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ASSESSMENT OF LABOR SKILL AND DEVELOPMENT OF LABOR SKILL MATRIX FOR SEWING SECTION OF AN APPAREL INDUSTRY

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Abstract: *The Ready Made Garments (RMG) industry is the largest export earning industry contributing around 80% of total export earnings of Bangladesh. This industry is labor intensive and provides employment to around 4 million Bangladeshis. The engagement of all kind of male and female workers; skilled to unskilled is its added advantage. This study aims to find out the categories of the workers based on their skill levels and builds up labor skill matrix in a systematic methodology for highly labor intensive sewing section of an apparel industry. The categorization was based upon the well-established attributes from literature and relevant practical fields and done in two ways-i) skills on operation (types and number of operations) and ii) skills on machine (types and number of machines). The study reveals two general matrices in each way individually and a combined matrix for both ways. The matrix for skills on both operation and machine show that around 0.0%, 0.4% and 32.4% workers were identified for poor, fair and average skill level respectively per sewing line. In case of higher skill levels-good, excellent and super skill about 56.4%, 10.8% and 0.0% workers were identified respectively per sewing line in both matrices. The study also reveals that almost all operators were multi skilled for operation whereas only 10.2% operators were multi skilled for machine with two machines. The matrices also enlightened the practitioners about high potentiality to gain the advantages of labor flexibility in the paradigm of flexible manufacturing system for improving the manufacturing performance.*

Keywords: RMG industry, sewing section, labor skill matrix.

1. INTRODUCTION

The Textile & Clothing (T&C) industry is the starter industry for export-orientated industrialization [1] and economically developed countries. Now with the advantages of globalization this industry shifted to developing countries. In Bangladesh the inauguration of T&C industry started with RMG sector was in late 70s after the independent war of the country. With a very slow start, it rose faster with the advantages of MFA (Multi-Fiber Agreement), Quota system and low labor wages and became a pioneer apparel sourcing choice for many developed countries [2], [3]. Now this is the leading sector of Bangladesh in terms of largest foreign exchange earnings and in 2015-16 fiscal year with US $28.09 billion of exports accounting around 82 percent of the total export earnings was achieved from this sector. This is also second largest employment creating sector after agriculture. In 1984-85 the number of garment factory was 384 with 0.12 million worker, but in 2015-16 the number of garment factory has increased to 4328 with around 4 million workers, freeing them from the curse of poverty [4]. A huge number of skilled and unskilled workers contribute for apparel industries performing various operations in this labor-intensive industry [5], [6], [7]. For any labor intensive manufacturing process improvements of labor performance for labor productivity along with process and product quality are important for achieving the target goal [8].

A firm's human resources are major resource for its productivity [9]. With experience and training people become more valuable to firm with time. Whereas machine capacity can extend within its limitations and by time it becomes worn out, outdated and must be replaced. In apparel manufacturing manpower are hired as direct labor, management and support staff. The direct labors are engaged on the products being produced, such as cutting, sewing and finishing operators and convert materials into finished products by adding value to products [10]. This case study focused on the skill level of the sewing worker to establish an easy way to assess the individual workers based on the operation and machine type. It also reveals useful skill matrix which will help the management to take initiative for the daily manpower management, worker improvement program and adaption of modern technology.

2. LITERATURE REVIEW

Literature on major human resources challenges reveals

that there is a limited pool of skilled employees and to cope with emerging technologies and sustain in global marketplace, there is a prerequisite to develop of skill sets [11]. There are different types of skill rating methods in literature. Time study rating is the most widely used rating technique, has led to the development of modified forms of performance assessment. Techniques such as multi-image in objective rating by Mundel in 1955 [12] and step film in pace comparison by Nadler in 1955 [13] aid the observers in assessing working pace. In comparisons between conventional (speed and effort rating), multi-image and step film assisted techniques it was found that advantages of these three systems may depend on the job being studied [14]. Performance rating method is mainly depends on the judgment of the time study man. Important types stated by Reddy (2007) [15] as; performance rating, skill and effort rating, Westinghouse system of rating, synthetic rating, physiological evaluation of performance level and objective rating are tabulated in the following table 1.

Table 1: Different types of Performance rating method

Author, Year	Performance rating system	Brief description
Reddy, 2007	Performance rating method	This is a subjective method and mainly depends on the judgment of the time study man. The worker's pace is compared with three scales consisting of 100, 75 and 60 as the base for the normal performance [15].
Reddy, 2007	Skill and effort rating	This method was developed by Charles E. Bedaux in 1916. Time standards used in this method are expressed in point or "Bs" which corresponds to another name for a standard minute. Standard performance was regarded as 60 points or 60 Bs. 60Bs per hour was expected from a worker working at a normal pace. The worker's pace is compared with three scales consisting of 100, 75 and 60 as the base for the normal performance [15].
Barnes, 1980	Westinghouse method	In this method four factors; skill, effort, conditions and consistency [16] were considered and there are six classes (poor, fair, average, good, excellent and super skill) of each factor.
Patil et. al., 2008	Synthetic rating	In this system, performance rating is performed by comparing some manual element's observed times with the known time values of PMTS (Predetermined motion and time studies) elements whose time values are known. A ratio is obtained by dividing predetermined time for elements to average actual time value for the same element. This ratio is considered as the performance index or the rating factor for the worker for the specific element [17].
Reddy, 2007	Physiological evaluation of performance level	Here heart-beat rate and oxygen consumption are measured with the required electronic equipment to evaluate the physical work [15].
Mundel and Danner, 1994	Objective rating method	This was developed by Mundel and Danner (1994) [18]. In this method, performance rating is considered as the multiplication of the pace rating factor and the job difficulty adjustment factor. Firstly the pace is judged regarding a standard pace independent of job difficulty then a second factor showing its relative difficulty is assigned [19].

Skill level is also related with task or job difficulties. These difficulties also may categorized depending the issues such as Amount of body used, Foot pedals, Bi-manualness, Eye-hand coordination, Handling requirements and Weight [20]. The apparel industry is particularly dependent on the sewing machine operators who dominate the apparel production and their skills affect the productivity and quality of garments. A study shows that the tasks of making garments were also categorized in four ways, these are - Critical and non-critical operation, Skill level required to perform an operation, Machine used, such as Single Needle Lock Stitch, Over-edge, semi-automatic machine, Flat Lock machine etc. and Area of operation in the garment [21]. Some researchers also categorized the workers in different ways considering their various capability and skill level. The following table 2 shows some categorization with their attributes.

Literatures also show the importance for categorization of worker skill level and development of skill set or skill matrix to attain the emerging advantages of modern technologies and to cope up the volatile market demand. As well as the proper debate over necessary skill acquisition and incentives should be focused in labor-intensive industry. This categorization helps the management to implement the systematic wages, incentives and trainings to find their skills unneeded, unrewarded and development. Modern manufacturing systems also include complex technical equipment as well as skilled human operators. Such as in flexible manufacturing, labor flexibility is the ability of workers to transfer from one work center to another. Due to differences in worker skill, a rule based model was developed for their assignment at every work center [27]. In this connection multi skilled labors are become one of the most important resources for Modern manufacturing systems.

Table 2: Workers' skill levels category with their attributes

Agarwal, N. & Chatterjee, A., 2013 [22]	Pravin, P. & Narendra P., 2016 [23]	S. Janaki, 2010 [24]	5-Point Rating Scale [25]	A.F. Devotta, 1988 [26]
Worker of B category (Semi Skilled operator**):** 1. They are specialized only in a particular sewing operation. 2. They cannot handle critical operation. 3. They lack leadership qualities. 4. They don't have good communication skill. 5. They are not capable of decision taking because they do not have subject or subject work knowledge. **Worker of A category** (Skilled operator**):** 1. They Undertake difficult operations. 2. Operators possess multi skills with good communication ability. 3. They can handle little breakdown. 4. They produce expected quantity by ensuring prescribed quality standard.	**Level 1:** They cannot perform without help. **Level 2:** They can perform with help under supervision. **Level 3:** They can perform task and train others. **Level 4:** They can perform task, train others and suggest improvement.	**Category 1:** They are not trained on the subject. **Category 2:** They have been given basic training on the subject. **Category 3:** They have working knowledge of the subject and can work under supervision. **Category 4:** They have adequate knowledge of the subject and can work independently on the job. **Category 5:** They are expert of the subject and can give training to others.	**Level 1 (Unsatisfactory):** Their performance is always below expectation and they need improvement. **Level 2 (Improvement needed):** They sometime meets expected performance goal. **Level 3 (Meets expectations):** They consistently meets expected performance goal. **Level 4 (Exceeds expectations):** They consistently exceeds expected performance goal. **Level 5 (Exceptional):** Their performance far exceeds expectations due to exceptionally high quality of work.	**Poor skill:** 1. Very slow in work. 2. Error occurs frequently. **Fair skill:** 1. Error occurs sometimes. 2. Very slow in work. 3. Cannot coordinate with the sequence. **Average skill:** 1. Works with reasonable accuracy. 2. Little slow in work. 3. Follow sequence of the operation. **Good skill:** 1. Work speed is good. 2. Correctly follows the sequence of operation. 3. Performance is more than satisfactory. **Excellent skill:** 1. Works without errors in action or sequence. 2. Performance is fast. **Super skill:** 1. They are so fast that they are hard to follow. 2. Machine like appearance and action.

3. METHODOLOGY

The study was conducted on an export oriented composite knitwear industry of Bangladesh. It consists of eight sewing floors with 128 sewing lines employing around 6000 workers and among them around 4000 are sewing operators. The industry is practicing two policies for hiring new sewing operators. Firstly, fresher who are undergone training within industry premises and then employ in floor after their development. Secondly, experience operators who are assessed on the spot and if found satisfactory then recruited. The study framework is shown in figure 1.

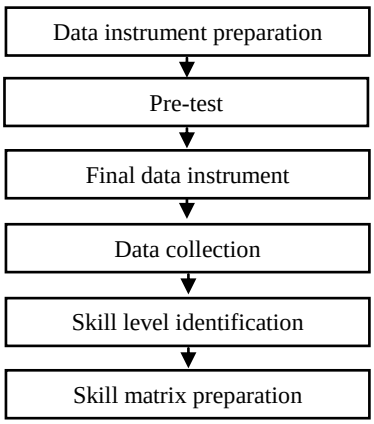

Fig 1: Study framework

3.1 Data Instrument

It was prepared based on the literature review and relevant experts' opinion and was finalized after pre-test by relevant experts and practitioners. The skill levels of the operators were divided into six categories (Poor, Fair, Average, Good, Excellent and Super skill) considering six selected attributes which were also leveled within 0 to 1. The attributes with their levels and level points are given in table 3. The attribute levels in each skill level category and attributes level points are also given in table 4. Total level points for each skill level were also calculated by summing up the attributes level points. Two data instruments were produced; one based on operation types and another based on machine types. Those were shown partially in table 5 and table 6 respectively with data in data collection section.

3.2 Data Collection

As this was a case study the data were collected from a sewing floor which consists of 18 sewing line and which were designated as Line A, Line B, ……..and

Line P. During the data collection line G, H and O were not included due to some unavoidable restrictions of the factory. However, from 13 lines consists of 300 sewing operators were included in the study. For all lines, respective supervisors were the respondents and data were collected from them through face to face interview. The example, data from line K (partial) for two instruments were shown in table 5 and 6 respectively.

3.3 Skill Level Identification

Responses were converted according to table 3 and skill levels were identified according to table 4. For example, the skill level of workers for given data in table 5 and 6 are shown in table 7 for operation and table 8 for machine based respectively.

3.4 Skill Matrix Preparation

Combining skill level based on operation and machine a skill matrix was prepared for 300 sewing operators. For instance, a part of the skill matrix (according to data shown in table 7 & 8) is given in table 9. The worker, who possesses skill level in more than one machine, s/he was also identified as multi skill on machine.

Table 3: Selected attributes with levels and level points

Selected attributes	Levels of attributes	Level point (0 to 1)
They can perform with/without help.	Under supervision	0
	Independent	1
They are trained/not trained.	Not trained	0
	Trained	1
Achieve expected performance goal.	Never	0
	Rear	0.25
	Sometimes	0.50
	Frequently	0.75
	Always	1
Error frequency	Always	0
	Frequently	0.33
	Sometimes	0.66
	Never	1
Suggest improvement	No	0
	Yes	1
Leadership qualities	No	0
	Yes	1
		0 = lowest level and 1= highest level

Table 4: The relationship of skill levels, attributes, levels of attributes and skill level points

Skill Level	Attributes	Attribute level points	Skill Level points
Poor	1. They can perform with help under supervision.	0	
	2. They are not trained.	0	
	3. They rear exceed expected performance level.	0.25	
	4. Error occurs frequently.	0.33	0.58
Fair	1. They can perform with help under supervision.	0	
	2. They have been given basic training on the subject.	1	
	3. They sometimes exceed expected performance level.	0.50	
	4. Error occurs frequently.	0.33	
	5. No Suggestion for improvement.	0	1.83
Average	1. They can perform with help under supervision.	0	
	2. They have been given basic training on the subject.	1	
	3. They sometimes meet expected performance level.	0.50	
	4. Error occurs sometimes.	0.66	
	5. No Suggestion for improvement.	0	2.16
Good	1. They can perform with help under supervision.	0	
	2. They have basic training on the subject.	1	
	3. They frequently meet expected performance level.	0.75	
	4. Error occurs sometimes.	0.66	
	5. No Suggestion for improvement.	0	2.41
Excellent	1. They have adequate knowledge of the subject and can work independently on the job.	1	
	2. They have been given basic training on the subject.	1	
	3. They always exceeds expected performance goal.	1	
	4. Error occurs sometimes.	0.66	
	5. They have no leadership qualities.	0	3.66

Super	1. They can work independently on the job. 2. They have been given basic training on the subject. 3. They always exceeds expected performance goal. 4. Error occurs sometimes. 5. They can suggest improvement. 6. They have leadership qualities.	1 1 1 0.66 1 1	5.66

Table 5: Data Instrument based on operation with response

SL. No.	Name of the operator	Operation type	Does s/he have training on the subject?		Does s/he achieve expected performance level Rear(R), Sometimes (S) or Frequently (F) Or always exceeds expected goal?				Error frequency Frequently (F) or Sometime(S)?		Can s/he operate independently (i) or needs supervision(S)?		Can s/he suggest improvement?		Is s/he an expert with leadership qualities?	
1.	Masud	Critical	Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
		Non-critical	√Yes	No	R	√S	F	E	√F	S	I	√S	Yes	√No	Yes	√No
2.	Koli	Critical	√Yes	No	R	√S	F	E	F	√S	I	√S	Yes	√No	Yes	√No
		Non-critical	Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
3.	Shahinur	Critical	√Yes	No	R	S	√F	E	F	√S	I	S	Yes	√No	Yes	√No
		Non-critical	Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
4.	Saiful	Critical	√Yes	No	R	S	F	√E	F	√S	√I	S	Yes	√No	Yes	√No
		Non-critical	Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No

Table 6: Data Instrument based on machine with response

SL. No.	Name of the operator	Name of the machine	Does s/he have training on the machine?		Does s/he achieve expected performance level Rear(R),Sometimes (S) or Frequently (F) Or always exceeds expected goal?				Error frequency Frequently (F) or Sometime(S)?		Can s/he operate independently (i) or needs supervision(S)?		Can s/he suggest improvement?		Is s/he an expert with leadership qualities?	
1.	Masud	Plain	√Yes	No	R	√S	F	E	√F	S	I	√S	Yes	√No	Yes	√No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
2.	Koli	Plain	√Yes	No	R	√S	F	E	F	√S	I	√S	Yes	√No	Yes	√No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
3.	Shahinur	Overlock	√Yes	No	R	S	√F	E	F	√S	I	√S	Yes	√No	Yes	√No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No
4.	Saiful	Flat lock	√Yes	No	R	S	F	√E	F	√S	√I	S	Yes	√No	Yes	√No
		Over lock	√Yes	No	R	S	F	√E	F	√S	√I	S	Yes	√No	Yes	√No
			Yes	No	R	S	F	E	F	S	I	S	Yes	No	Yes	No

Table 7: Skill level based on operation

Name	Operation	Does s/he has training?	Does s/he achieve expected performance level?	Error frequency	Can s/he Operate independently or needs supervision?	Can s/he suggest improvement?	Is s/he an expert with leadership qualities?	Total point	Skill Level
Masud	Non critical	1	0.50	0.33	0	0	0	1.83	Fair
Koli	Critical	1	0.50	0.66	0	0	0	2.16	Average
Shahinur	Critical	1	0.75	0.66	0	0	0	2.41	Good
Saiful	Critical	1	1	0.66	1	0	0	3.66	Excellent

Table 8: Skill level based on machine

Name	Machine	Does s/he has training?	Does s/he achieve expected performance level?	Error frequency	Can s/he operates independently or needs supervision?	Can s/he suggest improvement?	Is s/he an expert with leadership qualities?	Total point	Skill level
Masud	Plain	1	0.50	0.33	0	0	0	1.83	Fair
Koli	plain	1	0.50	0.66	0	0	0	2.16	Average
Shahinur	Over lock	1	0.75	0.66	0	0	0	2.41	Good
Saiful	Flat lock	1	1	0.66	1	0	0	3.66	Excellent
	Over lock	1	1	0.66	1	0	0	3.66	Excellent

Table 9: A small portion of Skill matrix

Name	Operation	Grade point based on operation	Skill level based on operation	Machine	Grade point based on machine	Skill level based on machine	Multi Skill
Masud	Non critical	1.83	Fair	Plain	1.83	Fair	--
Koli	Critical	2.16	Average	Plain	2.16	Average	--
Shahinur	Critical	2.41	Good	Overlock	2.41	Good	--
Saiful	Critical	3.66	Excellent	Flatlock	3.66	Excellent	Overlock

4. RESULT AND DISCUSSION

This case study explored the operators' skill levels of the studied floor and as well as each sewing line. Among 300 operators there was no one with poor skill or super skilled in both operation and machine based assessment. There was only one operator with fair skill for operation and no one for machine. The figure 2 and 3 present the skill levels based on operation and machine for line wise respectively.

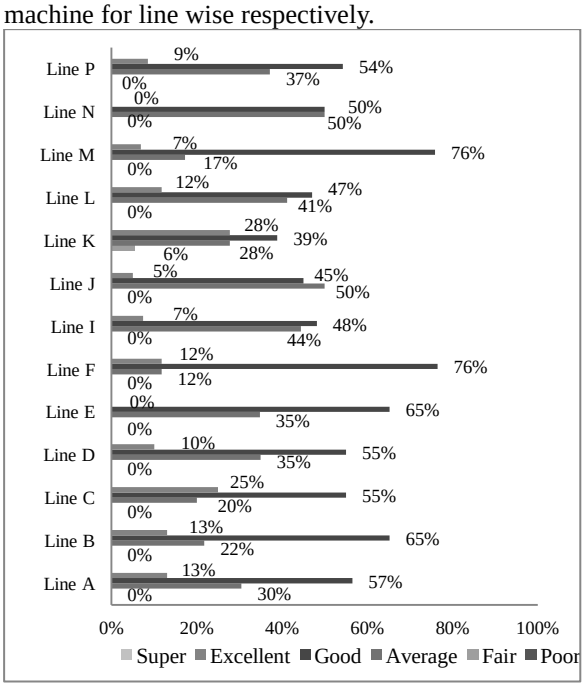

Fig. 2 Operators % of various skill level based on operation among the line.

Both figure 2 and 3 shows that each line consists of operators for good, average and excellent skill levels with their percentages against total operator of respective line.

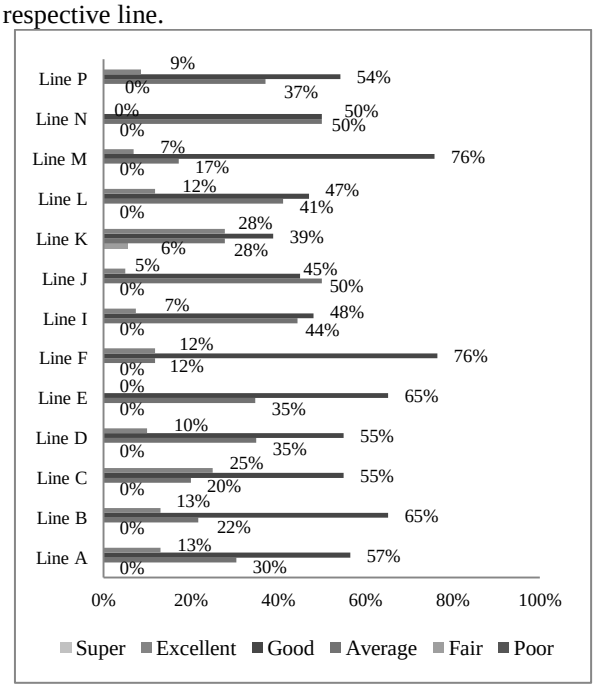

Fig. 3 Operators % of various skill level based on machine among the line.

Similarly figure 4 and 5 present very similar results for the skill levels based on machine for overall respectively. These also show there were three skill levels operators, good (56.7%), average (33%) and excellent (10%) in both case.

Based on operation, operators with average skill and higher are able to critical operation hence they are multi skilled based on operation. The table 9 (partial of skill matrix) also shows such. From this it can be said that almost 100% operators were with multi skilled in case of operation and they can perform both critical and non-

critical operations.

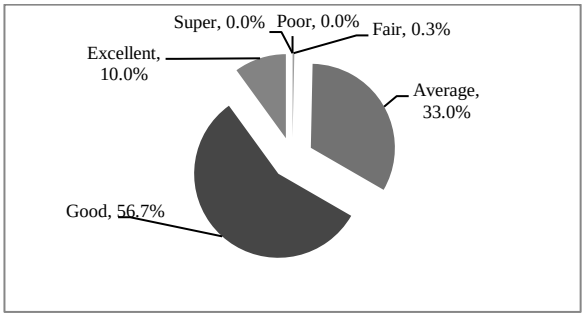

Fig. 4 Operators % of various skill levels for operation

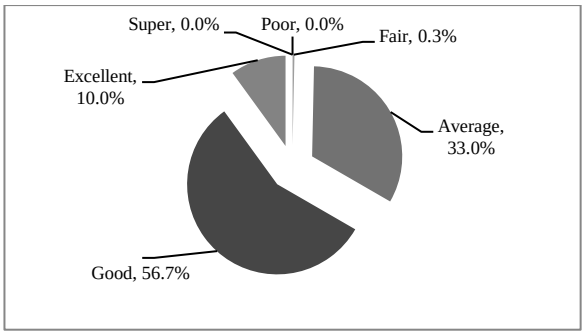

Fig. 5 Operators % of various skill levels for machine

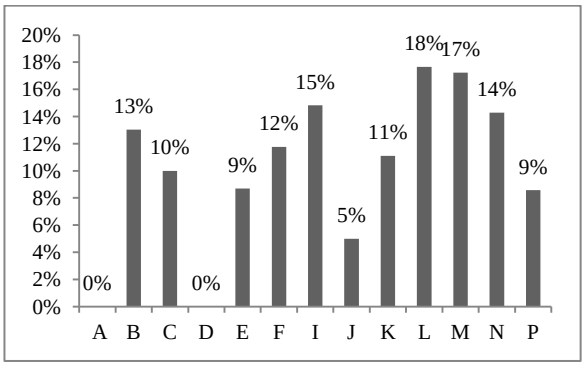

Fig. 6 Multi skill Operators % in line based on machine

Figure 6 shows the status of operators' percentage for multi skill in individual line based on machine. Except two lines A and D, in other lines there were some multi skilled operators ranging from 5% to 18%.

5. CONCLUSION

This case study on a sewing floor established an easy way to assess the sewing operators by their supervisors. There were some limitations and inconsistency due to busy schedule of supervisors and bias judgment to some workers who were mainly excellent skill. May be due to such negative biasness no operators were found as super skill. In further study the excellent skill operators should be assessed further by floor in-charges or industrial engineers. However the study reveals that more than 80% operators were with average and good skill. All operators almost 100% were multi skilled in operation with one machine as they can perform both non-critical and critical operations in a particular machine. Whereas only 10.2% operators were found skilled with second machine and considered as multi skilled in machine. The matrix also shows that usually excellent skill on machine workers were usually multi skilled and average to higher skill workers on operation also multi skilled.

The authors also found that as the sewing line production system was progressive bundle system, there were no advantageous uses of multi skilled operators except absenteeism adjustments. But multi skilled operators are highly potential to provide more advantages of labor flexibility in the paradigm of flexible manufacturing system. Following the skill matrix they can be employed with flexibility for operations widely. Flexible use of operators for both operation and machine was little bit difficult due to scarcity of multi skilled in machine. With further training the good and average skill workers may be updated to super and multi skill. So that practitioners can get the advantages of labor flexibility in the paradigm of flexible manufacturing system for improving the manufacturing performance.

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