out the capacity utilization of both man and machine of all operators by the use of work measurement. From the result obtained in Table 1 , for the Capacity utilization of man and machine, it is shown that the molding machine is busy for 91.66 % as the highest capacity utilization running efficiently to produce 90, 000 pieces of barrel/plunger per day. Worker 2 being busy for 83.3% contributed the largest percent to make sure the company set target for the day is achieved. From these results obtained, on the capacity utilization the three workers, there is an increase in production output.

Table 1. Consolidated results from Man machine by multiple activity chart:

Man/Machine time	Moulding Machine	Assembling Machine	Packing Machine	Worker 1	Worker 2	Worker 3
IDLE TIME	5	15	10	15	10	20
Working time	55	45	50	45	50	40
Total cycle time	60	60	60	60	60	60
Percentage Utilization (%)	91.66	75	83.33	75	83.3	66.6

Figure 6: Bar graph showing percentage utilization comparison of existing and proposed plant. From the bar graph in Figure. 6, it shows that there is an increase in the capacity utilization of both machine and man in the proposed plant.



Production Improvement Analysis: For this process,3 machine unit was used. Company set target for these machine is 21,600 pieces per shift per machine .The target for all the machine is 64,800 pieces per shift. The number of complete syringe pieces produced in 8hr (480 minutes) using standard time (Time study) is 26667 pieces per shift which results to 80,001 pieces for the three machine unit. From the percentage improvement in productivity, it shows therefore that 15,201 more pieces of completed syringe can be produced in 8 hours by following the time study approach. The resultant improvement in productivity is 23.45% as shown in Table 2.

Table 2. Results of the improvement from the work study

FMSP	1 Before Improvement	2 After Improvement	$\left[\frac{(2)-(1)}{(1)}\right]\times 100 =$ % of Difference
No of machine Unit Used	3	3	–
Productivity (pieces/day)	64,800	80,001	23.45
Productivity (pieces/hr/man)	21,600	26667	23.45
Utilisation Average (%)	68.05	79.15	16.31

Financial Evaluation

Table 3. Payback Period of Investment

	Years	Cost (₦)	Cumulative Balance (₦)
Capital Asset	0	1,285,000,000	1,285,000,000
Net Cash In Flow	1	(281,591,000)	1,003,409,000
	2	(281,591,000)	721,818,000
	3	(281,591,000)	440,227,000
	4	(281,591,000)	158,636,000
	5	(158,636,000)	0/ NIL

The pay- back period, also called pay – off period is the period required for recovering the original investment outlay through the accumulated net cash flows earned by the project. Accordingly, based on the projected cash flow it is estimated that the project's initial investment will be fully recovered in 5 years.

Table 4. Net Present Value

	Cash Flow	Discount Factor	Present Value
Year	₦	**18%**	₦
0	(1,285,000,000)	1	(1,285,000,000)
1	281,591,000	0.8475	238,648,371
2	281,591,000	0.7182	202,238,656
3	281,591,000	0.6086	171,376,288
4	281,591,000	0.5158	145,244,638
5	281,591,000	0.4371	123,083,426
6	281,591,000	0.3704	104,301,306
7	281,591,000	0.3139	88,391,415
8	281,591,000	0.2660	74,903,206
9	281,591,000	0.2254	63,470,611
10	281,591,000	0.1911	53,812,843
11	281,591,000	0.1619	45,589,583
NET PRESENT VALUE			**26,059,534**

Net present value (NPV) is the total present (discounted) value of a time series of cash flows. NPV aggregates cash flows that occur during different periods of time during the life of a project in to a common measuring unit i.e. present value. It is a standard method for using the time value of money to appraise long-term projects. NPV is an indicator of how much value an investment or project adds to the capital invested. In principle, a project is accepted if the NPV is non-negative. Accordingly, the net present value of this company at 18% discount rate is found to be ₦26,059,534at 11th year. This proves that when the time value of money taken into consideration, the project has a longer break-even period. In this case 11 years.

Internal Rate of Returns: The internal rate of return (IRR) is the annualized effective compounded return rate that can be earned on the invested capital. It is an indicator of the efficiency or quality of an investment. A project is a good investment proposition if its IRR is greater than the rate of return that could be earned by alternate investments or putting the money in a bank account. Accordingly, the IRR of this project is computed to be 18.56% indicating the viability of the project. For details on IRR, See appendix H.

Recommendations

To improve productivity and enhance the production process, the following recommendations are made which are thus;

- It is establish that the assembling machine takes 75 % utilization and rest of the time it is idle condition, while capacity utilization of packing machine is 83.33% and utilization of moulding machine is 91.6%, so therefore for 100 utilization of assembly and packing machine the capacity of moulding machine should be increase.
- The distance between the stored raw material and moulding machine is too much which will take too much time to load material on the moulding machine and it will cause delay to start the operation. Therefore, it is put into consideration to reduce the distance between store and moulding machine to increase productivity.
- Since there are 2 skilled workers on assembly and 3 skilled worker on packing machine, so there isa need of total 4 workers only. So I worker should be remove since we have seen worker 3 is busy only for 66.6% and worker 1 is busy for 75% so other two worker have the capacity to aid worker I and III.

CONCLUSION

This research deals with time and motion study. The essential requirement of time and motion study are to minimize the human effort and it is aimed at finding the best and most efficient process of using available resources, i.e., man, money, material and machinery. Time and motion study analysis may easily aid in the improvement of efficiencyof the manufacturing process thereby reducing the amount of time and material mobility thus decreases the production cost and valuable time. Implementing work study and method study and establishing new efficient process for particular operation, productivity is increased or raised. A Flexible concepts have been applied, to effect greater productivity and improved resource utilization the case study company. A project is a good investment proposition if its IRR is greater than the rate of return that could be earned by alternate investments proposals. Accordingly, the internal rate of return(IRR) computed to be 18.56% indicate the viability of the company.

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