CA Final SPOM Set B – Strategic Cost & Performance Management
ICAI Module Questions Compilation

Chapter 3 - LEAN SYSTEM AND INNOVATION

Illustration 1

KP Ltd. (KPL) manufactures and sells one product called "KEIA". Managing Director is not happy with its current purchasing and production system. There has been considerable discussion at the corporate level as to use of 'Just in Time' system for "KEIA". As per the opinion of managing director of KPL Ltd. –

"Just-in-time system is a pull system, which responds to demand, in contrast to a push system, in which stocks act as buffers between the different elements of the system such as purchasing, production and sales. By using Just in Time system, it is possible to reduce carrying cost as well as other overheads".

KPL is dependent on contractual labour which has efficiency of 95%, for its production. The labour has to be paid for minimum of 4,000 hours per month to which they produce 3,800 standard hours.

For availing services of labour above 4,000 hours in a month, KPL has to pay overtime rate which is 45% premium to the normal hourly rate of Rs 110 per hour. For avoiding this overtime payment, KPL in its current production and purchase plan utilizes full available normal working hours so that the higher inventory levels in the month of lower demand would be able to meet sales of month with higher demand level. KPL has determined that the cost of holding inventory is Rs. 70 per month for each standard hour of output that is held in inventory.

KPL has forecast the demand for its products for the first six months of year 2023 as follows:

Month	Demand (Std. Hrs.)
Jan'23	3,150
Feb'23	3,760
Mar'23	4,060
Apr'23	3,350
May'23	3,650
Jun'23	4,830

Following other information is given:

(i) All other production costs are either fixed or are not driven by labour hours worked.

(ii) Production and sales occur evenly during each month and at present there is no stock at the end of Dec'22.

(iii) The labour are to be paid for their minimum contracted hours in each month irrespective of any purchase and production system.

Required

As a chief accountant you are requested to COMMENT on managing director's view.

Solution

Workings

Statement Showing 'Inventory Holding Cost' under Current System

Particulars	Jan	Feb	Mar	Apr	May	Jun
Opening Inventory* (A)	---	650	690	430	880	1,030
Add: Production*	3,800	3,800	3,800	3,800	3,800	3,800
Less: Demand*	3,150	3,760	4,060	3,350	3,650	4,830
Closing Inventory* (B)	650	690	430	880	1,030	---
Average Inventory $\frac{A+B}{2}$	325	670	560	655	955	515
Inventory Holding Cost @Rs70	22,750	46,900	39,200	45,850	66,850	36,050

*in terms of standard labour hours.

Inventory Holding Cost for the six months = Rs 2,57,600
(Rs 22,750 + Rs 46,900 + Rs 39,200 + Rs 45,850 + Rs 66,850 + Rs 36,050)

Calculation of Relevant Overtime Cost under JIT System

Particulars	Jan	Feb	Mar	Apr	May	Jun
Demand*	3,150	3,760	4,060	3,350	3,650	4,830
Production*	3,150	3,760	4,060	3,350	3,650	4,830
Normal Availability*	3,800	3,800	3,800	3,800	3,800	3,800
Shortage (=Overtime*) (C)	---	---	260	----	----	1,030
Actual Overtime Hours (C / 0.95)	---	---	273.68	----	----	1,084.21
Overtime Payment @ Rs 159.50 [110 + 45%]	---	---	43,652	----	----	1,72,931

Total Overtime payment = Rs 2,16,583
(Rs 43,652 + Rs 1,72,931)

Therefore, **Saving in JIT system** = Rs. 2,57,600 – Rs 2,16,583
= Rs. 41,017

Comments

Though KPL is saving Rs41,017 by changing its production system to Just-in-time but it has to consider other factors as well before taking any final call, which are as follows:

(i) KPL has to ensure that it receives materials from its suppliers on the exact date and at the exact time when they are needed. Credentials and reliability of the supplier must be thoroughly checked.

(ii) To remove any quality issues, the engineering staff must visit suppliers' sites and examine their processes, not only to see if they can reliably ship high-quality parts but also to provide them with engineering assistance to bring them up to a higher standard of product.

(iii) KPL should also aim to improve quality at its process and design levels with the purpose of achieving "Zero Defects" in the production process.

(iv) KPL should also keep in mind the efficiency of its work force. KPL must ensure that labour's learning curve has reached a steady rate so that they are capable of performing a variety of operations in an effective and efficient manner. The workforce must be completely retrained and focused on a wide range of activities.

Case Scenario 1

M. India Ltd. (MIL) is an automobile manufacturer in India and a subsidiary of Japanese automobile and motorcycle manufacturer Leon. It manufactures and sells a complete range of cars, from the entry level to the hatchback to sedans and has a present market share of 22% of the Indian passenger car market. MIL uses a system of standard costing to set its budgets. Budgets are set semi-annually by the Finance department after the approval of the Board of Directors at MIL. The Finance department prepares variance reports each month for review in the Board of Directors meeting, where actual performance is compared with the budgeted figures. Mr. Suzuki, group CEO of Leon, is of the opinion that the Kaizen costing method should be implemented as a system of planning and control in the MIL.

Required
RECOMMEND key changes vital to MIL's planning and control system to support the adoption of 'Kaizen Costing Concepts'.

Solution

Kaizen Costing emphasizes small but continuous improvement. Targets, once set at the beginning of the year or activities are updated continuously to reflect the improvement that has already been achieved and that is yet to be achieved.

The suggestive changes which are required to be adopted in Kaizen Costing concepts in MIL are as follows:

Standard Cost Control System to Cost Reduction System: Traditionally Standard Costing system assumes stability in the current manufacturing process and standards are set keeping the normal manufacturing process into account thus the whole effort is on to meet performance cost standard.

On the other hand, Kaizen Costing believes in continuous improvements in manufacturing processes and hence, the goal is to achieve cost reduction target. The first change required is the standard setting methodology i.e., from earlier Cost Control System to Cost Reduction System.

Reduction in the periodicity of setting Standards and Variance Analysis: Under the existing planning and control system followed by the MIL, standards are set semi-annually and based on these standards monthly variance reports are generated for analysis. But under the Kaizen Costing system cost reduction targets are set for small periods, say for a week or a month. So, the period covered under a standard should be reduced from semi-annually to monthly and the current practice of generating variance reports may be continued or may be reduced to a week.

Participation of Executives or Workers in standard setting: Under the Kaizen Costing system participation of workers or executives who are actually involved in the manufacturing process is highly appreciated while setting standards. So, the current system of setting budgets and standards by the Finance department with the mere consent of Board of Directors required to be changed.

Case Scenario 2

Y & E Chartered Accountants offers a wide range of specialized, multi-disciplinary professional services that meet the immediate as well as the long-term business needs of clients. One of partner 'E' was upset with office documentation. 'E' argued that a document management solution is needed to maximize efficiency within the firm. The senior partner 'Y' has recently attended a seminar on lean system and heard the '5S'. He said that old files hide the key files from the eye and force staff to ask which to use. Accordingly, he desires to implement '5S'.

Required
ADVISE on the implementation of '5S' in Y & E.

Solution
Office processes often have huge amounts of paperwork, and this not only makes processes slower but also allows errors to be introduced. 5S is a method of both cleaning out the working area and maintaining its cleanliness to improve process quality. The 5S process is based on:

Sort (Seiri)
This is the sorting and removal of unnecessary files, papers, books, and documents in the work area. Sorting is designed to make the work area neat, organized and arranged so that relevant items can be found easily. If an item is not relevant to the work, then it should not be in the work area.

Set in Order (Seiton)
Set in order means systematic arrangement of things, i.e., arrange all necessary items into the most efficient and accessible arrangement so that they can easily be identified for use. It is advisable to have proper indexing of files and proper documentation, i.e., a proper index should be made and pasted on each file about its contents, and in that pattern of contents, documents should be kept inside the files so that specific document can easily be traced and withdrawn on time. Even inside a cupboard, paper indexing about files with their names should be pasted so that specific file can easily be traced. Same can be done w.r.t. folders in computer, right file should be saved in the right folder with an identifiable name so that anyone can easily find any file. Frequent use items should be close by, and infrequent use items can be further away in a central area. All storage areas should be clearly labelled to allow items to be put in the correct place, e.g., where did I leave the office stamp again?

Shine (Seiso)
After sorting and simplifying, it is necessary to keep the work area clean and safe. Shining is also an inspection process for the area, i.e., is everything in good condition? It is desirable to involve employees for 15-20 minutes each day to clean the work area so that they can develop the habit of cleanness. In the same way, unimportant files either in desktop or in any driver should be permanently deleted.

Standardize (Seiketsu)
A clean and tidy work area allows the process to be standardized and examined for quality or process improvements. Best practices are documented and rolled out across the work area, standards and process measures are established and displayed in the work area.

For example, a red file can be standardized for very important files (can be required anytime), a green file for important files, and a yellow file for unimportant files.

Sustain (Shitsuke)
It means to maintain discipline; this can only be achieved by auditing work areas and processes to make sure that the 5S standards are maintained. It is worthwhile to apply 5S standards continuously, i.e., daily basis, and check for any upgrades if needed, so that firm can have good management in terms of documentation, cleanness, time savings for partners as well as clients.
Overall, 5S in offices streamlines the work (low to reduce errors as well as improving process times) and employee satisfaction.

Illustration 2

KIWI Ltd. manufactures spare parts and can be called a "high volume based" manufacturing environment. The company is using the system of TPM for maintaining and improving the integrity of the manufacturing process. There are several different automated manufacturing machines located in the plant, through which the manufacturing of spare parts is done and supplied to cater the demand in the market.

A 12- hour shift is scheduled to produce a spare part in KIWI Ltd. as shown in the schedule below. The shift has three 15- minute breaks and a 10- minute clean up period.

Production Schedule for Automated machine NZ 10:
Cycle: 10 (seconds),
Spare parts Manufactured: 3,360,
SCRAP: 75,
Unplanned Downtime: 36 minutes

Required
CALCULATE OEE (Overall Equipment Effectiveness) and comment on it.

Solution
Calculation of Planned Production Time

	Min
Total time (12 hrs. × 60 mins.)	720
Less: Planned downtime	
Break (3 × 15 mins.)	45
Clean up time	10
Planned Production Time	665

Availability Ratio per shift = $\left\{\frac{665\ min\ -\ 36\ min}{665\ mins}\right\} * 100$
= **94.59 %**

Actual Production = 3,360 parts
Standard time = 10 seconds

Standard Time Required	=	3,360 parts × 10 seconds/ 60
	=	560 minutes
Actual Time Taken	=	665 mins. – 36 mins.
	=	629 minutes

Performance Ratio = $\left\{\frac{560\ mins}{629\ mins}\right\} \times 100$

= **89.03%**

Quality Ratio = $\left\{\frac{3{,}360\ parts - 75\ parts}{3{,}360\ parts}\right\}$ **x 100**

= **97.77%**

Thus, OEE = **0.9459 × 0.8903 × 0.9777**

= **82.34%**

Comment

Since the OEE of KIWI Ltd. is very close to 85%, i.e., world class performance level, the company should take measures to improve it and strive to attain 85% level. Availability Ratio of machine NZ 10 is 94.59%, exceeding the ideal value of > 90%, which is good; but the Performance and Quality Ratios need attention as they are below their ideal values of > 95% and > 99%, respectively.

(Note- OEE can be calculated using the formula - (Good Count × Ideal Cycle Time) / Planned Production Time)

Case Scenario 3

Derby Grey is a leading manufacturer of leather luggage bags (up to 62") for style-conscious people around the globe. It is made up of two independent divisions in New Delhi. The division 'Mx' performs all manufacturing and packaging operations. All sales are made through the division 'Rx', which has 11 retail stores in New Delhi, as well as through Derby Grey's own well-developed website. Derby Grey also has retail operations in Dubai, Kuala Lumpur, Bangkok, as well as in Singapore. These overseas businesses operate as independent subsidiaries within Division 'Rx'.

Derby Grey revolutionized the industry by offering cheap but stylish luggage bags. Derby Grey is able to keep its prices low by offering a very basic level of service. Luggage bags are sold in boxes for customers to assemble themselves, and all deliveries are made through third party distributor 'Çosta Cruise'.

Dr. Philips (Managing Partner) is bothered about increasing sales returns and massive complaints about products purchased from Derby Grey on social media. With this concern, Dr. Philips has appointed you as a performance management expert to help the firm to execute the six-sigma technique to reduce the number of sales returns and to evaluate the firm's existing performance.

Dr. Philips has heard that Six Sigma analysis involves large quantities of data. Dr. Philips stated– "I'm not confident in our current IT systems. I doubt whether the system would be able to identify the required data related to cutting, preparation, closing, lasting, etc. These manufacturing subdivisions may be the

root cause of the problem. Further, the quarterly compiled sales return data lacks enough detail. We may need to do more analysis on customer satisfaction and manufacturing quality."
You have been given access to feedback given by customers for returning goods to measure existing performance in this area (refer below):

Difficult to assemble or pieces missing (47%) – Bags were not as demanded (24%) – Poor Quality (19%) - Arrived damaged (9%) – Arrived late (1%)

Required
ADVISE Managing Partner on Six Sigma implementation to reduce the number of sales returns using the DMAIC method.

Solution
DMAIC is a methodology of Six Sigma used to improve existing business processes. It is advisable for the Managing Partner to execute the following phases of DMAIC–

Define the process
This phase emphasises exactly what the customer's requirements are? In this case, focus is precisely on why bags are returned. The objective of the process needs to be clear, as in this case, to reduce the number of customer returns. Customers expect certain minimum requirements from the manufacturing and packaging process, for example, that the bags are properly packed in boxes. They also expect the goods to be delivered undamaged within a reasonable time and at the time & date committed. Further, customers' perceptions of quality should coincide with the price paid, though different customers may have different expectations.

Measure the existing process
This phase measures the process to determine existing performance. In this case, the sales returns figures do not show a complete picture as to why customers return bags, which of the classes belongs to 'poor packing', which belongs to 'defective item', which belongs to 'activities of other subdivisions', etc. The ambiguity of the data and the classification of definitions will need to be addressed to enable the process to be measured effectively.

Analyse
This phase detects the root cause of the problems. Possible root cause of sales returns are as follows:

- Difficult to assemble or pieces missing (47%) – Returns could be because the bags were not manufactured or packed properly in the 'Mx' division, but they could also be due to poor design, customers losing pieces, or simply being unable to assemble the bag.
- Bags were not as demanded and of poor quality (24%) – Returns could be due to defective manufacture or if the customer had merely changed their minds and no longer required the bag. In 'bags were not as demanded', the identification of 'defective items' are too vast.
- Arrived damaged (9%) – It may be that customers wrongly classified defective bags as damaged. Though bags may become damaged by the 'Çosta Cruise', only a small number of returns relate directly to them.

- Arrived late (1%) – Reasons of arrived late could be either 'Costa Cruise' could not make delivery on time or 'Mx' division could not complete the order on time, and this causes only 1% of returns, which is relatively insignificant.

Further, information could be analysed, like country wise sales returns, product wise sales, or with more clear definition of 'defective items' from the customer's perspective. By doing so, the firm may easily get information related to areas of the business where sales returns are high and hence be able to focus on.

Improve

In this phase, recommendations are made to minimize or eliminate the root cause of the problem, and then those recommendations are implemented to improve the process in a systematic manner. Derby Grey is required to consider aspects of production or packaging which could be improved, for example, the timely repair and maintenance of equipment or training of existing staff, etc. Further, availability of resources and likely costs of making the improvements need to be carefully considered.

Control

Here, control means maintaining improved performance and future performance . Derby Grey would be required to monitor the performance on an ongoing basis. If sales returns reach a particular level, it should be reported to the responsible person, and he should act immediately.

In addition, Derby Grey needs to redesign its IT system in such a way so that it can provide the required detail. Since this is continuous monitoring, it may also require revisiting some phases in DMAIC.

TEST YOUR KNOWLEDGE

Question 1 - Just in Time

Pearson Metal and Motor Works (PM2W) deals in manufacturing of the copper wired electronic motor, which is specifically designed. PM2W is thinking to shift from traditional system to JIT system as part of process innovation.

CEO among the other top bosses at PM2W are hopeful that implementation of JIT will not only improve value in value chain for end consumer, but also improve overall manufacturing cycle efficiency. JIT pre-implementation team was formed to evaluate the probabilities, which collects following actual and estimated data about process –

Activity Category	Traditional System (Actual)	JIT System (Estimated)
Inspection	40	30
Storage	80	20
Moving	20	10
Processing	60	40

 # All data in minutes

Further, PM2W decided to practice single piece flow under JIT. PM2W received an order which is due to manufacture and delivered for 10 such motors. Total available production time to produce what customer demands is 480 minutes out of which it normal practice that 30 minutes will be spent in shutdown and cleaning. CEO is also considering JIT purchase apart from JIT production.

Required

(i) EXPLAIN just in time.

(ii) CALCULATE the 'takt time' and INTERPRET the results.

(iii) ADVISE whether company should shift to JIT.

Solution

(i) Just-in-time (JIT) is a collection of ideas that streamline a company's production process activities to such an extent that wastage of all kind viz., of time, material and labour systematically driven out of the process with single piece flow after considering takt time.

In JIT, production facility is required to be integrated with vendor system for signal (Kanban) based automatic supply which depends upon demand based consumption. Under JIT system of inventory storage cost is at lowest level due to direct issue of material to production department as and when required and resultantly less/no material lying over in store or production floor.

Prerequisite of JIT system is integration with vendor, if vendor is not integrated properly or less reliable, then situation of stock out can arise and which can result into loss of contribution.

Multitasking by employee is another key feature of JIT, group of employees should be made based upon product instead based upon function. Hence, functional allocations of cost become less appropriate.

Overall, JIT enhance the quality into the product by eliminating the waste and continuous improvement of productivity.

(ii) **Takt Time** is the maximum available time to meet the demands of the customer; this will help to decide the speed of/ at manufacturing facility.

Takt time is the average time between the start of production of one unit and the start of production of the next unit, when these production starts are set to match the rate of customer demand.

$$\textbf{Takt Time} = \frac{\text{Available Production Time}}{\text{Total quantity required}}$$

Here, Available Production Time is 'total available time for production' – 'planned downtime i.e., spent in shutdown and cleaning' i.e., 450 minutes = 480 minutes – 30 minutes. Total Quantity Required is 10 units.

$$\text{Takt Time} = \frac{450 \text{ minutes}}{10 \text{ units}} = 45 \text{ min}$$

Interpretation

Customer's demand is 10 units, to calculate the takt time, divide the available production time (in minutes) by the total quantity required. The takt time would be 45 minutes. This means that process must be set up to produce one unit for every 45 minutes throughout the time available. As order volume increases or decreases, takt time may be adjusted so that production and demand are synchronized.

(iii) Advise on Shifting to JIT

To evaluate how much of the old cycle time was spent in inventory, we need to know how organizations assess the efficiency of their manufacturing processes. One commonly used measure is process cycle efficiency and to calculate the same every process is breakdown into combination of activities such as value added activities, non-value added activities and non-value added activities but strategic activities. In order to generate highest value to customer, only value added activities are included in process. But those non-value added activities, which are strategic in nature, also need to be part of process. Therefore, it may be possible that entire process is not efficient.

To measure efficiency of process, managers keep track of the relation between 'times taken by value added activities' in comparison 'total cycle time'. Such relation/ratio is processing cycle efficiency.

$$\textbf{Process Cycle Efficiency} = \frac{\text{Value Added Time}}{\text{Cycle Time}}$$

Processing time is considered as value added time; whereas time spend on inspection, storage and moving is non-value added time and included in cycle time. The higher the percentage, less the time (and costs) needs to be spent on non- value added activities such as moving and storing etc.

Computation of Processing Cycle Efficiency

Sr. No.	Activity Category	Traditional System (Actual)	JIT System (Estimated)
A.	Inspection	40	30
B.	Storage	80	20
C.	Moving	20	10
D.	Processing	60	40
E.	Value Added Time	60	40
F.	Cycle Time …(A)+(B)+(C)+(D)	200	100
	Process Cycle Efficiency …(E)/ (F) × 100	30%	40%

Of the 200 minutes required for manufacturing cycle under PM2W's traditional system, only 60 minutes were spent on actual processing. The other 140 minutes were spent on non- value added activities, such as inspection, storage, and moving. The process cycle efficiency formula shows that processing time equalled to 30% of total cycle time. The cycle time is reduced substantially in the JIT system from 200 minutes to 100 minutes. In addition to this, the amount of time that used up in inventory i.e., non-value-added activities is also reduced. Therefore, process cycle efficiency has been increased from 30% to 40%. This significant improvement in efficiency over the previous system comes from the implementation of JIT system. Therefore, it is advantageous to shift to JIT system.

Question 2 - Just in Time

A manufacturer is considering implementing Just in time inventory system for some of its raw material purchases. As per the current inventory policy, raw materials required for 1 month's production and finished goods equivalent to the level of 1 week's production are kept in stock. This is done to ensure that

the company can cater to sudden spurt in consumers' demand. However, the carrying cost of inventory has been increasing recently. Hence, the consideration to move to a more robust just in time purchasing system that can reduce the inventory carrying cost. Details relevant to raw material inventory are given below:

- The average inventory of raw material held by the company throughout the year is Rs 1 crore. Procurement of raw material for the year is Rs 12 crore. By moving to just in time procurement system, the company aims at eliminating holding this stock completely in its warehouse. Instead, suppliers of these materials are ready to provide the goods as per its production requirements on an immediate basis. Suppliers will now be responsible for quality check of raw material such that the raw material can be used in the assembly line as soon as it is delivered at the company's factory shop floor.
- Increased quality check service done by the suppliers as well as to compensate them for the risk of holding the inventory to provide just in time service, the company is willing to pay a higher price to procure raw material. Therefore, procurement cost will increase by 30%, total procurement cost will be Rs 15.6 crore per year. Consequently, quality check and material handling cost for the company would reduce by Rs 1 crore per year. Similarly, insurance cost on raw material inventory of Rs 20 lakh per year need not be incurred any longer.
- Raw material is stored in a warehouse that costs the company rent of Rs 3 crore per annum. On changing to Just in time procurement, this warehouse space would no longer be required.
- Production is 1,50,000 per year. The company plans to maintain its finished goods inventory equivalent to 1 week's production. Despite this, in order to have a complete cost benefit analysis, the management is also factoring the possibility of production stoppages due to the unavailability of raw material from the suppliers. This could happen due to of delay in delivery or non-conformance of goods to the standard required. Labor works in one 8-hour shift per day and will remain idle if there is no material to work on. Due to the stoppage of production for the above reason, it is possible to have stockout of 3,000 units in a year. Stockout represents a lost sales opportunity due to unavailability of finished goods, the customer walks away without purchasing any product from the company. Therefore, in order to reduce this opportunity cost and to make up for the lost production hours, labor can work overtime that would cost the company Rs 10 lakh per annum. This is the maximum capacity in terms of hours that the labor can work. With this overtime, stockout can reduce to 2,000 units.
- Currently, the sale price of product is Rs 5,000 per unit, variable production cost is Rs 2,000 per unit while variable selling, general and administration (SG&A) cost is Rs 750 per unit. Raw material procurement cost is currently Rs 800 per unit, that will increase by 30% to Rs 1,040 per unit under Just in time inventory system.
- On an average, the long-term return on investment for the company is 15% per annum

Required

(i) CALCULATE the benefit or loss if the company decides to move from the current system to Just in Time procurement system.

(ii) RECOMMEND factors that the management needs to consider before implementing the just in time procurement system.

Solutions

i. Implementing Just in time procurement system will benefit the company as explained below:

Particulars	Current Purchasing Policy (₹)	JIT Procurement System (₹)
Raw material procurement cost per year	12,00,00,000	15,60,00,000
Quality check and material handling cost (No longer required in JIT)	1,00,00,000	---
Insurance Cost on raw material inventory (No longer required in JIT)	20,00,000	---
Warehouse rental for storing raw material (No longer require in JIT)	3,00,00,000	---
Overtime Charges under JIT to reduce Stockouts (note1)	---	10,00,000
Stockout Cost (note 2)	---	40,20,000
Total Relevant Cost	**16,20,00,000**	**16,10,20,000**

Therefore, moving to just in time procurement system results in savings of Rs 9,80,000 per year for the company. If reinvested, long-term return on investment for the company at 15% would yield a return of Rs 1,47,000 per year.
In addition, by switching over to JIT system, the company will also save working capital requirement of Rs1 crore on account of average inventory of raw material held at present. The company can earn a further 15% on this amount i.e. Rs 15,00,000 per year.
Therefore, total benefit for the company would be Rs 26,27,000 per year.

Note 1: Should overtime cost be incurred to reduce Stockouts?
Contribution per unit = Sale price - Variable production cost - Variable selling, distribution cost per unit; Variable production cost under the just in time system = Rs 2,000 + (1,040 - 800) = Rs 2,240 per unit; Contribution per unit = Rs 5,000 – Rs 2,240 - Rs 750 per unit = Rs 2,010 per unit.

Overtime cost can reduce stockouts from 3,000 units to 2,000 units, that is customers' demand of 1,000 units more can be met.

Contribution earned from selling these 1,000 units = 1,000 × Rs 2,010 per unit = Rs 20,10,000.
Therefore, the contribution earned of Rs 20,10,000 is more than the related overtime cost of Rs 10,00,000. Therefore, it is profitable to incur the overtime cost.

Note 2: Stockout Costs
Out of the total shortfall of 3,000 units, by spending on overtime 1,000 units of demand can be met. Therefore, actual stockout units is only 2,000 units. As explained above, contribution per unit is Rs 2,010 per unit. Therefore, stockout cost = 2,000 units × Rs 2,010 per unit = Rs 40,20,000.

ii. The company plans to eliminate its raw material inventory altogether. Raw material will be delivered as per the production schedule directly at the factory shop floor, from whence production will begin. The management should therefore carefully consider the following points:

(a) The entire production process has to be detailed and integrated sequentially. This is essential to know because it should be known in advance when in the sub-assembly process is each raw material is required and in what quantity.

(b) Since production is dependent on delivery and quality of raw material, heavy reliance is being placed on suppliers. They should be able to guarantee timely delivery of raw material of the appropriate quality. The company is paying a premium of 30% of the original cost, that is Rs 240 per unit (Rs 1,040 – Rs 800 per unit) in order to ensure the same. Each unit gives a contribution of Rs 2,010 per unit, which is 40.2% of the sale price per unit. Lost sales opportunities due to unavailability of raw material or non- conformance of the material can result in substantial losses to the company. While a portion of this has been factored while doing the cost benefit analysis of implementing Just-in-time systems, it needs careful consideration and monitoring even after implementation. Therefore, to hedge its loss, the management and suppliers should agree on penalties or costs the supplier should incur should there be any delay or non-conformance in quality of materials beyond certain thresholds.

(c) Accurate prediction of sales trends is important to determine the production schedule and finished goods planning.

(d) Continuous monitoring of the system even after implementation is essential to ensure smooth operations. Management commitment and leadership support are essential for its successful implementation and working.

Question 3 - Total Productive Maintenance (TPM)

Pacific Coast Company Ltd. manufactures spare parts. It works in two shifts of 9 hours for 6 days in a week. Lunch break is 30 mins and other miscellaneous breaks add up to 15 minutes. The following details are collected for the last 4 weeks by the TPM team for one of their important equipment

Hours for Planned Preventive Maintenance = 15 minutes per shift
For Breakdown Maintenance = 6 hours total
Set up Changes = 14 hours
Total Power Failure = 4 hours
Total Standard Cycle Time per piece = 3 minutes
No of Parts Produced per shift = 140
Parts Accepted per shift = 131

Required
CALCULATE 'OEE'.

Solutions

Calculation of Shifts

Days per week	...(A)	6
Shifts per week	...(B)	2
Total Working Shifts per week	...(C = A × B)	12
Total Weeks	...(D)	4
Total Shifts	...(E = C × D)	48

Calculation of Un-Planned Downtime

Breakdown Maintenance (in mins)	360
Set up Changes (in mins)	840
Power Failure (in mins)	240
Total …(A)	1,440
Loss of Minutes per shift …(A/ 48)	30

Calculation of Planned Production Time (Mins)

Total time (9 hrs. × 60 mins.)	540
Less: Planned downtime	
Lunch break	30
Miscellaneous breaks	15
Preventive maintenance	15
Planned Production Time	480

Availability Ratio = $\left\{\frac{480\ mins - 30\ mins}{480\ mins}\right\}$ × 100
= 93.75 %

Actual Production = 140 units per shift
Standard time = 3 minutes
Standard Time Required = 140 units × 3 minutes
= 420 minutes
Actual Time Taken = 480 mins. – 30 mins.
= 450 minutes

Performance Ratio = $\left\{\frac{420\ mins}{450\ mins}\right\}$ x 100
= 93.33%

Quality Ratio = $\left\{\frac{131\ parts}{140\ parts}\right\}$ x 100
= 93.57%

Thus, OEE = 0.9375 × 0.9333 × 0.9357 = 81.87%

Question 4 - Total Productive Maintenance (TPM)

GVK Pharmaceuticals Ltd. is producing medication products (pills, balms etc.) and can be called high volume based production environment. There are several different automated production machines located in the plant, through which production of medicines is accomplished and fulfilled the demands.

Plant operates in double shift a day each consisting of 8 hours with 25 minutes' lunch break and tea break of 10 minutes. Following data pertains to automated machine 'X-78'.

X-78
19 April 2023, Wednesday

Breakdown, repair and start up time (unplanned)	90 minutes
Standard cycle time	2.5 minutes per tablet
Quality loss due to scrap, rework, and rejection	40 tablets
Total quantity produced	280 tablets

Required
CALCULATE 'OEE'.

SOLUTIONS
Calculation of Planned Production Time

Total time	480
Less: Planned downtime	
tea break	10
lunch break	25
Planned Production Time	445

Availability Ratio = $\left\{\frac{445\ mins - 45\ mins}{445\ mins}\right\}$ x 100

= 89.89 %

Actual Production = 140 tablets per shift
Standard time = 2.5 minutes

Standard Time Required = 140 units × 2.5 minutes
= 350 minutes

Actual Time Taken = 445 mins. – 45 mins.
= 400 minutes

Performance Ratio = $\left\{\frac{350\ mins}{400\ mins}\right\}$ x 100

= 87.50%

Quality Ratio = $\left\{\frac{140\ tab - 20\ tab}{140\ tab}\right\}$ x 100

= 85.71%

Thus**, OEE** = 0.8989 × 0.8750 × 0.8571
= 67.41%

Question 5 - Total Productive Maintenance (TPM)

Hindustan Ltd. supplies the following information relating to a vital equipment used in its production activity for April 2023:

Total time worked during the month	210 hrs.
Total production during the month	2,800 units
No. of units accepted out of total production	2,520 units
Standard time for actual production of the month	180 hrs.
Time lost during the month	28 hrs.

Required

(i) STATE an appropriate approach to measure the total productive maintenance performance of an equipment.

(ii) Quantify the total productive maintenance performance of the above-mentioned equipment by using the approach stated in (i) above.

(iii) COMMENT on the effectiveness of maintenance of the equipment.

SOLUTION

i. The most important approach to the measurement of TPM performance is known as Overall Equipment Effectiveness (OEE) measure. The calculation of OEE measure requires the identification of "six big losses".

- Equipment Failure/ Breakdown
- Set-up/ Adjustments
- Idling and Minor Stoppages
- Reduced Speed
- Reduced Yield and
- Quality Defects and Rework

The first two losses refer to time losses and are used to calculate the availability of equipment.
The third and fourth losses are speed losses that determine performance efficiency of equipment.
The last two losses are regarded as quality losses.

Performance × Availability × Quality = OEE %

OEE may be applied to any individual assets or to a process. It is unlikely that any manufacturing process can run at 100% OEE.

Availability Ratio per shift $= \left\{\frac{210\ hrs}{210+28\ hr}\right\} \times 100$

= 88.24%

Performance Ratio $= \left\{\frac{180\ hrs}{210\ hrs}\right\} \times 100$

= 85.71%

Quality Ratio = $\left\{\frac{2{,}520\ units}{2{,}800\ units}\right\} \times 100$
= 90.00%

Thus, **OEE** = 0.8824 × 0.8571 × 0.90
= 68.06%

(iii) Comment

World Class OEE is 85% or greater, Hindustan Ltd.'s OEE is somewhere around 68%. It just means that company got some opportunities for improvement. Hindustan Ltd. may improve OEE by collecting information related to all downtime and losses on equipment, analyzing such information through graphs and charts, making improvement decisions thereon like autonomous maintenance, preventive maintenance, reduction in set up time etc. and implementing the same.

(Note – This question has been solved by considering "Time Available" equals to "Total Time Worked plus Time Lost")