

# **Industrial Engineering and Operations Management Functions in the Apparel Manufacturing Industry**

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### **Abstract**

The role of Industrial Engineering Department (IED) is very crucial in improvement of factory performance. The involvement of Industrial Engineers (IE) starts from sampling stage through product analysis to ensure the sample sent for approval is most suited for bulk production. The IED forms the backbone of the entire factory operations by setting production targets and defining methods that need to be followed in the shop floor. The responsibility of IED is to maximize overall efficiency of the manufacturing functions through provision of an effective, appropriate and timely work study and Industrial Engineering service and maintenance of an ideal production environment. The key tasks includes product analysis through determining optimum method of construction and establishing Operation Bulletin (OB); product costing by determining standard minute cost of each operation specifying the equipment type and work aids used; production planning for effective and balanced flow of product; operator performance monitoring systems by hourly production monitoring and skill matrix; off-standards of different functions and implement methods to reduce; method; justify all changes based on analysis of work content; continuous improvement; taking cost saving opportunities; monitor operator performances and take action to improve performances and eliminate causes of underperformance.

### **Keywords**

Industrial Engineering Department, Industrial Engineer, Operation Bulletin, Production Planning, Off-Standards

### **1. Introduction**

Role of the Industrial Engineering and Operations Management functions is crucial in improvement of factory performance. Involvement of Industrial Engineer starts at the sampling stage where he would be involved in product analysis. This analysis is carried out to ensure that the sample sent for approval is most suited for production. This department forms the backbone of the entire factory operations by setting production targets and defining the methods that need to be followed on the shop floor.

In case of apparel manufacturing industries where thousands of peoples are involved for production and majority of the tasks involves manual and semi-automated tasks industrial Engineering and operations management techniques provides the most valuable output within shorter time. Traditionally, most of the persons involved in apparel manufacturing were not aware of costings involved with the production. But day by day with increasing costings of raw materials and worker's salary, the use of industrial Engineering and Operations Management techniques becomes vital for required production quantity, desired quality and on time production process.

If we analyze the history of top class industries, they were pushed to employ the Toyota production system, bundle production system, just in time manufacturing, total productive maintenance, total quality management, 5s, six Sigma, lean manufacturing etc. which are just the industrial Engineering tools that giving the best output at minimum cost within shorter period of time.

Now a day any production system without operations management and industrial Engineering functions impossible to sustain. The ultimate benefits coming from these implementations is the maximum use of labors and cost savings. The major responsibility who are handling these types of activities includes maximizing the overall efficiency of the manufacturing functions through provision of an effective, appropriate and timely work study and industrial engineering service and maintenance of an ideal production environment.

## **2. Methodology**

In order to maximize the overall efficiency of the manufacturing functions it requires to perform some key tasks which may be summarized as follows:

### **Key Tasks**

- ❖ Product Analysis:
  - o Determining optimum method of construction to achieve required finished product efficiently
  - o Establish operation bulletin
- ❖ Product Costing: Determine the standard minute "cost" of each operation specifying the equipment type and work aids to be used
- ❖ Production Planning: Provide a line plan for effective, balanced flow of the product, incorporating line and individual (operation) productivity standards
- ❖ Operator Performance: Develop operator performance monitoring systems by the means of hourly production monitoring, gum-sheet and skill matrix etc.
- ❖ Off-standards: Analyze different factors of increasing off-standards in the factory and implement methods to reduce it
- ❖ Performance Development: Apply industrial engineering techniques to develop the performance of teams and individuals
- ❖ Method Engineering - Develop detailed man and material movement methods. Document all methods using manual, computer based or video/visual systems as appropriate. Justify all changes based on analysis of the work content in the operation, taking account of the skill requirements
- ❖ Maintenance: Ensure that production methods, production equipment and workplaces, work-study data and time standards are effectively and rigorously maintained
- ❖ Continuous Improvement:
  - o Constantly review production methods to identify and take cost saving opportunities
  - o Constantly monitor operator performances against time standards and targets and take action to improve performances and eliminate causes of under performance

In case of apparel manufacturing the key tasks mentioned above is crucial in all stages. During the study a reputed apparel manufacturing industry was chosen and the overall functions has been understood at each stage and for implementation these functions these are documented using block diagram and responsibilities given to respective departments.

### 3. Research and Findings of the Study

The overall Industrial Engineering and Operations Management study functions have been shown and explained at several sections of apparel manufacturing depending on the requirements.

#### 3.1 Sampling & Pre-Production Standard Operating Procedures

The Sampling & Pre-Production Starts from order entry from merchandizer and goes through preparation of operation bulletin, target production, thread-fabric-accessories consumption, pp sample approval, order confirmation and after subsequent changes finishes through pp meeting as shown in Figure-1.

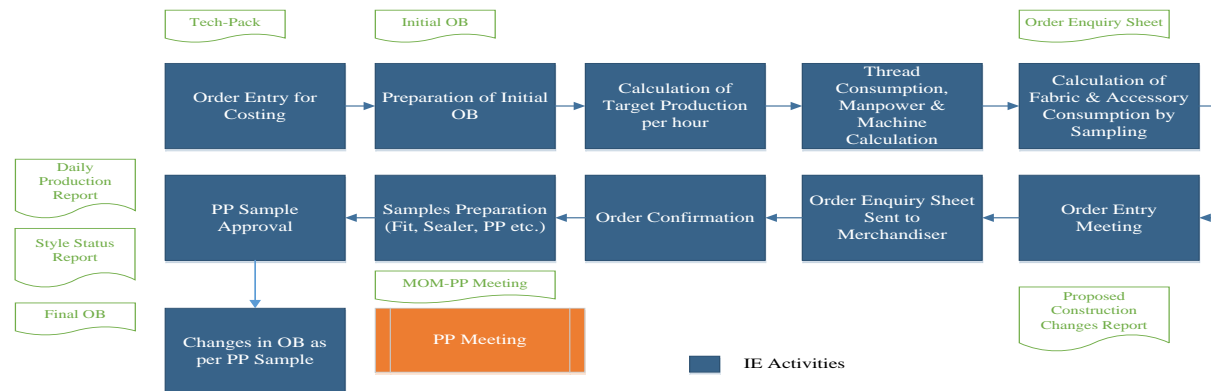


Figure 1: Sampling & Pre-Production SOP

The whole responsibilities of department responsible and necessary coordination has shown in Table 1.

Table 1: Responsibilities of Different Persons according to SOP

SL No	Tasks	Responsibility	Reports
1	Merchandiser requests for various details regarding initial costing purpose from production team.	Merchandiser	
2	A sample or sketch of the style with all the construction details must be received by the Industrial Engineering department. This sketch and all construction details must be sent in hard copy and also soft copy should be sent via e-mail to IE Head cc to GM-Production, IE-Head & Production Planner and Sampling Department Head.	Merchandiser	
3	Depending on product details, IE-Sampling prepares an Initial Operation Bulletin (OB) which contains all product related operations and requirements	IE-Sampling	Initial Operation Bulletin
4	On the Basis of the Initial Operation Bulletin, IE Sampling calculates the target production per hour and total number of hours required to complete the order.	IE-Sampling	
5	Once the target production per hour is finalized, different requirements (thread consumption, Manpower & Machine requirements, etc.) are calculated by IE - Sampling.	IE-Sampling	
6	Simultaneously, Sampling Team calculates consumption for the fabric and sewing accessories (lace, tape, etc.), which is then reviewed by IE Sampling.	Sampling Team & IE-	
7	IE-Sampling organizes order enquiry meeting. All required and recommended changes pertaining to feasible production are discussed / finalized in the meeting.	IE-Sampling	Construction Changes Report

8	IE-Sampling fills the order enquiry sheet with details and sends the same via e-mail to respective merchandiser cc to GM-Production, IE Head, Sampling Head and Quality Manager.	IE-Sampling	Order Enquiry Sheet
9	Total Lead Time to send the report is 2 working days.	Merchandiser	
10	Merchandiser receives the Order Enquiry Sheet and prepares his order cost sheet. Merchandiser then sends the order cost sheet to Buyer.	Merchandiser	
11	Buyer receives order costs sheet and reviews the same, as per his defined criteria.	Buyer	
12	Once buyer approves the cost sheet, merchandiser confirms the order to GM-Production, IE Head, sampling head and quality head.	Merchandiser	
13	Sampling prepares samples (Fit, Sealer, PP etc.). The samples are sent to merchandiser and he forwards the same to buyer for approval.	Sampling Team	
14	Buyer reviews the samples and recommends the required changes (if any).	Merchandiser	
15	IE-Sampling incorporates the changes in operation bulletin as per changes recommended by buyer at every pre-production stage and generates Final Operation Bulletin.	IE-Sampling	
16	Quality team organizes the Pre-Production Meeting. Production Team, Industrial Engineering Team, Quality Team & Maintenance Team attend the meeting in order to discuss the Production details related to the style.	Factory	Daily Production Report & Style Status Report
17	Sampling team maintains Daily Production Report and Style Status Report.	Sampling Team	

### 3.2 Fabric Store Standard Operating Procedures

Store functions starts through supplier and goes through fabric inhouse, shrinkage and shed checking and finishes through finally stored in warehouse for production as shown in Figure-2.

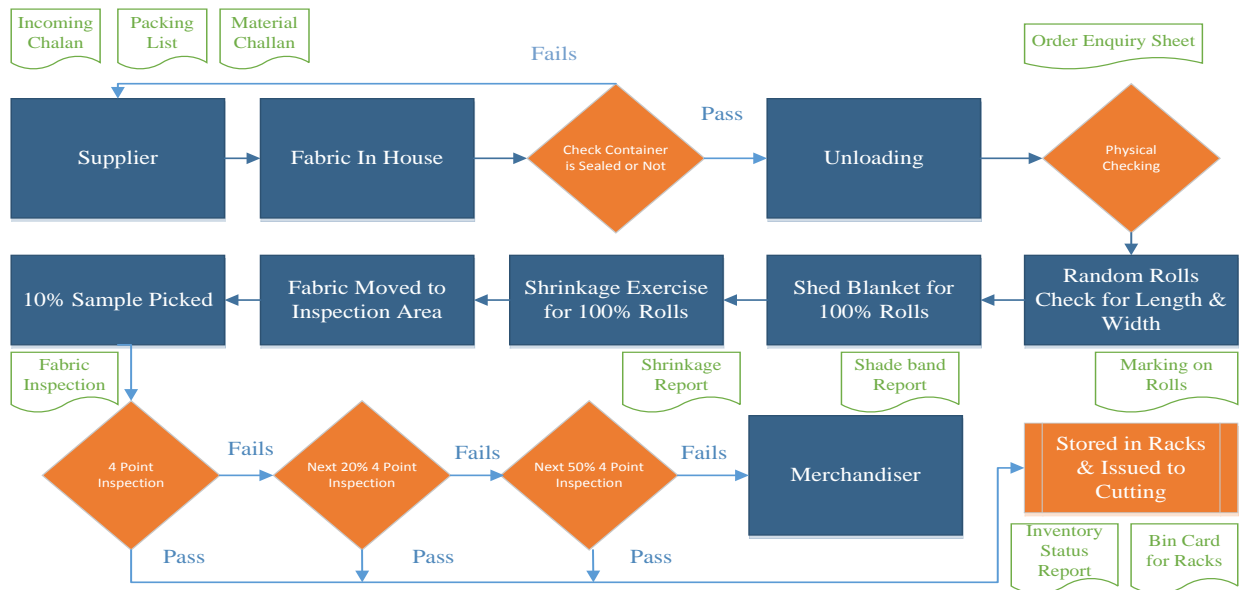


Figure 2: Fabric Store SOP

The responsibilities of different designated persons has been explained in Table 2 which requires many decisions regarding quality control department and sometimes from buyers also.

Table 2: Responsibilities of Different Persons according to SOP

SL No	Tasks	Responsibility	Reports
1	Supplier receives order from purchase department on challan & the same is supplied by him with packing list & material challan for reference.	Supplier	
2	2 Fabric is received in In-house by Store In-charge.	Store In-charge	
3	Store In-charge checks whether the container is sealed/not sealed as per the challan.	Store In-charge	
4	If any issues are found, the details are advised to merchandiser and the respective supplier.	Store In-charge	
5	If container is sealed, store in-charge guides unloading helpers to unload material	Helpers	
6	While unloading, rolls are counted & physically checked if there is any deviation from what is mentioned in challan.	Store In-charge	
7	Random rolls are picked and checked for length and width by Fabric QC. Rolls are marked as per their length and width.	Fabric QC	
8	Cut and prepare a continuity card from 100% rolls of fabric (Prepare a shade blanket from 100% roll). Washing exercise is done and a shrinkage and shade band report is prepared by Fabric QC.	Fabric QC	
9	Once this is done, fabric is moved to Fabric Inspection Area.	Helpers	
10	10% roll from the body fabric will be selected by Fabric QC.	Fabric QC	
11	Roll number, color / lot no. (Reference from the shade card is entered in the fabric inspection form by Fabric QC.	Fabric QC	
12	The rolls are then inspected as per 4-point grade system.	Fabric QC	
13	If 10% inspection is passed, the inventory status report and bin cards for racks are updated and rolls are stored on racks to be issued to cutting department.	Fabric QC & Helpers	
14	If 10% inspection fails, another 20% of the rolls are randomly selected and put to 4-point inspection test.	Fabric QC	
15	If 20% inspection is passed, the inventory status report and bin cards for racks are updated and rolls are stored on racks to be issued to cutting department.	Fabric QC	
16	If 20% inspection fails, 50% of the rolls are randomly selected and put to 4-point inspection test. If 50% inspection is also fail, then the merchandiser & respective supplier is updated about the situation.	Fabric QC, Store & Merchandiser	

### 3.3 Accessories Store Standard Operating Procedures

Similar procedure applies for accessories store starting from supplier finishes through stored in warehouse for production through major decisions as shown in Figure 3.

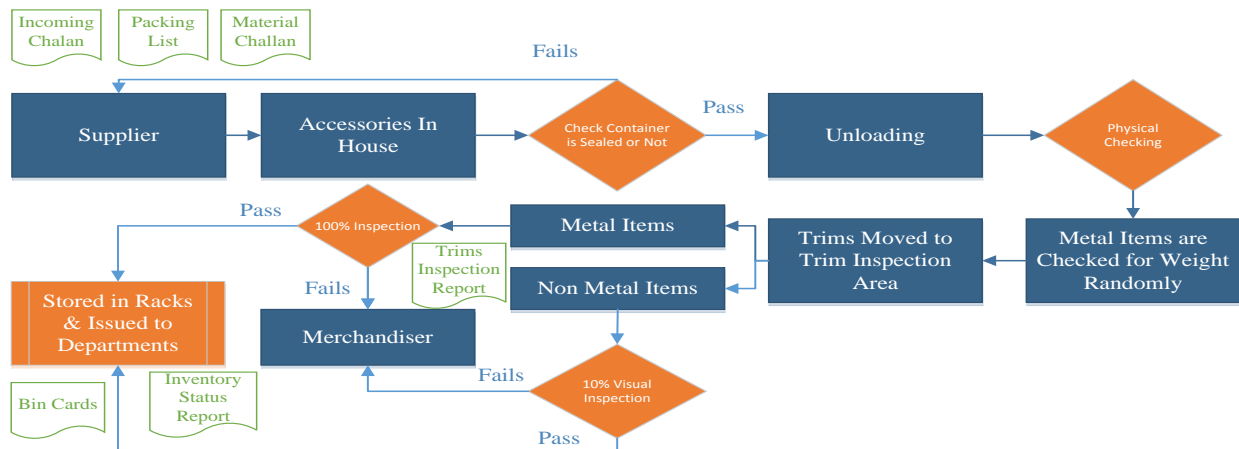


Figure 3: Accessories Store SOP

Table 3 shows the major responsibilities of responsible persons for storing at warehouse for production.

Table 3: Responsibilities of Different Persons according to SOP

SL No.	Tasks	Responsibility	Reports
1	Supplier receives order from purchase department on challan & the same is supplied by him with packing list & material challan for reference.	Supplier	
2	Fabric is received in In-house by Store In-charge.	Store In-charge	
3	Store In-charge checks whether the container is sealed/not sealed as per the challan.	Store In-charge	
4	If any issues are found, the details are advised to merchandiser and the respective supplier.	Store In-charge	
5	If container is sealed, store in-charge guides unloading helpers to unload	Helpers	
6	While unloading stock, store in-charge counts & physically checks the stock if there is any deviation from what is mentioned in challan.	Store In-charge	
7	Metal items are randomly selected & checked for weight confirmation.	Store In-charge	
8	Trims are then moved to trims inspection area and put to inspection after segregating metal items from non-metal items.	Accessories QC	
9	100% of Metal items are then passed through metal detector machine and trims inspection report is updated accordingly	Accessories QC	Trims IR
10	If stock passes this test, the inventory status report and bin cards for racks are updated and trims are stored on racks, to be issued to departments.	Accessories QC	
11	If this stock fails, it is returned back to supplier and the same is informed to Merchandiser via email with cc to all department heads.	Accessories QC	
12	10% of non-metal items are then visually inspected & trims inspection report is updated accordingly	Accessories QC	
13	If stock passes this test, the inventory status report and bin cards for racks are updated and trims are stored on racks, to be issued to departments.	Accessories QC	
14	If this stock fails, it is returned back to supplier and the same is informed to Merchandiser with cc to GM-Production, Quality Manager, IE Head.	Accessories QC	

### 3.4 Cutting Section Standard Operating Procedures

The cutting section functions starts from cut plan preparation and finishes through cutting, numbering, bundling and handover to sewing section as shown in Figure 4.

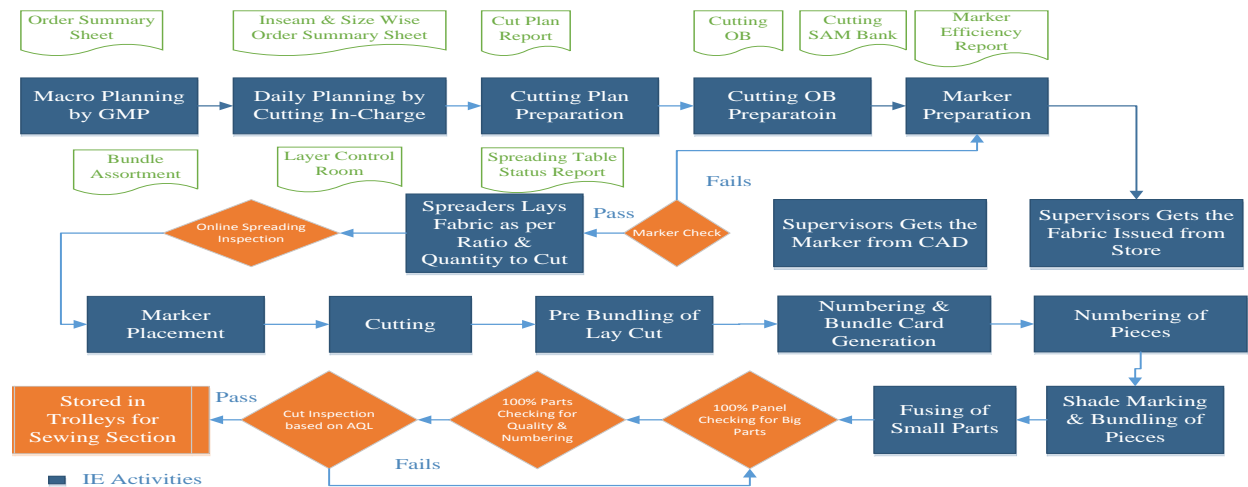


Figure 4: Cutting Section SOP

Cutting section plays the first and main role for quality control and production. The major responsibilities has shown in Table 4.

Table 4: Responsibilities of Different Persons according to SOP

SL No	Tasks	Responsibility	Reports
1	GM-Production prepares the macro plan of order execution.	GM-Production	
2	Cutting In-charge prepares Inseam & Size-wise Order Summary.	Cutting In-Charge	
3	Cutting In-charge prepares a Cut Plan in order to streamline the process of cutting and fabric utilization.	Cutting In-Charge	
4	IE-Cutting prepares the Cutting-OB which contains cutting operations, manpower and machines requirements.	IE-Cutting	OB, SMV Bank
5	AutoCAD Operator prepares marker as per Inseam & Size-wise Order Summary Sheet. He also calculates marker efficiency and generates a marker efficiency report.	AutoCAD Operator	Marker Efficiency Report
6	Cutting supervisor gets the fabric issued from store as per cut plan	Cutting Supervisor	
7	Cutting Supervisor receives the marker form CAD department and checks the marker for the number of parts and sizes as per cut plan.	Cutting Supervisor	
8	If marker check fails marker is sent back to AutoCAD Operator to modify and incorporate the recommended changes.	Cutting Supervisor	
9	If marker is OK, spreader lays the fabric as per marker length to be cut and also fills layer control form.	Spreader	
10	Spreader manually performs on the job spreading inspection on the lays to check fabric defects like shade variation or major holes.	Spreader	
11	Spreader fills the start time, end time & type of activity in the Spreading Table Status Report located at each table.	Cutting In-Charge	Spreading Table Status Report
12	Cutter cuts the lay as per the marker and fills daily cutting production report which highlights the actual status of cutting.	Cutting Man	
13	IE-Cutting prepares the fabric utilization report to calculate the wastages in cutting.	IE-Cutting	Fabric Utilization
14	Helpers start pre-bundling of lay cut as per cut no and stores in the racks.	Helpers	
15	Cutting In-charge allocates the bundle number as per style, sizes, shades etc. and generates a bundle card	Cutting In-Charge	
16	The cut parts are numbered by the numbering operators.	Numbering Operators	Daily Numbering/Bundling
17	Bundling operators perform shade marking and bundle the pieces accordingly.	Bundling Operators	
18	Fusing is done for small parts like collar, cuff etc. using fusing machine by fusing machine operators.	Fusing M/C Operators	
19	100% panel checking for big parts and 100% parts checking for fabric quality, numbering & shade are performed by quality inspectors.	QC In-charge	
20	Quality Auditor performs inspection for cuts using AQL 1.5 method of sampling.	Quality Auditor	Cutting Prod.
21	Bundled Cut parts are stored in trolley, ready to input for the sewing department	Helpers	
22	IE-Cutting prepares Daily Efficiency Report for cutting.	IE-Cutting	Cutting Eff.

### 3.5 Sewing Section Standard Operating Procedures

Sewing section functions starts from line plan receiving and finishes at hand over to washing or finishing as shown in Figure 5.

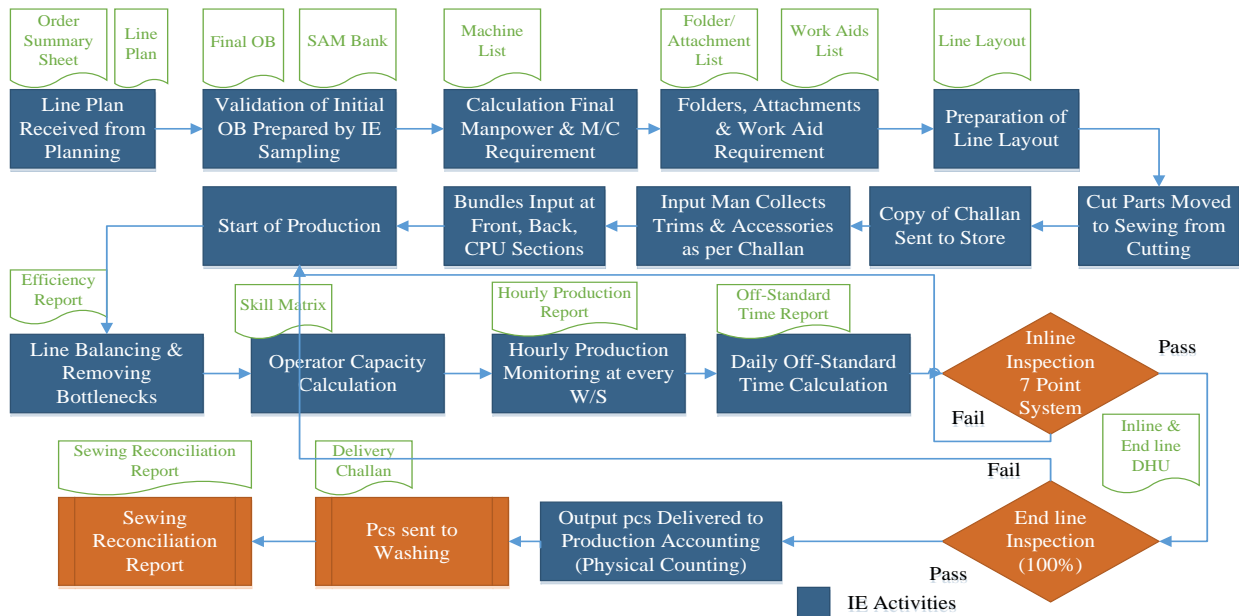


Figure 5: Sewing Section SOP

The responsibilities of different section incharge has shown in Table 5.

Table 5: Responsibilities of Different Persons according to SOP

SL No.	Tasks	Responsibility	Reports
1	Sewing department receives line plan from planning department.	Planning In-charge	
2	IE-Sewing validates Initial Operation Bulletin prepared by IE-Sampling.	Sewing - IE	Final OB, SAM
3	IE-Sewing calculates final requirement of manpower and machinery using the basis final operation bulletin.	Sewing - IE	
4	IE-Sewing advises the folders, attachments and work-aids requirements and gets it prepared.	Sewing - IE	
5	IE-Sewing also prepares a line layout for optimal utilization of space and resources	Sewing - IE	
6	Cut parts are moved to sewing area using a trolley by an Input man (loader).	Loader	
7	A copy of input challan is sent to store.	Loader	
8	Store in-charge issues the trims and accessories as per the challan to the input man.	Store In-charge	
9	Batch Setting is being performed by the IE-Sewing, Production Manager, Quality manager & Maintenance Manager. All the machines are set as per required quality.	Sewing Team	
10	Bundles are then input at each section (front & back) as per the layout defined by IE-Sewing.	Loader	
11	Start of production.		
12	Sewing Line is being balanced by Sewing-IE on the basis of operator capacity and target of the line	IE-Sewing	



13	IE-Sewing calculates capacity of each operator to maintain operator-wise performance.	IE-Sewing	
14	The pieces move in the lines on the center table in the form of bundles till the last operation i.e. End line Quality Inspection.		
15	Supervisor monitors every workstation every hour to ensure smooth movement of bundles in sewing line and fills the hourly production sheet.	Line Supervisor	
16	Supervisor monitors off-standard activities at each workstation and fills the off-standard time report at each workstation. IE-Sewing monitors the off-standard time of every line and takes necessary action to reduce the same.	IE-Sewing	Off-Standard Report
17	Line QC performs quality check during sewing using Inline 7-point system.	Line QC	
18	If any wrong piece is found, the piece is being corrected and then the bundle is moved ahead in line. If the bundle is passed, then the bundle is moved ahead in the sewing lines.	Line QC	
19	Once bundle passes end-line inspection, output pieces are delivered to production accounts where pieces are counted manually.	Production Accounts	
20	Once counting of pieces is complete, pieces are sent to washing department bundle-wise for washing of the pieces and a delivery challan is issued against the same.	Production Accounts	
21	IE-Sewing prepares daily sewing efficiency report.	IE-Sewing	Eff. Report
22	At the end of every style, Production Manager prepares Sewing Reconciliation Report.	Production Manager	

### 3.6 Finishing & Packing Section Standard Operating Procedures

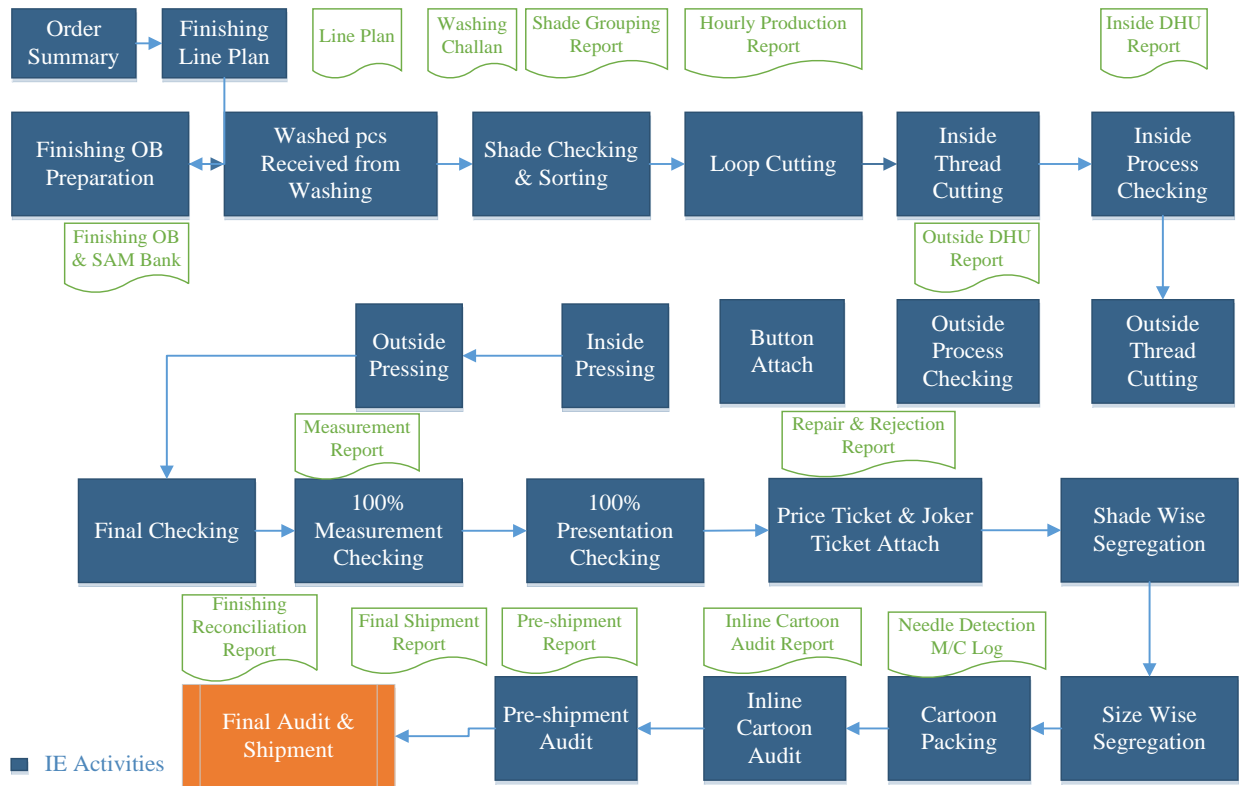


Figure 6: Finishing & Packing Section SOP

Table 6: Responsibilities of Different Persons according to SOP

SL No.	Tasks	Responsibility	Reports
1	Order summary sheet is received from GM Production.	GM-Production	
2	Finishing Line Plan is prepared by Finishing Manager.	Finishing Manager	
3	IE-Finishing prepares Operation Bulletin depending upon the order size & quantity.	IE-Finishing	OB
4	Pieces are received by finishing department from washing as per washing challan.	Production Accounts	
5	Shade Segregation Operator segregates the washed pieces as per shade and Initial Shade Sorting is performed.	Finishing Operators	
6	Loops are being cut and hourly production report is being maintained by Supervisor.	Trimmers	
7	Inside Thread Cutting, Checking, Outside Thread Cutting & Checking	Trimmers & QI	
8	Snap, Button or Fastener Attach	Operators	
9	Pieces are then blown through the Thread Sucking Machine to remove all unwanted loose threads from the piece.	Operator	
10	Inside pressing	Pressman	
11	Outside pressing	Pressman	
12	Final checking	QI	
13	Measurement Check for Key Points I.e. Out seam, Inseam & Waist.	QI	
14	Final Presentation Check	Quality Auditor	
15	Price ticket and joker tag attach	Operators	
16	Pieces are passed through Needle Detector Machine to Needle Free Zone for packing.	Operator	
17	Shade-wise and size-wise segregation of pieces as per requirements	Segregators	
18	The product is then packed into cartons PO-wise and stored in carton warehouse.	Carton Packers	
19	Inline carton audit is performed by Finishing Quality Auditor.	Quality Auditor	
20	Once the style is shipped, Finishing Manager prepares Finishing Reconciliation Report.	Finishing Manager	Reconciliation Report

It has been observed from the findings that the Industrial Engineering & Operations Management Functions are very crucial for the success of the organizations. Without implementation of these functions in apparel manufacturing industries it's impossible to sustain in respect of costings, on time shipments and especially final customer satisfactions. Countries which are still in developing stage, need to start working on these functions.

There are lot of consultants or consultancy firms are working on the implementations of Industrial Engineering and Operations Management Functions and the industries who are accepting these as necessity are highly successful in the business. Moreover, Universities, Technical Institutes, Training Centers, Colleges, Schools are teaching these subjects in their course materials. It would be very helpful if consultants can be appointed for implementation of the functions then faster and successful implementation could be done and existing employees could be trained for maintaining their responsibilities.

### 3.7 Style Change over Standard Operating Procedures

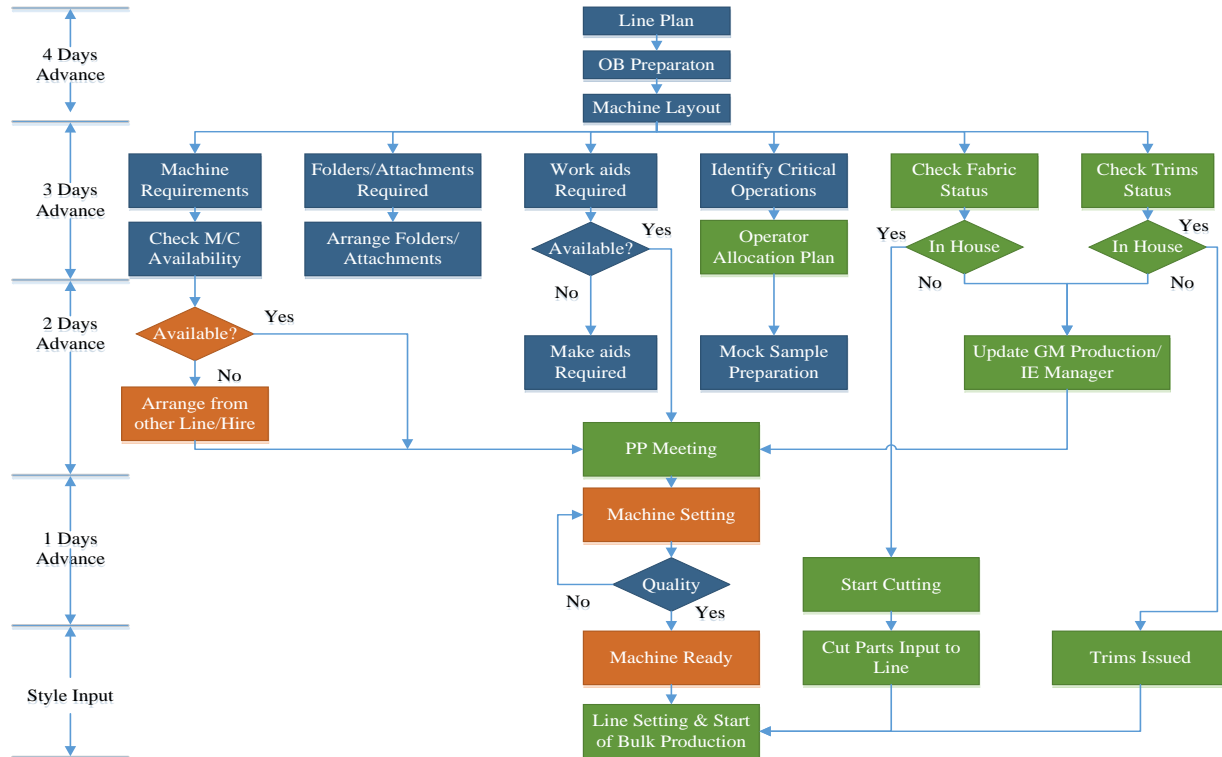


Figure 6: Style Changeover SOP

### 4. Future Recommendation

The Industrial Engineering and Operations Management Functions was analyzed and successfully implemented at some major sections of apparel manufacturing industry including sampling & preproduction, cutting, sewing, finishing & packing and finally changeover areas. For future study, several other sections could be included for implementation. For example, maintenance section purpose Total Productive Maintenance (TPM) could be implemented so that machine idle time & setting time could be reduced, some standard parameters based on similar type of styles could be set and made visible to all concerned persons so that for future production of similar styles the difficulties faced could be identified and solved in advance. Among so many folders, attachments and work aids a machine tools storing system could be developed so that faster arrangements could be done.

Since, the analysis was done for sections, the analysis and implementation could be done for every workstation and operators could also be trained about these functions so that everyone can develop and implement these functions.

In order to reduce inventory and costings Just in Time (JIT) could be implemented so that every requirement could be fulfilled exactly on time not before or after. Some other Industrial Engineering tools such as six sigma, total quality management, supply chain management, quality circle, quality assurance could also be implemented for better cost savings and high productivity.

### 5. Conclusion

Implementing the Industrial Engineering and Operations Management Functions is not a single man's task. Involvement of every person working in the industry requires. Before starting implementation, the top management persons need to understand and be motivated first. Everyone need to be concerned about the challenges, responsibilities and finally the benefits coming through this. Since, these functions will control all the processes of the industry proper training should be provided to all and a highly -decorated team should establish for monitoring the activities and maintain. Before implementation these functions, the targeted apparel industry was missing the on-

time shipment regularly and costings were very high and for critical styles the industry was facing losses and very lower productivity. After implementation, the industry started early shipment in all styles and costings reduced nearly 55%. The productivity improved around 42% and lot fail percentage by buyer inspection become 0.3% within 2 months. Finally, the implementation of the Industrial Engineering and Operations Management Functions are very crucial for sustaining in the business and need proper monitoring to success.

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### **Biography**

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