The International Journal Research Publication's ISSN:2251 1555
Research Journal of Economics & Business Studies

# A Study on Factors to Effectively Manage the Dyeing Process House

**Ananth S**
Part time - PhD Scholar, Alagappa Institute of Management, Alagappa University, Karaikudi
&
**Dr. Sivakumar V**
Associate Professor, Department of Logistics Management, Alagappa University, Karaikudi.

**Abstract:**
*Apparel making is the last process in the consumer textile before reaching to the customer. The apparel industry is fashion driven; the turnaround time is the major criteria from design concept to manufacturing and till reach the customer. In the process of manufacturing, dyeing process is one of the critical processes, which makes the colouring and finishing of the fabric as per customer preference. In this paper the author understands the dyeing process and to improve the efficiency of the dyeing management process; identified the factors which directly affect the efficiency of the dyeing management process and found that there is a positive association between the size of the company and the companies booking order in advance.*
**Key words:** Apparel, Dyeing process house, Planning, Factor analysis.

## 1. Introduction:

Apparel making is the last process in the consumer textile before reaching to the customer. The apparel manufacturing process consists of major raw material as yarn, then convert the yarn to form the fabric, then dyeing / finishing the fabric as per the customer requirement, which includes colouring the fabric, printing and finishing the fabric and finally it is ready for apparel making purpose. The planning department will allocate optimum time for all the major activities which includes sourcing of raw material, converting the yarn to fabric [Weaving / Knitting], dyeing / finishing, and apparel making. [Cutting, sewing and packing]. Any delay in the initial activities will have the cumulative effect on the next activity; the time lost in the previous activity will reduce the allocated time of the following activities. As apparel making is the last process, the pressure adds to deliver the goods on time to the buyer.

The apparel industry is fashion driven; the turnaround time is the major criteria from design concept to manufacturing and till reach the customer. In the process of manufacturing, dyeing process is one of the critical processes; the dyeing process involves the chemical reaction which makes it very difficult to predict the exact output. By using the trial and error method and experience the output can get within the tolerance level. The capacity of the machine decides the number of batches to be carried out, more quantity requires multiple batches. Colour variation between the batches should be within acceptable limits, getting the consistency between the batches is very difficult, so the dyeing process is playing a vital role.

Most of the scheduling related papers dealt with algorithms, these algorithms are concentrating on few parameters only, by changing these few parameters how the final output is varying. Practically, few parameters are not enough, there are a lot other factors need to be considered. To manage the dyeing process effectively, the author identified the factors by using factor analysis and trying to find the association between the sizes of the company and booking the order in advance. By identifying the factors, the dyeing manager can concentrate the areas to be improved, so that the overall process is improved getting the first time right and the delivery date can be achieved.

## 2. Review of Literature

William M. Goriwondo, Walter Chipambwa addressed the sequencing of colours to be dyed with reference to different cleaning time required for different colours dyed by developing a model. "Colour engineering and scheduling the different colour shades for processing with minimal set-up costs while attaining the required quality within delivery deadlines is a major challenge for TN Textiles. Due to the

differences in colour compositions, machines have to be cleaned between batches, but the intensity of cleaning differs on the preceding colour shades. Some need deep cleaning while others require light cleaning and this has an impact on the set-up costs. The other challenge of getting the right colour the first time and this is due to the nature of the dyeing operation. It is a key industry success factor to be able to schedule colours with minimum setup costs while achieving right colour quality as required by the different customers"[1.] In this paper the author addressed two factors, type of product and type of manufacturing.

Laoboonlur, Preecha, addressed "With multiple products and multiple sequence dependent setups in the dyeing and finishing process, studying the relationship between fabric types, order requirements (e.g., color, finishing characteristics), order size, and setup time are critical for developing a scheduling method. This relationship provides the information that determines when a setup is necessary. Thus, one of the objectives of this research is to develop setup matrices for scheduling dyeing and finishing processes. The setup matrices are developed based on information and experience of the case plant."[3] Grouped four types of fabric.

For every colour to be dyed, Morales et al, developed a colour matrix using the colour value.[4]

Livingston and Sommerfeld, developed a simulation model considered the machines used, processing time for the each job, people, maintenance activities, policy on quality control, work in process and market requirement.[5]

Single machine scheduling, Monma and Potts, addressed the setup time, maximum lateness, completion time and lateness considered for each batch and optimally sequenced the batches into a proper schedule[6]

**3. Objective:**

1. To find the association between the size of the company and the order booked in advance.
2. Identifying the factors for effectively manage the dyeing process house.

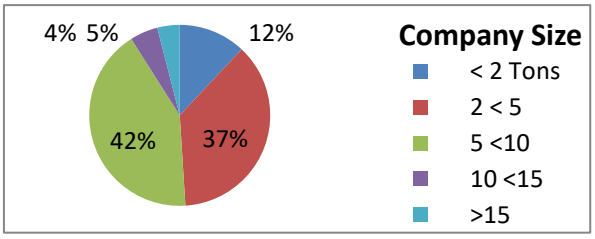
**4. Methodology**

- Sample size is 100 and the sampling technique adopted is convenience sample.
- Statistical tools used for analysis are frequency distributions, charts, Chi Square test and Factor analysis
- SPSS 17 and MS Excel software's are used for data analysis.
- The scope the study is limited to the knitted dyeing processing unit.

**5. Analysis**

**5.1 Company Size**

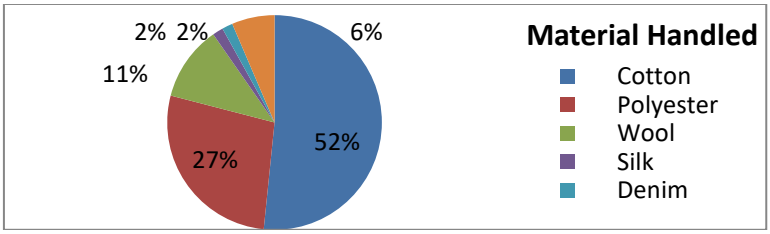
Fig: 1




37% of companies are operating in the range of 2-5 tons per day and 42% of companies are operating in the range of 5-10 tons per day, 79% of companies are operating between 2-10 tons per day. Only 4% of the companies are doing more than 15 tons per day, 12% of the companies are operating at very small level as less than 2 tons per day.

**5.2 Material Handled**

Fig: 2



52% of the companies involved in cotton products, 27% of the companies involved in polyester material.

**5.3 Type of fabric handled**

Table: 1

| Type of Fabric Handled | Frequency |
|---|---|
| Weaving | 28 |
| Knitted | 72 |

72% of the companies handled knitted type fabric and 28% of companies handled weaved type fabric.

**5.4 Order booking days in advance**

Table: 2

| Number of Days in Advance | Frequency |
|---|---|
| < 3 | 10 |
| 3 - 6 | 47 |
| 6 - 15 | 22 |
| 15 – 30 | 14 |
| > 30 | 7 |

47% of the companies, booking orders in less than 3 days in advance, 22% of the companies, booking orders in 3-6 days in advance and 39% of the companies booking orders in above 15 days in advance.

**5.5 Delivery Date Confirmation**

Table: 3

| Delivery Date Confirmation | Frequency |
|---|---|
| Yes | 72 |
| No | 28 |

72% of the companies confirm the delivery date and 28% of the companies are not confirming the delivery dates for the booked orders.

**5.6 Number of days to confirm the delivery date**

Table: 4

| Number of days to confirm the delivery date | Frequency |
|---|---|
| < 2 | 39 |
| 2 – 4 | 28 |
| 5 – 7 | 11 |
| > 7 | 22 |

39% of the companies confirm the delivery dates in less than 2 days, 28 % of the companies confirm in 2-4 days and 11% of the companies in 5-7 days.

**5.7 Associations between the size of the company and the order booked in advance**

To find out the relationship between the size of the company and the order booked in advance, Chi square test has been carried.

***Ho: There is no relationship between the size of the company and order booked in advance***

***Ha: There is a relationship between the size of the company and order booked in advance***

Level of Significance: 0.01

Table: 5

| **Chi-Square Tests** | | | |
|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) |
| Pearson Chi-Square | 122.826[a] | 16 | 0 |
| Likelihood Ratio | 125.594 | 16 | 0 |
| Linear-by-Linear Association | 8.387 | 1 | 0.004 |
| N of Valid Cases | 100 | | |

**Inference:**
There is no sample evidence to accept ***Ho***. i.e., there is a relationship between the size of the company and order booked in **advance,** since the "*p"* value is less than the level of significance ( 0.01).

**5.8 Factor analysis**

To identify the important factors which lead to effectively manage the dyeing process house, factor analysis is carried out.

The primary data consisted of 100 replied questionnaires, pertaining to planning in the dyeing process house to improve the overall performance of the dyeing house. Reliability and validity have done by using Cronbach's Alpha and KMO - Bartlett's test of spherecity respectively.

Table: 6

| **Reliability Statistics** | |
|---|---|
| Cronbach's Alpha | N of Items |
| .937 | 30 |

The reliability of the questionnaire is 0.937 which is calculated using Cronbach's Alpha. It indicates the level of internal consistency of the multiple item scale which is greater than 0.7.

**5.8.1 KMO and Bartlett's Test for sampling adequacy**

The below table indicates the KMO value for sample adequacy 0.812, as the KMO value is greater than 0.5, the data can be used for factor analysis.

Bartlett's test of sphericity testing for the significance of the correlation matrix of the variables indicates that the correlation coefficient matrix is significant by the "p" value corresponding to the Chi square statistic. The "p" value is less than 0.05, the sampling adequacy is significant.

Table: 7

| **KMO and Bartlett's Test** | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .812 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 2409.907 |
| | df | 435 |
| | Sig. | .000 |

The data were subjected to principal component analysis and varimax rotation. Prior to principal component analysis, the communalities involved were first established. [Table : 8] Communality explains the total amount an original variable shares with all other variables included in the analysis and it is very useful in deciding which variables to finally extract in the varimax rotation and in determining the adequacy of the sample size.

Table: 8

| **Total Variance Explained** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Component | Initial Eigen values | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 10.934 | 36.447 | 36.447 | 10.934 | 36.447 | 36.447 | 4.292 | 14.308 | 14.308 |
| 2 | 3.297 | 10.990 | 47.437 | 3.297 | 10.990 | 47.437 | 3.983 | 13.276 | 27.584 |
| 3 | 2.490 | 8.299 | 55.737 | 2.490 | 8.299 | 55.737 | 3.628 | 12.093 | 39.677 |
| 4 | 2.242 | 7.473 | 63.210 | 2.242 | 7.473 | 63.210 | 3.434 | 11.447 | 51.123 |
| 5 | 1.472 | 4.908 | 68.118 | 1.472 | 4.908 | 68.118 | 3.276 | 10.919 | 62.043 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 1.264 | 4.213 | 72.330 | 1.264 | 4.213 | 72.330 | 2.397 | 7.990 | 70.032 |
| 7 | 1.107 | 3.689 | 76.020 | 1.107 | 3.689 | 76.020 | 1.796 | 5.988 | 76.020 |
| 8 | .796 | 2.654 | 78.674 | | | | | | |
| 9 | .725 | 2.415 | 81.089 | | | | | | |
| 10 | .664 | 2.213 | 83.302 | | | | | | |
| 11 | .595 | 1.985 | 85.287 | | | | | | |
| 12 | .559 | 1.864 | 87.151 | | | | | | |
| 13 | .461 | 1.536 | 88.687 | | | | | | |
| 14 | .425 | 1.417 | 90.104 | | | | | | |
| 15 | .383 | 1.278 | 91.382 | | | | | | |
| 16 | .338 | 1.126 | 92.507 | | | | | | |
| 17 | .314 | 1.047 | 93.554 | | | | | | |
| 18 | .275 | .916 | 94.470 | | | | | | |
| 19 | .254 | .845 | 95.315 | | | | | | |
| 20 | .237 | .790 | 96.106 | | | | | | |
| 21 | .200 | .666 | 96.772 | | | | | | |
| 22 | .179 | .597 | 97.369 | | | | | | |
| 23 | .156 | .522 | 97.891 | | | | | | |
| 24 | .136 | .454 | 98.345 | | | | | | |
| 25 | .122 | .408 | 98.753 | | | | | | |
| 26 | .102 | .338 | 99.091 | | | | | | |
| 27 | .084 | .281 | 99.372 | | | | | | |
| 28 | .073 | .243 | 99.615 | | | | | | |
| 29 | .061 | .203 | 99.818 | | | | | | |
| 30 | .054 | .182 | 100.000 | | | | | | |

Table: 9

| **Rotated Component Matrix[a]** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Component | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| VAR00001 | .514 | .410 | .338 | -.104 | .048 | .086 | .352 |
| VAR00002 | .030 | .168 | .325 | .729 | .327 | .136 | -.146 |
| VAR00003 | .651 | .270 | .467 | -.112 | .041 | .270 | .033 |
| VAR00004 | .034 | .170 | -.008 | .752 | .238 | .240 | .250 |
| VAR00005 | .774 | .181 | .177 | -.221 | .132 | .375 | .093 |
| VAR00006 | .016 | .375 | .372 | .587 | .037 | -.120 | .125 |
| VAR00007 | .442 | -.043 | .044 | .092 | .762 | .165 | .187 |
| VAR00008 | -.030 | .361 | .584 | .434 | -.020 | .200 | .310 |
| VAR00009 | .593 | .247 | -.236 | .021 | .446 | .117 | .299 |
| VAR00010 | .128 | .251 | .847 | .163 | .112 | -.036 | .047 |
| VAR00011 | .168 | .744 | .050 | .262 | .076 | .164 | .116 |
| VAR00012 | .293 | -.160 | .685 | .160 | .282 | -.112 | .278 |
| VAR00013 | .069 | .806 | -.019 | .038 | .097 | .318 | .187 |
| VAR00014 | .156 | -.270 | .283 | .527 | .599 | .061 | -.071 |
| VAR00015 | .137 | .552 | .300 | .119 | .195 | -.077 | .563 |
| VAR00016 | .500 | .010 | -.316 | -.023 | -.050 | .481 | -.438 |
| VAR00017 | .003 | .428 | .115 | .305 | .645 | -.314 | .091 |
| VAR00018 | .426 | -.001 | .354 | .205 | .090 | .501 | .332 |
| VAR00019 | .268 | .633 | .098 | .113 | .454 | .231 | -.041 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VAR00020 | .762 | .103 | .185 | .401 | .099 | -.083 | .110 |
| VAR00021 | -.068 | .395 | .084 | .051 | .508 | .560 | .100 |
| VAR00022 | .787 | .105 | .172 | .374 | .030 | .098 | -.007 |
| VAR00023 | -.130 | .298 | .285 | .296 | .626 | .040 | .045 |
| VAR00024 | .240 | .087 | .219 | .611 | .225 | .036 | .174 |
| VAR00025 | .197 | .036 | .813 | .275 | .147 | .004 | -.003 |
| VAR00026 | .285 | .495 | .288 | .322 | .150 | -.116 | .240 |
| VAR00027 | .116 | .273 | .149 | .231 | .617 | .336 | -.051 |
| VAR00028 | .221 | .266 | .115 | .343 | .042 | .231 | .673 |
| VAR00029 | .507 | .612 | .165 | .104 | .123 | -.194 | -.108 |
| VAR00030 | .228 | .158 | -.094 | .184 | .139 | .817 | .051 |

The above factor analysis revealed seven factors which are labelled as Planning, Process, Material, Quantity, Rework, Maintenance and Urgency.

**5.8.2 The identified factors are:**

Table: 10

| | | |
|---|---|---|
| F 1 | Planning | All the order quantities will be delivered in one shot |
| | | Almost every day the production plan has changed |
| | | Different size of the machine is helpful for different types of order sizes |
| | | Every week the planned productions are strictly followed |
| | | Order quantity shortages will be identified after the delivery |
| | | Production plan for one week is made in advance |
| | | Rework happens due to protocol |
| F 2 | Rework | Rework always affects the production |
| | | Rework happens due to colour matching |
| | | Rework happens due to handling problems |
| | | Rework happens due to unskilled technician |
| F 3 | Quantity | All the dyeing machines are loaded to full capacity |
| | | Shortage in order quantities is accepted by the customers |
| | | Small orders can be combined and dyed in the bigger capacity machines |
| | | Some machines are operated with lesser capacity |
| F 4 | Material | Change in the dyestuff batch numbers creates delay |
| | | Material non availability leads to delay in the process |
| | | Production Plan has changed due to delays in the Greige fabric availability |
| | | Rework happens due to non availability of right dyes and chemicals |
| F 5 | Process | Bulk production requires more number of additions |
| | | Good to have a separate set of machines for dyeing light, medium and dark colour |
| | | Good to mix different GSM fabric in the same dye bath |
| | | Lab dip and bulk lot production exactly matches |
| | | Process route will be there for each production lot / production order |
| F 6 | Maintenance | Due to the age of the machines some lots take more time |
| | | Machine breakdown affects the delivery date |
| | | Machine breakdown affects the quality of the lot |
| F 7 | Urgency | Often customer changes priority |
| | | Production Plan has changed due to customer requirement |

**6. Findings:**

- 37% of companies are operating in the range of 2-5 tons per day and 42% of companies are operating in the range of 5-10 tons per day, 79% of companies are operating between 2-10 tons

per day. Only 4% of the companies are doing more than 15 tons per day, 12% of the companies are operating at very small level as less than 2 tons per day.

- 52% of the companies involved in cotton products, 27% of the companies involved in polyester material.
- 72% of the companies handled knitted type fabric and 28% of companies handled weaved type fabric.
- 47% of the companies, booking orders in less than 3 days in advance, 22% of the companies, booking orders in 3-6 days in advance and 39% of the companies booking orders in above 15 days in advance.
- 72% of the companies confirm the delivery date and 28% of the companies are not confirming the delivery dates for the booked orders.
- 39% of the companies confirm the delivery dates in less than 2 days, 28 % of the companies confirm in 2-4 days and 11% of the companies in 5-7 days.
- There is a significant relationship between the size of the company and order booked in advance.
- The factor analysis revealed seven factors which are labelled as Planning, Process, Material, Quantity, Rework, Maintenance and Urgency.

**7. Conclusion:**

- There is a significant relationship between the size of the company and order booked in advance.
- The factor analysis revealed seven factors which are labelled as Planning, Process, Material, Quantity, Rework, Maintenance and Urgency.

**8. Suggestions:**

- The dyeing process house has to concentrate on the following factors, namely Planning, Process, Material, Quantity, Rework, Maintenance and Urgency, address the efficient operation of the process house will lead to improve the performance and customer satisfaction.
- Plan the production in advance irrespective of the size of the company.
- Further study can be carried out with the identified factors with the different characteristics.

**References:**

1. *"Product Scheduling in a multi-product colour processing facility. Case Study at TN Textiles (Pvt) Ltd"*, William M. Goriwondo, Walter Chipambwa, Samson Mhlanga,Proceedings of the 2012 International Conference on Industrial Engineering and Operations Management Istanbul, Turkey, July 3 – 6, 2012
2. *"Production Planning And Control"* ,Deepak Sharma, Deepa Sharma, Jai Prakash Sharma ,International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882 Volume 3, Issue 3, June 2014
3. *"Production Scheduling in Knitted Fabric Dyeing and Finishing: A Case Approach"*, Laoboonlur, Preecha, PhD Dissertation, North Carolina State University.
4. *"Optimization of the Color Sequence in the Process of Fabric Dyeing,"*Morales L., Maldonado F., Radillo R., and Ciurlizza A., (1996), JSDC, Vol. 112, Dec., 361-363.
5. *"Discrete-Event Simulation in the Design of Textile Finishing Processes,"*Livingston D. L. and Sommerfeld J. T., (1989), Textile Research Institute, Oct., 589-596.
6. *"On the Complexity of Scheduling with Batch Setup Times,"*Monma C. L., and Potts C. N., (1989), Operations Research, Vol. 37, Issue 5, 798-804
7. *"Dyehouse management for the 21st century"*. MOORE, C. 1997. *Int. Dyer*, 182(8): 32–34