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Performance Evaluation through Work In Process (WIP) Analysis in Apparel Export Manufacturing Units of Jaipur

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Abstract:
The performance is evaluated with reference to time, material, labor and source provision. The main performance problem is the low productivity of the apparel industries due to lack of skilled labor, poor working conditions and absenteeism, etc. The Key Performance Indicators (KPIs) reports are considered to be an important achievement to get the required and desired enhancements on productivity, operators' efficiency, WIP, quality; (level of defects).
Work in process (WIP) inventory includes the set at large unfinished products in a production process. These products are not yet completed, but either just being fabricated or waiting in a queue for further processing. In garment manufacturing WIP is generally measured in pieces. High WIP is found to be common in garment industries.
The apparel industries in the Rajasthan are mainly concentrated in Jaipur. There are approximately 250 apparel manufacturing units in Jaipur. The present study aims to analysis of WIP in cutting, stitching and finishing section and find out the significant difference of WIP in between low, medium and high productivity units. Data was collected from 12 apparel export industries, Four from low productivity, four from medium pro
ductivity and four from high productivity using a questionnaire. The results revealed that higher WIP was found in low productivity units as compared to medium and high productivity units. There is a significant difference between low and high productivity units. It was also found there is no significant difference found in the WIP of cutting and stitching section and there is a significant difference in WIP of the finishing section between low and high productivity units.
Key words – Apparel Industry, WIP, Performance, Productivity, KPI

Introduction:

Performance is conceptually defined with respect to 'Key Performance Indicators' (KPI) e.g., lead time, cost, quality, and efficiency, work in process, effectiveness and dependability, to be a function of autonomous concepts. A variety of Key Performance Indicators (KPI) are investigated to get better the work method and attain superiority through productivity (Ali et al., 2011). The KPIs provide the results of the business performance and make sure indicators where the performance should be getting better in the future.
The Key Performance Indicators (KPIs) reports are considered to be an important achievement to get the required and desired enhancements on productivity, operators' efficiency, WIP, quality; (level of defects), industry structure; (relations between administration and operators), human resources; (absenteeism level and working shifts) and well-organized usage of resources; (usage of the fabric and accessories).
WIP is one of the Key Performance Indicators which openly influences different areas of production. Many industries either overlook or do not know its significance resulting in overproduction and wastage of both time and resources. The semi-finished or completed garments which are transported from one work station to the next work station are called work in progress (WIP). WIP is made-up of all garments and their parts that are not completely finished. It can be calculated in units (pieces) or time (minutes) (Babu, 2012). WIP is often an unseen part of the practice to decrease lead times and increases industry performance. It means that the number of garments or pieces made during production in the industry at any one time. WIP is one of the KPI which openly influences different areas of production. Many

industries either overlook or do not know its significance resulting in overproduction and wastage of both time and resources.

The areas which are affected by WIP are as follows:

- **Effective Use of Working Capital:** WIP overheads money, material, labor and overheads) to produce; and overload work in process means an excess of working capital occupied in a resource that is not adding any value.
- **Storage, Space and Housekeeping:** Higher the WIP, extra storage space is needed, which is provided by trolleys and racks that are used to store garment parts in an organized manner. With the enhancement in WIP, more storage equipment will be essential. It also results in work waiting in racks or trolleys for a longer time, thereby increasing the possibilities of garment getting dusty and crushed.
- **Quality Control:** High levels of WIP results in a large amount of piled pieces before them are detected by roving or final quality assurance and therefore raising the possibilities of defects and rework.
- **Response to Customer Needs and Risk:** WIP queuing also considerably decreases flexibility and speed of reaction to the market demand. A smaller amount work in process means, cutting can be closer to the final delivery giving the buyer more possibility to make last minute changes to style, size and color breakdowns, based on the latest market reaction. In today's rapid change fashion environment, high levels of WIP could mean that making the wrong product.
- **Production Control:** Another disadvantage with the high level of WIP is that it gives a false sense of safety. Problems are less obvious, the need for solutions are few and often ignored. High WIP levels make it harder to find and rapidly process an urgent order or size/color selection through the production system.

For such a significant business KPI industries simply do not know how much WIP they have at any point of time. During the production manage of WIP is not seen as a priority by managers and supervisors an organized approach is lacking. So, each department simply works to its own 'perceived' priorities, typically overproducing and carrying unnecessary high levels of WIP (Gibson, 2008). Therefore the objective of the study is to study the work in progress levels of cutting, sewing and finishing sections in low, medium and high productivity unit.

Methodology

Locale of the Study - The locale of the study was the apparel export units of Jaipur.

Selection of the Sample - In order to draw a comparison between low, medium and high productivity units, 12 units were selected in all. Four units from low, four units from medium and four units from high productivity were selected through purposive sampling. WIP in each department, i.e. cutting, sewing and finishing was calculated on a daily basis of seven days. It was measured in pieces (units).

Tools and techniques of data collection -The data was collected with the help of an interview schedule. WIP was measured with total pieces loaded in a process minus total pieces out from that process, which is the WIP of that process.

Calculations

- WIP of cutting section: For calculating the WIP of cutting section only cut pieces of stock were considered as cutting WIP. Fabric that were layered on table or received from fabric store for cutting was not considered as WIP.
  Total cut quantity - Total quantity sent to sewing
- WIP of Sewing section: Total pieces loaded to the operators - pieces completed
- WIP of Finishing section: Total received from sewing - Total pieces packed

(Gibson, 2008, Sarkar, 2013)

Data Analysis

Appropriate statistical tools were used as the collected data was analyzed. The data sheet was imported from Excel to the Statistical Packages for Social Sciences' (SPSS) 16 software for analysis of data. Mean, Standard Deviation, ANOVA (analysis of variance), Post- hoc were computed to find out the significant difference in the WIP of low, medium and high productivity units.

ANOVA- ANOVA was applied to test the hypothesis at the significance level of 5% and 1% (0.05, 0.01). It was used to test the main hypothesis of the study i.e. the significant difference between low, medium and high productivity units in terms of WIP of cutting, stitching and finishing section

Post-hoc test – Post-hoc analysis was used to find out the difference of variable between sub group of sample that would otherwise remain undetected and undiscovered. When ANOVA test results in a significant F value for a main effect of a factor with more than two levels then it is assumed that the samples are not all from populations with the same mean. It was used to find which groups differ from the rest.

Result & discussion

H_a1. There is a significant difference in the WIP of cutting section between low, medium and high productivity units

Table 1: ANOVA for WIP of Cutting Section (in pieces) in Low, Medium and High Productivity Unit

Productivity	n	Mean	SD	Source of variation	Sum of Squares	df	Mean Square	F
Low	4	1228	347.75	Between Groups	956308.167	2	478154.083	2.126
Medium	4	1134	714.24	Within Groups	2024196.750	9	224910.750	
High	4	588	208.91	Total	2980504.917	11		

*Significant difference at 0.05 level

The above table-4.30 indicates the Mean, SD and ANOVA to find out the difference in the WIP of cutting section in low, medium and high productivity units. The mean value of WIP in low productivity units is 1228 with SD of 347.75 whereas in medium productivity units mean is 1134 with the SD of 714.24 and in high productivity units mean is 588 with the SD of 208.91. Higher mean of WIP was found in low productivity units as compared to medium and high productivity units. F ratio is 2.126, $p>0.05$ is not significant. Hence, statistical analysis shows that there is no significant difference of WIP in low, medium and high productivity units. Thus, the framed hypothesis, which states that there is a significant difference in the WIP of cutting section between low, medium and high productivity units, is rejected.

It was observed that there was no difference in WIP of cutting section in low, medium and high productivity units. WIP of cutting section was interrelated with WIP of Stitching section in all the units. In all the units it was observed that stitching section affected the WIP of cutting section because operators did not complete their work timely so bundles were not loaded in stitching section. In cutting section, workers performed the task easily and less time was consumed in cutting and the pieces were piled resulting in a huge amount of WIP which further resulted in imbalance in WIP between two operations. In all the units it was observed that higher WIP of cutting section could be cause of over production in cutting section. Inventory in the cutting section was too high, cut pieces lying on the table till they were transferred to the sewing section and blocking the layering and cutting table for the next style. In some of the units, with the absence of storage racks the cut pieces were piled up unsystematically on the floor.

Slack et al., (2001) viewed that overproduction is the main cause of higher WIP. To produce the garment more than the requirement at a given point of time created an excess of inventories, which needed, excess staff, storage area as well as transportation, etc. Similarly Kumar and Sampath (2012) viewed that in a garment firm operations of sewing section is a very time consuming as compared to other sections. In most cases, the delivery time was delayed due to untimely completion of the garment by the sewing section. The delay in construction and rejection of garment is dependent on the skills needed in machine handling and material handling.

H_a2. There is a significant difference in the WIP of stitching section between low, medium and high productivity units

Table 2:ANOVA for WIP of Stitching Section (in pieces) in Low, Medium and High Productivity Units

Productivity	n	Mean	SD	Source of variation	Sum of Squares	df	Mean Square	F
Low	4	396	103.50	Between Groups	88866.667	2	44433.333	1.433
Medium	4	391	266.59	Within Groups	279140.000	9	31015.556	
High	4	211	106.12	Total	368006.667	11		

*Significant difference at 0.05 level

To identify the difference in the WIP of stitching section between low, medium and high productivity units mean, sd and Anova were calculated. Result shown in table-4.31.The mean value of WIP in low productivity units is 396 with SD of 103.50 whereas in medium productivity units mean is 391 with the SD of 266.59 and in high productivity units mean is 211 with the SD of 106.12. The higher mean is found in low productivity units than those of medium and high productivity units. F ratio is 1.433, $p>0.05$ which is not significant. The results reveal that there is no significant difference of WIP in low, medium and high productivity units. Thus, the framed hypothesis which states there is a significant difference in the WIP of cutting section between low, medium and high productivity units is rejected.

The above results indicate that there is **no difference in WIP of stitching section** between low, medium and high productivity units. The production rate was low in stitching section, so the WIP of Stitching section was higher. In some of the units it was observed machine breakdowns due to poor maintenance, lack of machine maintenance schedule and machine break down

record maintenance. It was observed specialized sewing machines were not used.

In all the units, absenteeism in stitching section was also the main cause of higher WIP. It was found that in stitching section on an average 5-10% operators remained absent per day. Delays in material procurement were another major problem of all the units. Delays in procurement of trims, accessories, thread spools, needles and embroidered pieces of the garment in stitching section affected the production rate of garments. It was seen that some parts of the garment were sent outside for the embroidery, dyeing and other specialized operations but were not received on time resulting in delays.

It was also found that in some of the units thread spools, needles and trims were not properly put in the boxes. The boxes were also not placed in the racks. Even in the store room all these things were unsystematically placed. Record was not maintained for trims and accessories. Searching for the right tool and trims took lots of time and operators were kept waiting for the same. In some of the units, production planning was poor. There was no planning for providing various details for a new style such as fabric details; sewing and construction details; pressing and packing details to ensured the success of the new style. In some of the units, operators shared the tools such as scissors, measuring tape, seam gauge, and seam pucker etc. Thread clippers were not attached to their machines, and sharing also affected their production.

Karim and Rahmaan (2012) depicted that in sewing section, most of the time there was a problem in Flat-lock machine and a significant time was being wasted to repair this machine. Other types of machine problems included pressure failure, breakdown of needle, needle piping and needle chain stitch problem. Most of the time, in sewing section, production was stopped due to variation in shades of fabrics which contributed about 30.12%. Similar results were found by Ratnayake, Lanarolle and Marsh (2009) that sewing lines were imbalanced in terms of (WIP levels), they further found that piles of WIP were seen at some workstations and other workstations were waiting for inputs. Operators were waiting due to bottlenecks, so workstations not only reduced the line efficiency but also broke the rhythm of working. The main reason behind the higher WIP was production setup which was not flexible towards the style changeover which increased the WIP and decreased the production rate. Karim (2013) also indicated that style change over time also influenced the WIP stock. There is a significant increase in WIP stock due to long changeover time as a result extra space or container was required for extra WIP inventory.

H_a3. There is a significant difference in WIP of finishing section between low, medium and high productivity units

Table 3: ANOVA for WIP of Finishing Section (in pieces) in Low, Medium and High Productivity units

Finishing section WIP	n	Mean	SD	Source of variation	Sum of Squares	df	Mean Square	F
Low	4	1370.50	87.76	Between Groups	875846.167	2	437923.083	5.545*
Medium	4	911.25	340.13	Within Groups	710794.500	9	78977.167	
High	4	728.25	336.95	Total	1586640.667	11		

*Significant difference at 0.05 level

To find out the difference in the WIP of finishing section between low, medium and high productivity units mean, sd and ANOVA were calculated. Result shows in table-4.32. The mean value of WIP in low productivity units is 1370.50 with the SD of 87.76 whereas in medium productivity units mean is 911.25 with the SD of 340.13 and in high productivity units mean is 728.25 with the SD of 336.95. The higher mean is found in low productivity units as compared to medium and high productivity units. F ratio is 5.545, $p<0.05$ which is significant at the 0.05 level. The above results show that there is a significant difference in low, medium and high productivity units in finishing section. Thus, the framed hypothesis which states, there is a significant difference in the WIP of finishing section between low, medium and high productivity units, is accepted.

Table 4: Post-hoc Analysis: Multiple Comparison between Low, Medium and High Productivity Units

Variable	Productivity		Mean Difference	Std. Error	Sig.
Finishing WIP	Low	Medium	459.250	198.717	.123
	Medium	High	183.000	198.717	.667
	Low	High	642.250(*)	198.717	.031

*Significant difference at 0.05 level

The above table-4.33 indicates the further results of post hoc analysis in case of WIP of finishing section. The mean differences of WIP between low and medium productivity units are 459.250, which are not significant. The mean differences of WIP between medium and high productivity units are 183.000, which are not significant. The mean differences of WIP between low and high productivity units are 624.250, which are significant at 0.5 level. The above results show that there is a significant difference found between low and high productivity units and there is no significant difference found between low

and medium productivity units and medium and high productivity units.

Difference of WIP of finishing section in low, medium and high productivity units

It was found that WIP of finishing section was higher in **low productivity units** rather than high productivity units. This might be because the garments could not be packed due to the high level of rework. Spots, stains, untrimmed threads, defective parts, washing of soiled garments and stickers in side of seam were some of the common reasons of rework. These were seen in all the low productivity units which increased the WIP in finishing section. It was observed that the rework level was high in low productivity units as compared to high productivity units. It is because of poor machine maintenance and poor material handling in low productivity units. It consumed more time, labor and increased the lead time. In some of the low productivity units it was observed that, sewing and finishing sections were situated on separate floor which created difficulty in transferring garment pieces from one section to another section. This excess transportation was also the cause of higher WIP.

In some of the units, defective pieces were mixed with the finished garment and lot of time wasted in separating the garments hence garments could not be packed on time. In low productivity units, a lot of alterations were found and lots of time was wasted in repair. Hence, WIP of finishing section was higher. Extra processing was also seen in low productivity units in terms of multiple checking in finishing section i.e. initial checking, in process checking and final checking were practiced.

In medium productivity units, rework was also seen. In some of the units it was observed that garments were soiled during the handling, because workplace was dirty and no regular cleaning was done. It was also seen in some of the medium productivity unit that bundling and ticketing stickers were stitched inside the seam and stitching operators did not removed them from the garment parts. Excess transportation was also seen, movement of garment was too time consuming due to poor layout of units. In medium productivity units, separate labeled baskets were not used to keep different sizes of garments hence extra process was done in separating different sizes garment for packing.

It was seen in **high productivity units** that transportation was not manually. Garments were transported from one section to another section with the help of trolleys. Layout was good in high productivity units so there was no unnecessary transportation and no excess motions were seen. No extra processing and proper work methods were used. It was found in high productivity units that machine maintenance was better. Workstations were neat and tidy so rework was less.

Similar results found by Kumar and Sampath (2012) revealed that in some cases, even though the operator completed the sewing operations, the garment could not be packed because of high WIP. Also, the defective garment pieces were hidden inside the batches and it was very difficult to clear them while completing the final order quantity. Workers wasted time in searching the missing garment pieces.

H_a4. There is a significant difference in total WIP between low, medium and high productivity units

Table 5: ANOVA for Overall WIP of Low, Medium and High Productivity Units

Productivity	n	Mean	SD	Source of variation	Sum of Squares	df	Mean Square	F
Low	4	9981	489.36	Between Groups	1462524.292	2	731262.146	3.463*
Medium	4	8123	544.03	Within Groups	6968063.396	33	211153.436	
High	4	5091	313.04	Total	8430587.688	35		

*Significant difference at 0.05 level

The above table-4.34 indicates the mean, sd and Anova of total WIP to find out the difference in low, medium and high productivity units. The mean value of WIP in low productivity units is 9981 with SD of 489.36 whereas in medium productivity units mean is 8123 with the SD of 544.03 and in high productivity units mean is 5091 with the SD of 313.04. The higher mean is found in low productivity units than those of medium and high productivity units. F ratio is 3.463, $p<0.05$ which is significant at the 0.05 level. It is found that there is a significant difference of total WIP in low, medium and high productivity units. Thus, the framed hypothesis which states, there is a significant difference in the total WIP between low, medium and high productivity units is accepted.

Table 6: Post-hoc Analysis: Multiple Comparison between Low, Medium and High Productivity Units

Variable	Productivity		Mean Difference	Std. Error	Sig.
Total WIP	Low	Medium	185.83333	1.87596	.588
	Medium	High	303.20833	1.87596	.253
	Low	High	489.04167*	1.87596	.035

*Significant difference at 0.05 level

The above table-4.35 indicates further results of post hoc analysis of total WIP. The mean differences of total WIP between low and medium productivity units are 185.833, which are not significant. The mean differences of total WIP between medium and high productivity units are 303.208, which are also not significant at 0.05 level. The mean differences of total WIP between low and high productivity units are 489.041, which are significant at 0.5 level. The results revealed that there is a significant difference found between low and high productivity units and there is no significant difference found between low and medium productivity units and medium and high productivity units.

Difference of overall WIP levels in low and high productivity units

The results revealed that in **low and medium productivity units** higher WIP were found compared to high productivity units. In some of the units it was observed that manual material handling, poor working conditions, overproduction, waiting time, unnecessary transportation due to poor layout, excess process due to unorganized work, rework due to poor maintenance of machines and lack of specifications and absenteeism were the main problems which increased the WIP levels.

It was found in **high productivity units** over production, less defect percentage and good material handling and trolleys were used by some of the units to transport the material from one section to another section. It was found that higher level of WIP in the units was the main cause of late delivery. It was seen that in all the units production planning was better. It helped to complete the production on time. It was seen in all the units low, medium and high none of the units were aware of the technology up gradation.

Similar, results obtained by Kajur and Singh (2010), evaluated the existing manufacturing system of that time and made an effort on achieving WIP control to find out the reasons contributing to higher WIP on sewing floor. They found that the material handling system led to a higher level of WIP between operations. Badurdeen (2007) viewed that WIP was a direct result of overproduction and waiting. Over production accounts for many losses and wastage. This also made the WIP higher and flow was not smoother. This led to low quality products and defects as quality problems are hidden in the WIP, maintained due to over production. Products are waiting for a long time against the time used for processing them. This is one contributory factor for the higher WIP resulting in higher lead time. Production flexibility reduced the waiting and this also reduced the WIP. Unnecessary transportation accounts for the quality defects, maintenance of a higher WIP and additional cost of transporting the goods. Unnecessary transportation was often caused by poor work place organization.

It was found that over production, high defect percentage, unnecessary transportation and long setup time were the major problems which increased the WIP levels in low productivity units as compared to medium and high productivity units. It was seen that in medium and high productivity units working conditions and material handing were good as compared to low productivity units. It was also observed that unnecessary transportation and overproduction was less in high productivity units.

Kumar and Sampath (2012) found that due to higher WIP through put time, rework level was very high. Higher WIP caused longer lead time, high percentage of rejections, production imbalance, over production, low efficiency and operator demotivation reduced the productivity. Similar results were obtained by Ratnayake, Lanarolle and Marsh (2009) that the low efficiency in manufacturing garments was carried out at 14 garment manufacturing companies in Sri Lanka which manufactured various types of garments. The data revealed that the WIP fluctuation within production lines was very high with Coefficient of Variation % ranging from 79.2 to 165.6. Bheda (2004) suggested that each worker should be provided with a minimum of two bundles, one for sewing and one for waiting. It is the simplest method of controlling WIP. Hayes (1981) viewed that in manufacturing inventory in the form of WIP was specially a wasteful item and it should therefore be reduced. Rejection in the WIP levels and stocks, improves the deliveries, set-up times and productivity level (Burbidge, 1979).

Conclusion

After the comparative assessment of low, medium and high productivity it was concluded that WIP of cutting and stitching section was higher in all the units. WIP of stitching was higher due to high rate of absenteeism, waiting of garment parts, poor production planning, high style change over time, poor machine maintenance. It was also concluded that WIP of finishing section and overall WIP, high productivity units performed better as compared to low and medium productivity units. In some of the low productivity units unnecessary transportation was found due to poor layout, poor material handling, and excessive handling of garments whereas in some of the medium productivity units manual transportation, untidy workstations were the main factors affecting the WIP. In high productivity

units, workstations were neat and tidy, no excess transportation between sections were found, proper use of trolleys to carry the garments and machine maintenance was better.

It is important to report the garment produced per day before it influences the industry workflow. It provides a lot of benefits; it makes good sense for any manufacturing business to invest not only its time and effort on achieving WIP control, but also invest in systems that greatly simplify the process of scheduling, capacity management, reporting and identifying problem areas. A modest and feasible decline in WIP in turn decreases working capital and can give a return on investment for a system like quick respond in just a few months.

Recommendations

- Daily reporting and though calculating the Work In Progress (WIP) in each section will help in controlling the WIP.
- Separate labeled baskets should be used for keeping garments of different sizes so that garments are not mixed of different sizes and time is not wasted in separating them. Similarly, separate boxes are to be kept for keeping the rejected and altered pieces.
- Machine maintenance schedule should be displayed and the operators should be trained for maintaining the machine and equipments as this will reduce the waiting time due to break down of machines.
- Entrepreneur Resource Planning (ERP) software should be installed for better performance.
- All tools should be properly placed at the specified places so that time is not waste for searching the tools.
- Material and trims should always be in stock and should be made available on time in the sewing section, when needed. The operators should be provided with extra bobbins and needles to save time.
- For reducing the WIP, there should be provision of over time in the units. Shift should be planned in such a way so that the pending work can be finished and WIP of stitching can be reduced.
- Bonus should be provided to the workers who are regular. This will motivate them and help in reducing the absenteeism of the workers.

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