International Journal of Scientific Research in Multidisciplinary Studies **Research Paper**
Vol.7, Issue.9, pp.87-93, September (2021) **E-ISSN:** 2454-9312 **P-ISSN:** 2454-6143

Impact of Implementation of Qualitative and Quantitative Parameter Standards on the Quality of Woven Textile Products

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Available online at: www.isroset.org

Received: 02/Sept/2021, Accepted: 20/Sept/2021, Online: 30/Sept/2021

***Abstract*-**As a country, it is basic to identify and set the main qualitative & quantitative parameters along with their standards. It helps Ethiopian weaving textile mills to know whether/not they are following the proper procedures. Accordingly, this study identifies the basic qualitative & quantitative parameters, which have to be followed and monitored in mills. Six representative factories are selected (Al-ASR, Almeda, Bahir Dar, Ethio-Japan, Huaxu and Kombolcha) based on: production & efficiency, technology mix, product mix, ownership status and organizational structure along with process flow. Basic qualitative systems such as: incentive schemes, management practices, best practices for social compliances, standard testing method for fabric inspection & quality control and quality assurance system have been assessed and compared with standard systems. The following basic quantitative parameters have also been studied: - plant utilization (in %), plant efficiency (in %), loom speeds (in RPM), productivity (in meters/day), and quality (in 'A' grade fabric %), working days (in No. of days/annum) & No. of looms/operator. It is then compared with best practice standards. The assessment shows lower average performances against best international standards. Possible root causes for lower-performing parameters are identified and areas of improvement have been recommended: - a system has to be there & followed for technical and production crew to attend in national/international exhibitions & seminars, best practices have to be there for skill development including proper training for operators on technical aspects, soft skills, attitudinal and behavioral changes, following of proper standard procedures for checking & optimization of raw material, implementation of quality circles, following of routine and preventive maintenance systems, implementation of best practices for environmental and social compliances, etc. Hence, proper implementation of the recommended systems helps the mills to be in line with international market & fit with best practice standards.

***Key words*-**Qualitative parameters, quantitative parameters, weaving mills, best practices

I. INTRODUCTION

Currently in Ethiopia, there are about 30 active weaving textile mills. The numbers are increasing due to the fact that the Ethiopian government moves a step to set up an industrial development strategy.

Although the number of mills are increasing, the woven textile products are neither competitive in international markets nor can substitute the imported products. This is due to the fact that while producing the fabrics, the basic qualitative & quantitative parameter standards are not properly identified, monitored & followed. The proper implementation of the stated standards helps in doing the basic tasks, which is held by operators, supervisors, shift in-charges, production managers, section heads, etc. in proper way. This in turn helps to increase productivity and improve the quality of the produced woven textile products. Hence, the quality improvement leads the mills to be competitive in international market.

Accordingly, in this paper, study is conducted in selected factories and assessment has been madeon the status of basic qualitative & quantitative parameters so that comparisons will be made between the current status of Ethiopian weaving mills and international best practice standards. After detailed analysis on the deviations, the root causes for the lower-performing parameters are identified and accordingly recommendations are also given on the possible improvement areas. Therefore, the implementation of the recommended qualitative systems brings the mills into international market track.

II. RELATED WORK

To bring the Ethiopian weaving mills into the international textile factories standards, different attempts have been made through implementation of benchmarking programs with the help of international consultants like Texcoms textile solution (TTS) of India with the collaboration of Ethiopian textile industry development institute (ETIDI). The implementation of the program has helped the factories and it results in achieving some good changes. But the beneficiary factories are not able to sustain the changes that have been seen. Since, the implemented

benchmarking programs were not supported with the proper documentation of the best qualitative standards and systems, sustaining the achieved quantitative figures have been a problem for the factories. So, here no published work has been found. But, this paper can be used as a reference material for the factories to implement the standard qualitative systems.

III. METHODOLOGY

For the study, primary data has been gathered for selected 6 weaving factories. The selection criteria are on the basis of:

- ✓ Production & efficiency of factories,
- ✓ Technology mix,
- ✓ Product mix,
- ✓ Ownership status (local versus foreign owned),
- ✓ Organizational structure & process flow (consideration of both integrated & segregated factories),

Based on the criteria, the following factories are selected:

- ❖ Al-ASR textile factory,
- ❖ Almeda textile factory,
- ❖ Bahir Dar textile factory,
- ❖ Ethio-Japan textile factory,
- ❖ Huaxu textile factory and
- ❖ Kombolcha textile factory.

Table 1 Detail profile of selected weaving mills [company dataset]

S.no	Factory name	Factory address	M/c technology rating	Product varieties	Ownership status	Process flow
1	Al-Asr textile	Dukem, Oromia	Conventional	Suiting, shirting, uniforms, work wear	Foreign	Segregated
2	Almeda textile	Axum, Tigray	Conventional	Trouser, Gown, Military items, canvas, work wear	Local	Integrated
3	Bahir-Dar textile	Bahir Dar, Amhara	Modern & Obsolete	Bed sheeting, poplin, abujedid	Local	Integrated
4	Ethio-Japan textile	Modjo, Oromia	Conventional	Cotton & poly-cotton fabrics, bed sheet, uniform, Nylon & polyester taffeta dyed & printed fabrics,	Local	Segregated
5	Huaxu textile	Kombolcha, Amhara	Modern & Obsolete	100% polyester woven fabric for school uniform	Foreign	Segregated
6	Kombolchatextile	Kombolcha, Amhara	Modern & Obsolete	Abujedid, mulmul fabric, khaki/drill, twill fabrics, sheeting, terry towel, etc	Local	Integrated

The following methods are used for conducting the study:

- Identifying basic weaving parameters along with best practice standards,
- Selection of representative weaving factories for data collection,
- Organizing the data gathered & analyze them properly,
- Documentation of analyzed data as Ethiopia's Weaving factories norms,
- Identification of causes for parameters, which most of the factories are under-performing,
- Based on the identified causes, proper best practice standard systems have been drawn,
- Recommendation & suggestion of the standard systems to be followed in the factories,

MATERIALS & EQUIPMENTS

- Equipments/instruments for checking of the quantitative parameters,
- Qualitative & quantitative best practice parameter standards,

Table 2 Best practice standards for selected quantitative parameters [1].

S.no	Parameters	Unit of measurement	Best practice standard
1	Plant utilization	%	90
2	Plant efficiency	%	85
3	Loom speed	RPM	750
4	Productivity	Meters/day	350-400
5	Quality	'A' grade fabric %	98
6	Age of machinery	No. of years	10
7	Working days	No. of days/annum	350-360
8	Looms per operator	m/c/operator	8

IV. RESULTS AND DISCUSSION

So, based on the data gathered from the visited six factories, the following result is achieved & comparisons are made with the best practice standards. The results are discussed in the tables below:

Table 3 current status for Almeda textile factory [company dataset]

S.no	Parameters	Unit of measurement	Almeda's status
1	Plant utilization	%	65
2	Plant efficiency	%	55
3	Loom speed	RPM-190cm RPM-360cm	380 280
4	Productivity	Meters/day	175
5	Quality	'A' grade fabric %	90
6	Age of machinery	No. of years	NA
7	Working days	No. of days/annum	350
8	Looms per operator	m/c/operator	6

Table 4 current status for Al-Asr textile factory [company dataset

S.no	Parameters	Unit of measurement	Al-Asr's status
1	Plant utilization	%	75
2	Plant efficiency	%	70
3	Loom speed	RPM	220
4	Productivity	Meters/day	135
5	Quality	'A' grade fabric %	92
6	Age of machinery	No. of years	>15
7	Working days	No. of days/annum	312
8	Looms per operator	m/c/operator	4

Table 5 current status for Bahir Dar textile factory [company dataset]

S.no	Parameters	Unit of measurement	Bahir Dar's status
1	Plant utilization	%	63
2	Plant efficiency	%	57
3	Loom speed	RPM-180cm RPM-190cm	300 600
4	Productivity	Meters/day-180cm Meters/day-190cm	86 245
5	Quality	'A' grade fabric %	82
6	Age of machinery	No. of years	Both with <5 &>15
7	Working days	No. of days/annum	350
8	Looms per operator	m/c/operator	6

Table 6 current status for Ethio-Japan textile factory [company dataset]

S.no	Parameters	Unit of measurement	Ethio-Japan's status
1	Plant utilization	%	65
2	Plant efficiency	%	65
3	Loom speed	RPM-220cm RPM-360cm	400 380
4	Productivity	Meters/day	193
5	Quality	'A' grade fabric %	NA
6	Age of machinery	No. of years	NA
7	Working days	No. of days/annum	302
8	Looms per operator	m/c/operator	8

Table 7 current status for Huaxu textile factory [company dataset]

S.no	Parameters	Unit of measurement	Huaxu's status
1	Plant utilization	%	75
2	Plant efficiency	%	65
3	Loom speed	RPM	180-220
4	Productivity	Meters/day	NA
5	Quality	'A' grade fabric %	92
6	Age of machinery	No. of years	>15
7	Working days	No. of days/annum	340
8	Looms per operator	m/c/operator	6

Table 8 current status for Kombolcha textile factory [company dataset]

S.no	Parameters	Unit of measurement	Kombolcha's status
1	Plant utilization	%	58
2	Plant efficiency	%	70
3	Loom speed	RPM-190cm RPM-380cm	423 282
4	Productivity	Meters/day	200
5	Quality	'A' grade fabric %	93
6	Age of machinery	No. of years	NA
7	Working days	No. of days/annum	350
8	Looms per operator	m/c/operator	6

Below is a table (table 9) that shows comparisons of the average results of the identified parameters with the best practice standards.

Table 9 Summary of comparisons of the stated weaving mills' status versus the best international standard

S.no	Parameters	Unit of measurement	Ethiopian weaving mills status	International standard
1	Plant utilization	%	Avg. of 65	92
2	Plant efficiency	%	50-70	85
3	Loom speed	RPM-190cm RPM-360cm	350-380 (Rapier) 280 (Rapier)	600 (Rapier) 350 (Rapier)
4	Productivity	Meters/day-190cm Meters/day-190cm	175 (Rapier) 245 (Air jet)	325 (Rapier) 466 (Air jet)
5	Quality	'A' grade fabric %	80-95	98
6	Working days	No. of days/annum	300-350	350
7	Looms per operator	m/c/operator	6	10-12

So from the above table, it is observed that in almost all the selected quantitative parameters, Ethiopian weaving mills are under-performance in comparison with best practice international standards. The representative factories have an average plant utilization of 65%, which is lower against the best practice standard of 92%. The plant efficiency of best practice standard is 85% while Ethiopian weaving factories have a maximum efficiency of 70%. The factories' looms are running with only 60% against the required best practice speed of the looms. Coming to productivity, Ethiopian weaving mills are 50% lower in comparison with the standard. When we see operator efficiency, in Ethiopian textile mills, a weaver operates only 6 looms while internationally a weaver can operate up to 12 looms. So as to mitigate this problem, the possible root causes have been assessed and improvement areas are also shown below. Improvements will be there when the following qualitative best practice standards/systems are being followed and implemented.

Best practices/standards for personal skill:
In every mills a proper & dedicated training department has to be there to impart both refreshing theoretical and on job training to operators,

Technical skills of the managers (supervisors, shift in-charges, production-in charges, section heads, etc) will be improved by exposing them to new state-of-the art technologies, international exhibitions & workshops in process control and maintenance [3].

The maintenance crew has to be lectured to give more emphasis on preventive maintenance type than 'fire-fighting' approach. For those who follow it regularly, a motivational reward mechanism has to be set,

Best practices for job descriptions in weaving mill:
Section head:
Weaving section head is responsible for production, quality, product development, planning and administration of the department. The head is expected to have the following qualities:[3].

Good knowledge of textile technology, with specialization in weaving,

- Ability to organize and follow-up technique,
- Good initiative and leading quality,
- Ability to motivate the co-workers,
- Knowledge of human relationship,

Shift-in charge
Below are standard duties/responsibilities of shift officers:

- ❖ To allocate manpower on machines in a proper way for quality work and productivity
- ❖ To monitor each operator & machine in work area for maximum efficiency and production
- ❖ Decision making after consulting the HOD for the major issues of the shift, if any
- ❖ Observe woven fabric to detect weaving defects
- ❖ To maintain shift log book and follow up and record
- ❖ To monitor the speed of running loom and to increase or decrease the speed as per quality during knotting or gaiting
- ❖ To achieve desired production, quality and reduce waste by directing maintenance services
- ❖ Schedule and conduct shift meetings
- ❖ Operate within standard operating procedures (SOPs)
- ❖ To plan daily gaiting and knotting and handover to beam gaiter and knotter with looms and urgency
- ❖ Maintaining shop floor discipline
- ❖ Assistance in repair of machine and equipments
- ❖ Maintaining documentation of records
- ❖ Housekeeping

Best practices for skill development program:
The formal training program for "Weaver/Operator "should be offered including technical aspects, soft skills, attitudinal and behavioral trainings:

- Discipline - To brief role of a weaver, importance of discipline, rules, importance of cleaning etc.
- Productivity - To understand importance of following management instructions and reaching targets
- Quality - To understand the importance of product quality
- Responsibility - To understand weaver's work and social responsibilities

- To be present at least 10 - 15 minutes earlier to the work spot and to take charge of shift from previous shift weaver and proper hand over of the shift to next shift weaver
- Meet and discuss with previous shift weaver, regarding the issues faced by them with respect to the quality,

production or any other specific instruction regarding weaving machine, etc.
- To attend end break efficiently (minimum 15 knots/minute)
- Attend a single warp end through dropper, heald and reed dent in 45 to 60 seconds
- To attend the weft break within 30 seconds
- To check and correct the fabric defects time to time and ensure that it get corrected at the earliest, before continuing to further production
- Use personal protective equipment such as ear plug, nose mask, head cap etc., as per protocol
- Maintain cleanliness of the machines & other work areas

Weaver/operator& Mechanic/technician shall have the knowledge of:

To maintain automatic looms efficiently, to get maximum output with minimum defects & with lesser cost of production, knowledge for the below stated roles and responsibilities are mandatory:

- Yarn counts, various types of yarns, the standard quantitative figures for different basic parameters of different mix/blend yarns, etc.[5].
- Types of weaving machines (Projectile, Rapier, Air jet, Water jet), etc
- Types of weave designs & fabric defects with inspection standards
- Functions of different parts of shuttle-less looms
- Importance of color coding followed for different counts
- Functions of different signal lamps
- To monitor weaving machine condition and availability of spare parts
- Ensure the proper functioning of stop motions, take-up and let-off mechanisms, back rest, shedding, picking and other parts of the machine
- Maintain temple settings, reed setting to avoid fabric rejections for reasons like: 'temple cut' & 'temple mark', 'reed mark', etc
- Importance of lubrication and oiling
- Knowledge of the standard maintenance practices
- Importance of team work
- Importance of safety procedures

Training mechanism:

Duration of the training shall be 6 weeks, each day 6 hours per operator & 3 hours per mechanic,

Training has to be given both in class room as well as shop floor

Best practices for management have to implement the following standard systems:

Checking for raw material quality and optimization techniques [4]

Quality circles - A quality circle or quality control circle is a group of workers who do the same or similar work, who meet regularly to identify, analyze and solve work-related problems

5 – S (Sort, Set in order, Shine, Standardize and Sustain) and Kaizen

TQM – Total Quality Management: Total quality management consists of organization wide efforts to install and make permanent a climate in which an organization continuously improves its ability to deliver high-quality products and services to customers

SOP - SOP can also be defined as a checklist for the user (operator) who is going to do a particular job and it is a sure success method of doing a job

- ✓ Routine and preventive maintenance practices
- ✓ Research & product development activities
- ✓ Cost reduction activities
- ✓ Quality complaints (resolve Cell)
- ✓ Communication meetings
- ✓ Environment and social compliances
- ✓ Motivational systems

Best practices for environmental compliances

- Preservation of natural resources
- Energy conservation
- Recycling of waste products
- Reduction in emission of harmful pollutants

Best practices for social compliances

- ✓ Avoidance of underage labor recruitment
- ✓ Availing dormitories for workers
- ✓ Freedom of association
- ✓ Creating a working environment where harassment and abuse is not there

- Health and safety - PPE (Mouth mask, scissor, cutter, knife, eye safety glass, hand gloves, goggles, ear muff, apron, proper toilet, pure drinking water, emergency exit, first aid box, smoke detector, fire extinguisher, aisles & arrow marking, doctor room)
- Child care room
- Canteen
- Avoidance of excessive work hours

Best practices/standards for maintenance management system

- Use machine audit and correction during annual maintenance
- Mechanical Intervention- where mechanics need immediate attention to the mechanical problem
- Preventive Maintenance- where mechanics do periodic job
- Spare Parts consumption & inventory management- where mechanics/store manager together work and decide about the minimum stock level for order
- Proper follow-up & implementation of machine manuals, maintenance catalogues & preventive maintenance procedures/checkpoints for daily, half-monthly, monthly, quarterly, half-yearly & yearly maintenance practices of the machines and the humidification plant.

Best practice for getting raw-material with the required quality:

The following yarn parameters have to be checked and compared with the requirement specification immediately before coming and used for weaving:[4] – [5]

- Actual count (with count CV)
- Yarn strength (RKM)
- Twist (TPM)
- U%
- Imperfection level/km (thin place, thick place, neps)
- Yarn elongation (%)

Best practice standard for fabric inspection & quality control

4 point system is most widely used standard fabric quality inspection system helps for grading of textile fabrics. Quality acceptable level of points is mentioned below for various types of fabrics:

4 point systems	Acceptable level
Suiting	<18 points/100 sq.yards of fabrics
Shirting	20 to 24 points/100 sq.yards of fabrics
Sheeting	24 to 28 points/100 sq.yards of fabrics
Cotton twill and denim	28 points/100 sq.yards of fabrics
All synthetic fabrics	20 points/100 sq.yards of fabrics

The criteria for giving penalty points are on the basis of the defect length. Defects of both warp & weft directions of the woven textile fabric will be given point using the following criteria:

Points	Inches (’’)	(mm)
1 point	Defects up to 3 inches	Up to 75mm
2 point	Defects >3 inches <6 inches	Defects >75mm <150mm
3 point	Defects >6 inches <9 inches	Defects >150mm <230mm
4 point	Defects >9 inches	Defects >230mm

Best systems/standards for quality assurance

The following systems help textile mills to reduce defects and produce woven products with an assured quality:[2].

- Prevention of quality problems through planned and systematic activities including documentation
- Establish a good quality management system

Quality assurance system should include:

a. Process
b. Pro-active response
c. Prevent the defects
d. Quality audits
e. Defining process
f. Trainings

Quality control of woven fabric should be ensured with 3 M’s:

- Men - Vision and focus of the management who run the company are the key to ensure the quality,
- Material -The various qualities of raw materials, which the factory uses to make the final product, are essential because only a good raw material can result in a good final product,
- Machinery -The manufacturing settings and the machinery used at the various levels of the manufacturing process are the keys to the final quality. It is not important to have the latest machinery but it is important to have the good and well-maintained machine with the correct settings.

Quality control processes:

Quality control is a multi-step procedure by which the following steps has to be monitored properly: [2].

i. Material testing/inspection,
ii. Analysis of results,
iii. Corrective/remedial actions

So to obtain an ‘A’ grade quality textile woven product, the above controlling procedures has to be strictly followed.

Besides, productivity and efficiency of loom shed can be affected by weaving operators’ inefficiency & carelessness, input yarn quality issues, absence of preventive maintenance schedule and follow-up of the productive machine and equipment, inappropriate processing of operating procedures, etc. [6]

In addition Neway has investigated that, proper care has to be given for sizing machine. Because if proper weavers’ beam is produced, i.e. weavers beam with less lappers and cross-ends, it will not create unwinding problem while the warp is letting-off during fabric production in loom operation. This can be ensured by properly checking squeezing rollers of sizing machine and working conditions of the stretch counters, tensioning zones & hygrometer. [7]

Best systems/standards to be followed for waste reduction in weaving section

- Developing better understanding about individual’s role & responsibility in waste control
- Enlist causes of hard waste generation &take measures to reduce the hard waste
- Prevailing level of hard waste in the mills and hard waste norms in best practice mills (max. of 4 %) required to display every day/every shift
- Various control measures related to work methods & systems
- Financial implications & losses due to higher waste generation

Any areas of weaving mill create a certain amount of waste, which can be divided as:

a. Process waste and
b. Incidental waste.

With the use of the above standard systems, it is possible to reduce incidental wastes. Because control of hard waste generation is another method of saving fabric manufacturing cost.

G. Castelli, et al discussed in their book that as sizing is the heart of weaving process in achieving the desired target efficiency, the machine settings have to be monitored for controlling the basic parameters. Controlling parameters at this stage helps for smooth operation of the beams in weaving section. This in turn helps in minimizing generation of process and incidental wastes. [8]

V. CONCLUSION AND FUTURE SCOPE

This study focuses on assessment of current qualitative and quantitative parameters best practices/standards for Ethiopian textile weaving mills. For assessing the parameters, six weaving mills have been selected on the basis of: productivity & efficiency, technology mix, product mix, ownership status and process flow.

From the study it is found that the representative factories have an average plant utilization of 65%, which is lower against the best practice of 92%. The plant efficiency of best practice standard is 85% while Ethiopian weaving factories have a maximum efficiency of 70%. The factories' looms are running with only 60% against the required best practice speed of the looms. Coming to productivity, Ethiopian weaving mills are 50% lower in comparison with the standard. When we see operator efficiency, in Ethiopian textile mills a weaver operates only 6 looms while internationally a weaver can operate up to 12 looms. In general, the above figures show that currently Ethiopian weaving mills are not competitive with international textile mills.

For addressing the problems, the discussed qualitative best practices/standard systems have to be properly implemented and followed. Thus, Ethiopian weaving mills can approach to international best practice standards/norms. This in turn helps to produce woven textile products, which are internationally competitive in productivity &quality. This leads the country to earn more foreign currency through exporting of the woven products to different international market destinations.

ACKNOWLEDGMENT

For conducting this research I have visited 6 factories. Most of the factories are found outside of the capital city Addis Ababa. Here, I would like to thank Ethiopian textile industry development institute for helping me with the transportation facilities. I also thank the factories to cooperate with me in giving all the necessary data and for their accommodation facilities.

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