

**“Operations Research in Manufacturing and Exports”**¹Harshneet Bhatia, ²Chetna Gupta, ³Devashish Didi, ⁴Harshita Phallor, ⁵Finella Shah*Operation Research, Narsee Monjee Institute of Management Studies, School of commerce*

Abstract:- Globalisation of market and operations places tremendous pressure in making timely and accurate decisions using data analysis and more accurate information. The increasing specialisations have created new problems which now can't be based on a single criterion. It is impossible to squeeze the complexity of opinions, motivations and the goals found in organizations and industry into a single objective. Therefore, decisions may involve several objectives that are conflicting in nature. The presence of several criteria which are wholly or partially contradictory in nature leads to the development of multi-criteria decision making problems or multi-criteria optimization problems. Therefore, decision making is a multi criteria optimization. This signifies the importance of developing suitable Operations Research techniques and models. This paper is addressed to indicate operations research application in the jewellery sector. The methodologies, techniques of OR are used by managers to deal with problems and constraints related to logistics, supply chain, inventory management. When jewellery is manufactured and exported, Operations Research finds its application in order forecasting, raw material procurement, manpower allocation and labour management, planning of equipment and consumer durables, final quality assurance and logistics. It is highly advantageous in taking planning decisions and it helps improve production efficiency. This paper will highlight the extent to which Operations Research is used in these steps, its advantages and limitations.

An overview of export operations of jewellery sector is given which is basically a three part process: pre-shipment, transport, and after-sale. Each of the three will be considered in turn from the perspective of business professionals attempting to expand their companies' interests across national boundaries.

INTRODUCTION

[The Indian Gems & Jewellery Industry is the back bone of the economy by being one of the major contributors towards the export led growth of India. The industry has gained global popularity because of its talented craftsmen, its superior practices in cutting and polishing fine diamonds and precious stones and its cost-efficiencies. The two major segments of the industry are gold jewellery (covers around 80% of the jewellery market) and diamonds. India is one of the world's largest manufacturers of cut and polished diamond with an aggregate contribution of approx 60% of the world's supply in terms of value and 80% in terms of volume. The industry contributes more than 14% towards the total export in India and provides employment to 1.3 million people directly and indirectly. The global market for gems and jewellery is over USD 100 billion with major contribution coming from India, Italy, China, Thailand and USA.

India's Position on the Global Front Indian gems & jewellery industry is the leading foreign exchange earner, as well as one of the fastest growing industries in the country. The market for gems and jewellery worldwide has grown steadily over the last few years but slowed down during the global economic recession in 2011-2012.

The hub of India's jewellery industry is Mumbai that receives the majority of the country's gold and rough diamond imports. Mumbai has a considerable number of modern, semi-automatic factories and laser-cutting units, the majority of which are located in the special economic zone(s). It is also the centre for machine made jewellery. The city is also India's largest wholesale market in terms of volume.

Operations Research is one of the means to arrive at an appropriate and valid decision. The managers use this quantitative data for taking the most optimal decision for the business. Hence, it is used to solve complex problems. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis. The roots of OR can be traced back to military services in world war 2 where lack of resources called for a need of optimum allocation of resources. The British and US military called upon large number of scientists to apply scientific approaches.]¹

OR techniques play a major role in scheduling and sequencing of the machine. They play a vital role in the production. OR methodology helps to choose the appropriate location of the plant, plant design, raw material, labour and much more. Operation management manages the demand, requirement, supply and delivery of product.

For instance, manufacturers produce luxury jewellery throughout the year and store them so that they don't run out of stock during festive times. The production needs to be forecasted to sell and import as well. The success of OR made its application grow in other sectors as well.

I. Advantages of Operations Research

[Better Systems: Often, an O.R. approach is initiated to analyze a particular problem of decision making such as best location for factories, whether to open a new warehouse, etc. It also helps in selecting economical means of

transportation, jobs sequencing, production scheduling, replacement of old machinery and much more. This leads to better productivity point.

Better Control: The management of large organizations recognizes that it is a difficult and costly affair to provide continuous executive supervision to every routine work. An O.R. approach may provide the executive with an analytical and quantitative basis to identify the problem area. The most frequently adopted applications in this category deal with production scheduling and inventory replenishment. With OR, organizations are greatly relieved from the burden of supervision of all the routine and mundane tasks. The problem areas are identified analytically and quantitatively. Tasks such as scheduling and replenishment of inventories benefit immensely from OR.

Better Decisions: O.R. models help in improved decision making and reduce the risk of making erroneous decisions. O.R. approach gives the executive an improved insight into how he makes his decisions. OR is used for analyzing problems of decision making in a superior fashion. The organization can decide on factors such as sequencing of jobs, production scheduling and replacements. Also the organization can take a call on whether or not to introduce new products or open new factories on the basis of a good OR plan.

Better Co-ordination: An operations-research-oriented planning model helps in coordinating different divisions of a company. Various departments in the organization can be coordinated well with suitable OR. An operations-research-oriented planning model helps in coordinating different divisions of a company. It facilitates smooth functioning for the entire organization. With OR, any organization follows a systematic approach for the conduct of its business. OR essentially emphasizes the use of computers in decision making. Hence the chances of error are minimum.

Improved Productivity: Operations Research helps to improve the productivity of the organization. It helps to decide about the selection, location and size of the factories, warehouses, etc. It helps in inventory control. It helps in production planning and control. It also helps in manpower planning. OR is used in expansion, modernization, installation of technology, etc. OR uses many different mathematical and statistical techniques to improve productivity. Simulation is used by many organizations to improve their productivity. That is, they try out production improvement techniques on a small scale. If these techniques are successful then they are used on a large scale. Basically, OR could be used in any situation where improvements in the productivity of the business are of paramount importance.]²

I. Limitations of Operations Research

[Lack of intelligence: Knowledge of some concepts of mathematics and statistics is prerequisite for adoption of quantitative analysis by the managers. According to the present training and experience of most managers, the actual use of these tools may be confined to a few cases.

Dependence on an Electronic Computer: O.R. techniques try to find out an optimal solution taking into account all the factors. In the modern society, these factors are enormous and expressing them in quantity and establishing relationships among these require voluminous calculations that can only be handled by computers.

Non-Quantifiable Factors: OR techniques provide a solution only when all the elements related to a problem can be quantified. All relevant variables do not lend themselves to quantification. Factors that cannot be quantified find no place in OR models. Many management problems do not lend themselves to quantitative measurement and analysis. Intangible factors of any problem concerning human behavior cannot be quantified accurately and all the patterns of relationships among the factors may not be covered. Accordingly, the outward appearance of scientific accuracy through the use of numbers and equations becomes unrealistic.]³

Distance between Manager and Operations Researcher: OR being specialist's job requires a mathematician or a statistician, who might not be aware of the business problems. Similarly, a manager fails to understand the complex working of OR. Thus, there is a gap between the two.

Money and Time Costs: When the basic data are subjected to frequent changes, incorporating them into the OR models is a costly affair. Moreover, a fairly good solution at present may be more desirable than a perfect OR solution available after sometime. The quantitative methods of operations research are many cases costly, elaborate and sophisticated in nature. Although complex problems are fit for analysis by tools of operations research, relatively simple problems have no economic justification for this type of quantitative analysis. The company has to make various models for solving different problems. All this increases the cost.

Implementation: Implementation of decisions is a delicate task. It must take into account the complexities of human relations and behavior. OR experts make very complex models for solving problems. These models may not be realistic.

The results of OR are often academic in nature. Their application and integration in real life situations may not be feasible or practical. The analyst conducting the research is usually a mathematician, who is not well versed in actual business scenarios, i.e., he may compute results that are idealistic in nature. Because the real world business situation is very different, the OR results may lose their charm and importance.

Substitution: Operations research is not a substitute for the entire process of decision making and it does not relieve the managers of their task of decision making. In one phase of decision making viz., selection of best solution through the evaluation of alternatives, operations research comes into the picture.

Estimates: In the quantitative analysis of operations research, certain assumptions and estimates are made for assigning quantitative values to factors involved. If such estimates are wrong, the result would be- equally misleading.

Operations Research has gained importance and proved to be a vital discipline after it was exercised in World War 2. It was mainly used to ensure maximum damage to the enemy's defence with minimum use of resource. Operational Research strains on efficient resource planning and allocation. Today, operational research is an industry on its own. The Operational Research Society of India, established in 1957 is among the oldest societies in the world. The society has about 500 members; the members of the society are predominately from the academic departments of mathematics, statistics, industrial engineering, computer science and management of universities and institutions of higher learning. Some of the early ground breaking contributions to operational research came from Indian scientists. However, the growth and development of OR in India and its application has been limited.

The delayed advancement of OR tools and techniques have been caused due to –

- Planned Indian economy (until 1990) and hence lack of appreciation of competition and a global outlook by industry and society
- Several opportunities to improve the economic performance of India as a nation was ignored by policy planners
- The decision making machinery was predominantly driven by rationing and resource allocation
- Efficiency and effectiveness was not a consideration in decision making and resource allocation
- Political class was driven by often narrow party considerations rather than the society welfare
- Ruling class was never held accountable for its performance and the economic growth in the country
- Bureaucracy was only interested in maintaining status quo related to development
- Under these circumstances policy planning choices were based on effectiveness of the stated programme objectives. Consequently, efficiency took back seat.
- Resource consumption was routinely monitored in all social projects. However, the utility of resources and its productivity was never monitored.

So far in the Indian Economy, Agriculture part has played a prevailing and key part. This is in addition to the economic context where industrialization in the nation has been timid. While agriculture would keep on playing an essential part in the years to come, the pace of industrialization has to be rapid to catch up with the rest of the world. India has already shown that it can assume a dominant part in global economy in the areas identified with information technology and other related services. At the point when the world is moving towards knowledge based economy, to be a developed country, India must be globally competitive in its policy, planning and its execution. It also needs to discover ways and means, by which the imprisoned resources like bio-decent variety, rich minerals, metals, and globally competitive manpower are efficiently utilized. The resources required are to be efficiently allocated without compromising on their effectiveness. This would request a great deal of application of scientific processes and approaches. It is in this setting that operational research would assume an extremely huge part to help policy planners, managers and administrators to change India as a developed country.

The role of operational research in the Indian context is clear. It is not just critical; it is even basic given the size and magnitude of the tasks ahead to change India as a developed country. We require a responsive and responsible government to cultivate a positive environment of OR applications. It is trusted that the Indian democracy would prompt this. It is believed that the globalization procedure would quicken this progress.

India has made a significant investment in industrial development over the most recent two decades. The groundwork and physical plant for a progressed industrial base have been made. At the same time an equivalent investment in technical education has been made. Be that as it may, the returns from this massive effort have been considerably less than expected. It is suggested that a factor adding to the grave financial glitch has been the disregard of the critical managerial dimension which has brought about a serious deficiency of trained managers. Operations research has an indispensable part to play in this circumstance as far as expanding administrative efficiency and subsequently facilitating scarce management assets to be utilized all the more effectively.

Case Study

In order to get an insight of jewellery manufacturing and export in India, we interviewed the production department of Goldstar Jewellery Pvt. Ltd. The company is a large scale jewellery manufacturing and exports based in SEEPZ SEZ, Mumbai. SIPOC diagram below will show more clearly about the business or operating process which takes place at the location of the study.

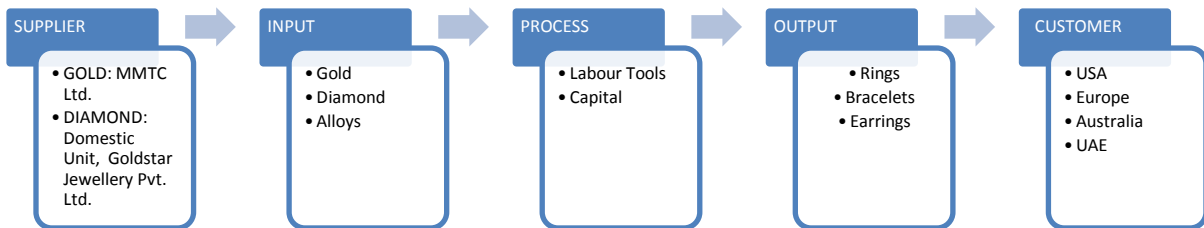


Figure 1 . SIPOC Diagram of Business Process Flow

Following is how its supply chain process works:

Planning and Order Forecasting:

The orders received are divided into 2 divisions: A and B.

Category A consists of retailers or special customers who order little quantity. The time frame for this order is 2 weeks.

Category B consists of whole sellers who order in bulk quantity. Time frame is roughly 3-4 weeks.

The planning for raw material, labour and equipment is done differently for each of the categories. The following dates are punched in the software: diamond received date, delivery date, pre casting date, delivery date. This is done keeping in mind the quantity, value and number of pieces. Based on the input given, the software returns a production plan, with the assumption of the time factor as the only constraint. This is one limitation of the software.

Raw Material Procurement:

The raw material includes gold, diamonds, and alloys, buttercups for earrings and locks for bracelets.

Once the order is obtained, based on the quantity of gold required, data is sent to the finance department, which arranges for the finances to pay for it. The gold is supplied to the company by MMTC Ltd. Gold procurement takes 15 days and orders are placed on a weekly basis. The gold is delivered in parts and not all at once. For example, if the requirement is 50 kgs, the first 20 kgs will be delivered in the first week and the remaining will come as 10 kgs. per week. Intense planning by making a detailed timeline is required; keeping all labour and capital constraints in mind so as to ensure that it doesn't fall short otherwise the labour and capital resources will lie idle. This will lead to opportunity loss in the production unit.

Diamonds are supplied by another unit of the same company. The diamond requirement has to be specified 5 days in advance after which it is delivered to the production unit.

There are multiple sources for the remaining raw material. Based on the advance, transportation time, and cost the company allots weights to each source as follows:

Factor	Higher weight	Lower weight
How many days in advance should the order be placed?	Lower no. of days	Higher no. of days
How many days will be required in delivery?	Lower no. of days	Higher no. of days
Cost of the raw material	Lower cost	Higher cost
Transportation costs	Lower cost	Higher cost

The raw material will be ordered from the source that has the highest weight allotment. The process is done assuming that the material is of the same quality.

Production Process:

After raw material procurement, the next step is production. The whole process comprises of various steps and a different mix of labour and capital. The process requires 15 days on an average, and more in case of a peak season, where the volume is larger.

Based on the customer requirements, a production bag is printed with the relevant data. A diamond bag containing the break-up of diamonds, requirement of stones and karats is printed.

After the planning is done and the production bags are made, the next step is to acquire the moulds that are used as a base for jewellery manufacturing. This is extremely tedious and time consuming as there are more than 2000 different moulds

that the company uses. For the purpose of mould procurement, a representative of the company punches the mould type required. Once acquired, the mould is kept in the production bag after which it is sent for shooting.

In the wax shooting process, molten wax is injected into the rubber mould through a machine as per weight requirement. The wax then cools and solidifies to assume the shape of the mould.

Then comes the wax finishing process wherein a 3D printed model from a Computer Aided Design (CAD) machine is made.

Depending on the project type, the production planning and control can be divided into wax model and QPC project. QPC is designed as per style and model number. It takes one day to generate QPC. This is a time constraint as the work cannot proceed unless the QPCs are made. The factory of Goldstar does not have a QPC generating machine. Hence, they have to import it from outside, or from the domestic unit of the very own company. Here, the concept of transfer pricing seeps in. Based on the cost, production and profit projection of the company, the domestic unit sells the machine to them for Rupees 300 per gram, whereas if it is to be acquired from outside, they are charged rupees 500 per gram which results in opportunity loss, if done in case of an emergency. This is a cost constraint as the piece is very delicate and is subject to breakage. The per month loss percentage is 2-3% in this unit. To overcome this, pieces are ordered in small lots. However, this is costly and time consuming.

The next step in production is wax setting. It is manual work and is very delicate. Hence, only experienced labour does it. Then comes casting, or replacing the wax with gold with the use of machines 10-12 moulds are taken at a time and are converted into a tree which is dipped into POP solution. Each tree requires 15 minutes and the capacity of the machine is 12 hours.

Post casting, cutting and filing of the gold tree is done. This is a manual process and requires time. It needs to be replaced with other techniques for time minimization. The pieces are then packed in bags as per their type sent for polish.

The next step is diamond setting with is done with the help of tools and labour in the ratio 1:1, after which the piece is sent for polish for the second time to ensure best quality possible to the customers.

The final quality assurance is the final step in production. Although quality check is done at every stage of the process, this is required to be done by the senior management as well as by a representative of the supplier. Post the completion of this, invoice is prepared and the order is dispatched. Custom clearance and insurance is done and it is finally given to courier companies which the company has tie ups with, ex. Cartel in Europe and USA.

Comparison with Capital Intensive Unit:

For the purpose of comparison, we interviewed another department of the same company. This department also focuses on jewellery production, but through capital intensive techniques. It consists of 130 workers and 15 staff members, both of which are permanent. Following is its structure:

- 1) Machine for mass production of rings (CNC Machine): Used to achieve a target of 700 pieces in 10 working hours
- 2) Pocketing Machine: target of 700 rings per day. Rings of 4000 styles can be manufactured in this machine. Labour to machine ratio: 1:1.
- 3) Setting: 600 pieces to be done per day. Each piece requires 50% labour work and 50% work done by machines. There are 7 machines and 27 workers in this department.
- 4) Polishing: Completely man made process. It is to achieve target of 600 rings per day by 31 workers.

The capital intensive unit is superior in the following ways:

1. Full manufacturing process is completed in one hour
2. The presence of multi skilled labour is an advantage as labour can be transferred when the workload of one department is more.
3. There is quality check at every stage.
4. No manual calculation; all the work is captured by the system, hence less chances of error.
5. Per unit cost and time is lesser.
6. After the target completion at each step, the machine is unutilized, and the remaining time is spent in product development through soft wares like Rhinores and Masscam.

Waste Management (Post Production):

The garbage and water used for washing hands is sent to a processing unit where gold is recovered.

The refining gives back 97% of the gold lost in production. This is the highest in the industry.

Hindrances:

Hindrance	Description
Time Hindrance	<p>This is mainly because production requires a lot of manual work.</p> <p>What can be achieved in 10 hours with the help of machines, takes 24 hours. This is not only the problem with Goldstar, but also with other companies in this industry. The current labour to capital ratio is the minimum possible one. However, the time taken per unit can be minimized to a further extent by increasing the extent to which machinery contributes to production per unit. Investing in new machines, keeping the manpower unchanged will increase the overall cost of production as each machine requires a fixed investment of 8-10 crores. However, the advantage of this is that more number of units will be produced in lesser amount of time which will help in achieving the target faster.</p>
Labour Hindrance	<p>80% of the work is manual and prone to error. Sometimes, diamonds are found to fall out (although it happens only 1% of the times) which leads to loss of goodwill among customers. For this purpose, quality control takes place at every stage of the production process.</p> <p>Labour strikes do not generally occur as the labour is on a contract basis. The labour hours are not fixed. They depend on the target that is to be achieved. Nightshifts are very common in the peak season. Labour is compensated on a per piece basis which also gives them higher incentive to work.</p> <p>Absence of labour union may lead to problems in the factory which will lead to decreased output.</p>
Cost Hindrance	<p>The company needs gets its supply of diamonds from its domestic unit which is loss making and ineffectively managed. This impacts production as supply does not come on time which delays the process. To make up for the losses, they supply to the company at a price higher than available outside which increases the cost of production and leads to a decrease in gross profit margin. This becomes a major constraint as the company cannot refuse the purchase. This is an opportunity loss that the company has to accept. During demonetization, supply was delayed by a great extent due to which things went haywire and the planning had to be redone. The introduction of GST has led to an increase in gold prices which again impacts profitability.</p>
Loss Acceptance	<p>There is loss at every stage of production. Maximum efforts in the form of refining are taken to recover the lost gold. Although the loss at each stage is minimal, it is to be borne by the company. Some losses have to be accepted. For example, if the gold requirement is 5.5 grams and the product when weighed is 5.6 grams, the company cannot do anything about it. A margin of 5% is allowed. Beyond this, the product will have to be melted and remade, which will again lead to additional cost and time. Also, the gold when melted does not recover by 100%.</p>

Problem Mapping Towards Total Productivity Input Factors:

TOTAL PRODUCTIVITY INPUT FACTOR	IDENTIFIED PROBLEM
LABOUR PRODUCTIVITY	MANUAL WORK
MATERIAL PRODUCTIVITY	HIGH COST OF PRODUCTION
CAPITAL PRODUCTIVITY	OBSELETE TECHNOLOGY
ENERGY PRODUCTIVITY	N/A

Transport Logistics: Dispatching Problems

[It is the goal of optimization to adopt system behaviour in order to maximize or minimize an objective function. In economic systems, this objective function refers to revenue maximization. Logistics is a classical area of application for optimization, because it includes multiple complex optimization problems. In transport logistics, these complex problems often refer to tour planning and routing problems. The goal of transport is, to pick up goods at their origin and deliver them to their destination to overcome special distances in order to fulfil the five objectives of logistics:

- To deliver the right object
- At the right time
- To the right place
- In the right quantity and quality
- At the right price.

Consequently, most logistics problems require multi criteria optimization taking into account several constraints.

Tour planning and routing problems in transport logistics are to be taken care of. The problems are categorized in two groups:

1) The well-known Travelling Salesman Problem (TSP) with various constraints which has the objective of determining the shortest route for a single vehicle which includes all stops and fulfils additional constraints.

The objective function minimizes the overall cost. Each service request has to be satisfied exactly once. There is a sub-tour elimination constraint which guarantees that all stops are visited in a single and connected tour. In short, the goal is to find the shortest tour of a vehicle, which ensures that all service requests are satisfied. Time window constraints as well as time consumption at the warehouse/customer have to be considered. The problem is solved using genetic algorithms.

2) Vehicle Routing Problem (VRP): It has Multivehicle variants. Not only the shortest tour, but also the optimal allocation of goods to vehicles must be determined.

The highest priority objective function of a VRP is to minimize the number of used vehicles. The second highest priority is to minimize the cost of the vehicles, which commonly depends on the distances driven or travel times of the vehicle.

If the VRP also includes direct tours between customers without any handling operations at a central depot, it is known as the Pickup and Delivery Problem (PDP).]°

Data Analysis

In this phase, both primary and secondary data will be processed based on the information obtained from the problems defined in the case study.

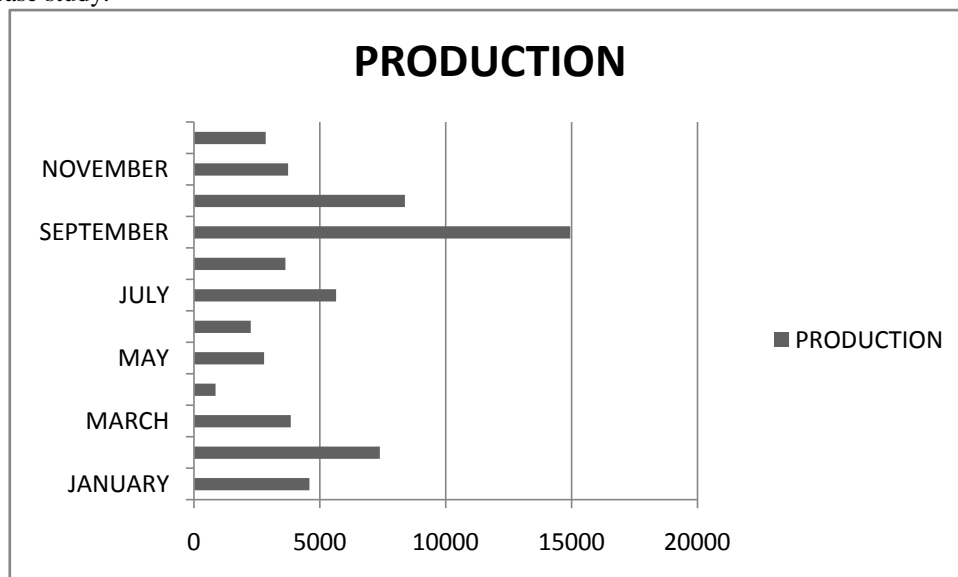


Figure 2

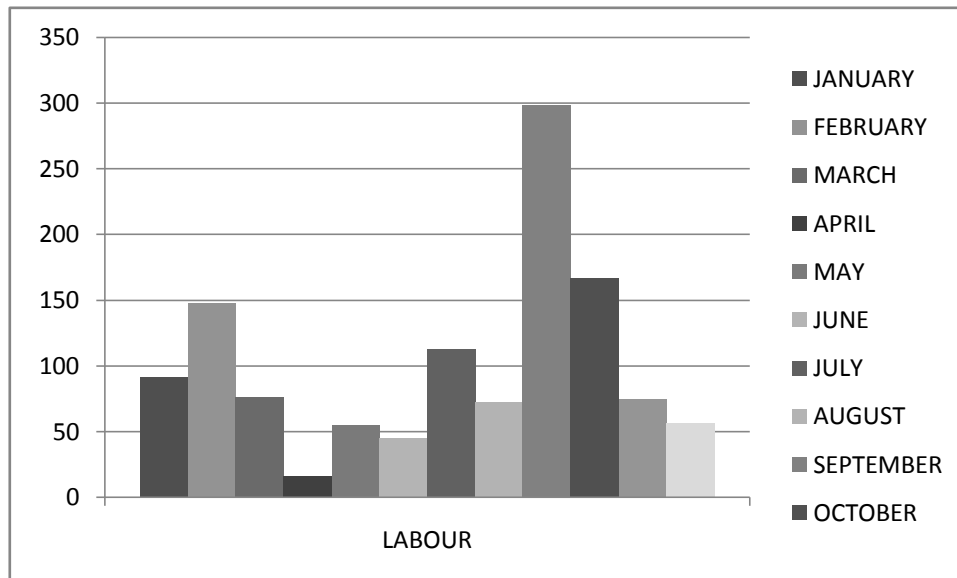


Figure 3

[To determine the factors that affect productivity at the level of productivity of the Manufacturing Industry, an initial interview with the Expert was conducted. From the results of the initial interviews it was decided that 3 out of 4 input factors of Total Productivity have influence on the performance of Productivity Manufacturing Industry performance, which will be the criterions in the following decision making process, which are:

- K1: Labour Productivity
- K2: Material Productivity
- K3: Capital Productivity]⁸

Alternatives:

- A1: Create a compelling high level vision and strategic theme for the Company (based on Customer Value)
- A2: Develop strong strategies and cultures in each Division/Team based on the respective requirement
- A3: Develop the strong Strategic and Continuous Improvement Thinking for Division/Team Leaders, through Training
- A4: Design a Productivity Improvement Framework through third party Expert Judgement/External Consultant. (Best practice approach)
- A5: Design a Productivity Improvement Framework through Internal Expert Judgement or Division/Team Leaders. (Internal requirement approach)
- A6: Design a Productivity Improvement Framework through employee character/divisional or team culture adjustments
- A7: Implementation of Priority Management System
- A8: Implementation of Daily Planning System (Daily Activity Planning) for all Employees
- A9: Implementation of Integrated Operational Planning Information System (e.g. ERP).

Analysis, Result and Discussion

- 80% is manual work and needs to be replaced.
- Punching of dates is done with the help of software. Rest of the calculations such as loss at every stage, arriving at optimum cost are tedious and time consuming and have to be done manually. This is likely to cause chances of error.
- A system for waste management needs to be developed. A lot of time and resources are wasted in sending one bag from one department to another.
- Post production reports that have to be made are time consuming. One report takes approx. one hour to make as everything is to be typed manually. For this reason, soft wares like SAP and ERP (2) (production and database software) need to be introduced.
- If factory is overloaded, nothing is done. This is the problem with every jewellery industry.
- Business process engineering should be introduced, although it works only 3% of the times.
- Six sigma (1) should be introduced as a quality improvement project. It takes into account qualitative factors, cost and labour constraints to improve the company's performance.

To support the implementation of system control through the above performance indicators, several supporting strategies need to be done to Jewellery Manufacturing Industry as follows:

- Designing an appropriate flow of business processes, which also pay attention to mapping the skills and abilities of each worker.

- Improve and develop the existing ERP system which should be adapted to business processes and other supporting data, such as the mapping of the skills and abilities of each worker.
- Creating a notification system, in the form Health check Notification system, due to lack minimum automation within the production process.
- Fix the new policy towards the need for performance indicators and standardized work.
- Designing a new tool of performance indicators, such as supporting tools to process data that can be created using Excel, to then be designed to be made automation integrated in the ERP system.

Conclusion and Terminologies Explained

The company should look into all the available alternatives and evaluate all the approaches so that it can arrive at a cost efficient model.

(1) [Six sigma should be introduced. It is a set of techniques and tools for process improvement. It takes into account qualitative factors, cost and labour constraints to improve the company's performance.

True believers and practitioners in the Six Sigma method follow an approach called DMAIC: define, measure, analyse, improve and control. It is a statistically driven methodology that companies implement as a mental framework for business process improvement.

The ideology behind DMAIC is that a business can solve any seemingly unsolvable problem. First, a team of people, led by a Six Sigma champion, defines a faulty process on which to focus, decided through an analysis of company goals and requirements. This definition outlines the problem, goals and deliverables for the project. Second, the team measures the initial performance of the process. These statistical measures make up a list of potential inputs that may be causing the problem and help the team understand the process's benchmark performance.

Third, the team analyses the process by isolating each input, or potential reason for failure, and testing it as the root of the problem. Through analysis, the team identifies the reason for process error. From there, the team works to improve system performance. Finally, the team adds controls to the process to ensure that it doesn't regress and become ineffective once again.]⁹

(2) ERP (Enterprise Resource Planning) software should be introduced. It integrates various business functions, such as inventory and order management, accounting, human resources, customer relationship management into one complete system to streamline processes and information across the entire organization.

The central feature of all ERP systems is a shared database that supports multiple functions used by different business units. In practice, this means that employees in different divisions—for example, accounting and sales—can rely on the same information for their specific needs.

ERP software also offers some degree of synchronized reporting and automation. Instead of forcing employees to maintain separate databases and spreadsheets that have to be manually merged to generate reports, some ERP solutions allow staff to pull reports from one system. For instance, with sales orders automatically flowing into the financial system without any manual re-keying, the order management department can process orders more quickly and accurately, and the finance department can close the books faster. Other common ERP features include a portal or dashboard to enable employees to quickly understand the business' performance on key metrics.

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