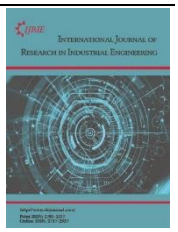
E-ISSN: 2717-2937 | P-ISSN: 2783-1337

International Journal of Research in Industrial Engineering

www.riejournal.com

Int. J. Res. Ind. Eng. Vol. 11, No. 3 (2022) 214–223.



Paper Type: Research Paper

Overall Productivity Assessment Using the Performance Objectives Productivity (PO-P) Approach: A Case Study

Seife Ebeyedengel*

Department of Industrial Engineering, Institute of Technology, College of Engineering, Debre Berhan University, Debre Berhan, Ethiopia; seifnet.ebeye@gmail.com.

Citation:

Ebeyedengel, S. (2022). Overall productivity assessment using the performance objectives productivity (PO-P) approach: a case study. *International journal of research in industrial engineering, 11*(3), 214-223.

Received: 17/12/2021 Reviewed: 16/01/2022 Revised: 22/01/2022 Accepted: 05/03/2022

Abstract

During my travel to the research case industry to advice internship placed students of our university, I have communicated with company owners that there is a problem related with productivity measurement and improvement. So that we have decided to assess the overall productivity of the company with the considerations of potential sub systems with in it. The existing system overall productivity level have been measured through Performance Objectives Productivity (PO-P) approach. In the case company six subsystems where identified: technology, production, marketing, ergonomics, values and goals and materials. Afterwards, their importance to the company have been prioritized using paired comparison analysis technique. By using Pareto analysis; technology, marketing, ergonomics and production have been identified as potential subsystems. By using PO-P approach the productivity of these four potential subsystems has been measured. As a result, productivity indices of production, marketing, technology, and ergonomics subsystems are 0.7379, 0.6661, 0.7882 and 0.7156 respectively. This resulted the existing system overall productivity of 0.652.

Keywords: Overall productivity assessment, PO-P approach, Productivity index, Potential subsystems, Sewing thread and yarn manufacturing.

1 | Introduction

In Ethiopia the economic impact of the textile sector for national GDP has been remarkable and this declares the beginning of modernizing the sector in the country in the late 1930s. The employment opportunity created by this sector is very prominent in job creation so that the graduated students from textile and manufacturing field are recruited to this sector. Due to the fact that the sector in Ethiopia demands a lot of man power either skilled or unskilled of textile sector is considered as number one priority sector by the Government's Industrial Development Strategy [1]. In such important industries evaluation of the levels of productivity is very essential to indicate the level of the performance and the continuity of the business. The performance of machines, machine tools, components etc. are measured in terms of efficiency, effectiveness and productivity by different scholars using different techniques, tools and models. This was done to take the commitment for

Corresponding Author: seifnet.ebeye@gmail.com

http://dx.doi.org/10.22105/riej.2022.320275.1273

further improvement of the working environment. Productivity is a useful indicator to analyze the performance of an organization, measuring productivity is a prerequisite to improve productivity.

In the above sense, Perdana and Saroso [2] tried to measure the performance of Thoshiba IS 350 GS 350 Ton machine in terms of productivity to explore the main causes. So that they tried to implement repairing production machine to improve productivity based on the OEE value achievement [2]. On the other research, two-stage data envelopment analysis model was used to calculate/measure the effectiveness and efficiency of petrochemical companies from the perspective of human health was calculated using two stage data envelopment analysis model. In this research five input indicators were analyzed to improve the health indicators [3]. In addition to this, research conducted by Hosseinzadeh Lotfi and Jahanbakhsh [4] revealed that the performance in terms of efficiency and effectiveness of a DMU can be calculate using DEA, but in rather to better performance assessment and show the efficiency and effectiveness distinction, it's needed to apply ICCR and IBCC models that can handling simultaneously efficiency and effectiveness, but they do not define the total performance [4]. In any manufacturing organization, enhancement of productivity is very prominent. But before improvement there should be a method to measure the productivity of that organization. The same thin was done by Halder et al. [5] to mark the possible major factors of productivity in Ready Made Garments (RMGs) sector in Bangladesh. During their study multi-criteria decision-making tool such as FAHP was used for evaluating the best criterion among several criteria to select the factor that directly affects the productivity of the sector. Finally they concluded that the result of this study provided a better solution the sector to increase the productivity [5].

The measurement the productivity of the machine, machine tools, work sections or the subsystem etc. within the system, it requires the consideration of other components within them [6]. For this research the selected case company called "Edget Yarn and Sewing Thread Share Company" is found in Sarbet, Addis Ababa, Ethiopia. The topic of overall productivity assessment of this case company came in mind after observing the company and discussed with the management staffs which is interesting and important. During our discussion they told me that they want to improve the overall productivity of the company but we agreed on to measure the current level of productivity intensively.

In general, the sector was chosen for a number of reasons. Firstly, through the researcher understanding of the case company's problems related with productivity during term paper works for partial fulfillment of different M.Sc. courses. The researcher needs to determine overall productivity of the company as a system by considering different subsystems within it. Therefore, it requires continuous productivity assessment and improvement. The aggregate measurement program is smart which combines productivity of the components within the systems [7]. Secondly, the Government of Ethiopia has planned to generate employment opportunities by the sector for about 48,000 citizens [8]. Therefore the objective of the study is overall productivity assessment of Edget Yarn and Sewing Thread Share Company so as to bring prioritized potential subsystems those needs for further system level improvement.

2 | Materials and Methods

The model designated as Performance Objectives Productivity (PO-P) has been used to assess the productivity level of the case company from the productivity level of the components/subsystems of the case company. Using the model the overall productivity level of the case company is developed by considering the productivity of potential sub systems/components those made the case company. Productivity Index (PI) of components/subsystems again developed from the productivity indices of the Key Performance Areas (KPA's) of that component/subsystem [9].

Therefore, using this hierarchical approach the data were collected from May 17, 2021 to September 3, 2021 to determine the overall productivity of the case company. These collected data sourced from different work sections of the case company namely production department, purchasing department, human resource office, maintenance office, marketing department, from the staffs' clinic and management

staffs. Now we see how the model is developed to assess the overall productivity of the case company/system.

u= the component/subsystem.

v = the KPA.

y = the performance objectives.

W = the weightage factor.

Oyvu = the Performance Value (PV) of POy in KPAv in component/subsystem u.

O'yvu = the Objectivated Output (OO) of PO-y in KPAv in component/subsystem u.

PI of component/ subsystem S, is given by,

$$PI = \sum_{u=1} W_u (PI)_u, \quad (1)$$

where, PI= $\sum_{U=1} Wu = 1$,

(PI)u the PI of the sub system u is determined as,

$$(PI)_u = \sum_{v=1} W_{vu} (PI)_{vu}, \quad (2)$$

where, $\sum_{v=1} Wvu = 1$, for all us,

(PI) vu, the PI of key performance area, v of component/subsystem u is given by,

$$(PI)_{vu} = \sum_{y=1} W_{yvu}\left(\frac{O_{yvu}}{O'_{yvu}}\right), \quad (3)$$

where, $\sum_{y=1} Wyvu = 1$, for all u and v.

Substituting the value of (PI)vu from *Eq. (3)* in *Eq. (2);* (PI)u of a subsystem u, can be summarized as

$$(PI)_u = \sum_{y=1} \sum_{v=1} W_{vu} W_{yvu}\left(\frac{O_{yvu}}{O'_{yvu}}\right). \quad (4)$$

The value of (PI)u from *Eq. (4)* can be substituted in *Eq. (1)* to provide PI, the PI of a system S, and is summarized as

$$PI = \sum_{u=1} \sum_{v=1} \sum_{y=1} W_u W_{vu} W_{yvu}\left(\frac{O_{yvu}}{O'_{yvu}}\right). \quad (5)$$

To make it clear, PO-P approach follows the following procedure shown in *Fig. 1* to identify the sub system with low productivity so as to bring continuous improvement.

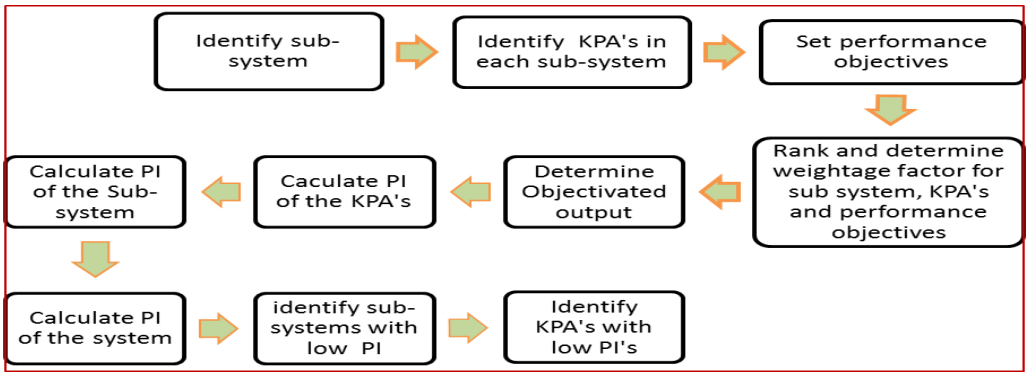


Fig. 1. The procedure of PO-P approach to assess productivity [9].

The steps in *Fig. 1* shows that the procedure that we follow to measure the productivity of the system. Through these steps there are a number of decisions made by the discussion of the researcher and the case company management staffs

3 | Result and Discussion

3.1 | Identification of Subsystems under the Case Company

In any manufacturing industries there are always the considerable list of subsystems those developed the systems as a functional unit [10]. Under the concerned yarn and tread manufacturing company the following sub systems have been identified and each sub-system has been coded in short version to simplify them for the next analysis.

I. Production component/subsystem (G).
II. Technology component/subsystem (H).
III. Material component/subsystem (I).
IV. Marketing component/subsystem (J).
V. Ergonomics component/subsystem (K).
VI. Goals and values component/subsystem (L).

3.2 | Ranking and Determining Weight for Subsystems using Paired Comparison Analysis Technique

Using the technique shown in *Table 1* the importance of the identified of subsystems relative to each other have been carried out and scores have been allocated to show how much more important one on the other. The relative weights are assigned by the company management staffs.

Then consolidate the comparisons so that each option is given a percentage importance.

1= is given to the component/subsystem when Minor difference is between the relative importance.

2= is given to the component/subsystem when Medium difference is between the relative importance.

3= is given to the component/subsystem when Major difference is between the relative importance.

Table 1. Paired comparison analysis results.

	H	I	J	K	L	Score
G:	H-2	G-3	J-3	K-1	L-1	G=3
	H:	H-2	H-2	H-2	H-2	H=10
		I:	I-1	K-1	I-1	I=2
			J:	K-1	J-2	J=5
				K:	K-1	K=4
					L:	L=1

* Source: the case company management staffs.

Based on paired comparison analysis technique here in *Table 1* we can see that the subsystem designated by 'H' is the most important of all subsystems that critically determines the productivity of the company which is followed by the subsystem 'J' and so on.

Table 2. Identified sub-systems with respective relative marks and cumulative distribution.

Sub-Systems	Total Relative Marks for Each	Cumulative Total	Percentage	Percentage Cumulative
H	10	10	40	40
J	5	15	20	60
K	4	19	16	76
G	3	22	12	88
I	2	24	8	96
L	1	25	4	100

* Source: own arrangement from *Table 1*.

Depending on relative marks assigned for each sub systems in *Table 2*, Pareto (80/20 rule) has been done. This tool has been done based on the percentage cumulative relative marks to show the potential subsystems among the givens for further attention and improvement. In addition, it used to identify the potential subsystems those determines the productivity of the systems in general critically.

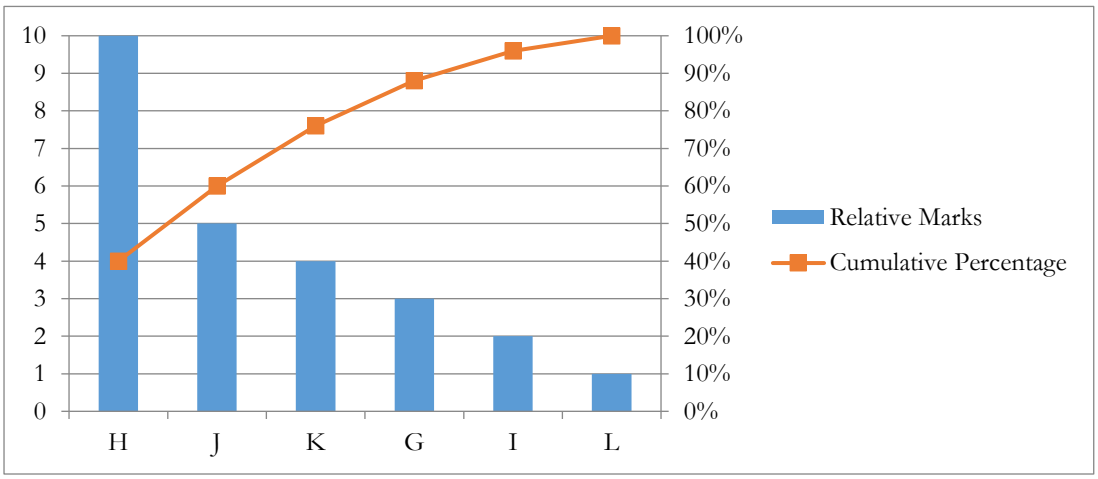


Fig. 2. Pareto curve (Source: own development using excel).

Based on the Pareto curve in *Fig. 2*, with cumulative percentage, technology (H), marketing (J), ergonomics (K) and production (G) components/sub systems have been identified as potential problems areas. These sub systems are considered as the candidates to be used for further productivity analysis and improvement.

3.3 | KPAs for Potential Subsystems

Table 3. The Identified of KPAs for potential subsystems with their relative weight.

Sub-systems	KPAs	Relative Weight (%)
Production (G)	Labor Usage	25
	Tangible Assets Usage	15
	Levels of Defects	40
	Others areas	20
Technology (H)	Products planning and development	45
	Research and Development	55
Marketing (J)	Sales related issues	30
	Market Analysis	50
	Marketing mix (promotion)	20
Ergonomics (K)	Levels of personal fineness to the work	30
	Workplace environment	50
	Any other issues	20

* Source: from the respected personnel of each sub-system.

Once the potential sub-systems have been identified using the Pareto analysis, KPAs have been decided with their respective weight out of 100% with the discussion of the personnel from each subsystem. Here also tried to consider the possible KPAs identified by the management staffs.

3.4 | PI for KPAs and Subsystems

Table 4. Analysis of PI for production KPAs and the subsystem itself.

Sub-System	KPAs	Relative Weight	Performance Objectives	Relative Weight	OO	PV
Production	Labor Usage	25%	Direct labor utilization: standard hrs recovery/direct labor attendance hrs	60%	0.7	0.65
			Cost effectiveness: standard hrs recovery/personnel expenses	20%	0.75	064
			Ethiopian labor utilization of the company	20%	0.8	078
	Tangible asset Usage	15%	Capacity usage: standard hrs recovery/personnel expense	100%	0.85	072
	Levels of Defects	40%	Index of defect free outputs: value of defect free output/value of total outputs	100%	1	0.95
	Other Areas	20%	-	-	-	-

* Source: from the respected personnel of production sub-system & management staff.

As we see from *Table 4* each key performance area has its own performance objectives. In the same manner, performance objectives under each key performance area have weight out of 100%, OO and PV. Using these three as an input PI of each key performance area have been determined. Once PI of each KPAs have been settled, using the relative weight of each KPAs as an additional input, the PI of the production sub system have been calculated in the following way:

$$(\mathrm{PI})_{\mathrm{vu}} = \sum_{\mathrm{y}=1} \mathrm{W}_{\mathrm{yvu}}\left(\frac{\mathrm{O}_{\mathrm{yvu}}}{\mathrm{O'}_{\mathrm{yvu}}}\right).$$

Using this formula, the PI of KPAs for production subsystem in *Table 4* became:

Labor Usage: $(PI)_{vu} = 0.6 * (0.65 \div 0.7) + 0.2 * (0.64 \div 0.75) + 0.2 * (0.78 \div 0.8) = 0.9232,$

Levels of Defects: $(PI)_{vu} = 1 * (0.95 \div 1) = 0.95,$

Tangible Assets Usage: $(PI)_{vu} = 1 * (0.72 \div 0.85) = 0.8471,$

Hence, PI for production sub-system became: $(PI)_u = 0.25 * 0.9232 + 0.4 * 0.95 + 0.15 * 0.8471 = 0.7379$.

Table 5. Analysis of PI for marketing KPAs and the subsystem itself.

Sub-System	KPAs	Relative Weight	Performance Objectives	Relative Weight	OO	PV
Marketing	Sales related issues	30%	Sales: absolute monetary	25%	51.6 million	2.5 million
			Profitability: profit/sales	75%	0.145	0.14
	Market Analysis	50%	Is production capability a limiting factor?	35%	1	0.83
			Is demand a limiting factor?	15%	1	0.94
			Do products mix (quality) and prices mixes are satisfying customers?	50%	0.86	0.78
	Marketing mix (promotion)	20%	Does Ethiopian government supports in creating demand for yarn and thread?	-	-	-
			Are marketing department effortful starting from the manufactures to market their product?	-	-	-
			Are the products exported?	-	-	-
			Does Ethiopian minister of trade and investment gives support for marketing activities?	-	-	-

* Source: from the respected personnel of production sub-system & management staff.

As we see from *Table 5* each key performance area has its own performance objectives. Using relative weight, OO and PV of the performance objectives as an input PI of each key performance area have been determined. Once PI of each KPAs have been calculated, using the KPAs namely contained sales related issues, marketing mix (promotion) and market analysis and their respective relative weight the PI of the marketing sub system have been calculated.

$(PI)_{vu} = \sum_{y=1} W_{yvu(\frac{O_{yvu}}{O'_{yvu}})}$, using this formula PI of KPAs for marketing subsystem in *Table 5* became:

Sales related issues: $(PI)_{vu} = 0.25 * (2.5 \div 51.6) + 0.75 * (0.14 \div 0.145) = 0.7362$,

Market Analysis: $(PI)_{vu} = 0.35 * (0.83 \div 1) + 0.15 * (0.94 \div 1) + 0.5 * (0.78 \div 0.86) = 0.8903$,

Hence, the PI for marketing sub-system became: $(PI)_u = 0.3 * 0.7362 + 0.5 * 0.8903 = 0.6661$.

As we see from *Table 6* each key performance area has its own performance objectives. Using relative weight, OO and PV of the performance objectives as an input PI of each key performance area have been determined. Once PI of each KPAs have been calculated, using the KPAs namely level of personal fitness to the work, workplace environment and other issues and their respective relative weight the PI of the ergonomics sub system have been calculated.

$(PI)_{vu} = \sum_{y=1} W_{yvu(\frac{O_{yvu}}{O'_{yvu}})}$, using this formula, the PI of KPAs for Ergonomics sub-system in *Table 6* became:

Levels of personal fineness to the work, $(PI)_{vu} = 0.4 * (0.4 \div 0.6) + 0.45 * (0.53 \div 0.82) = 0.5568$,

Workplace environment, $(PI)_{vu} = 0.25 * (0.56 \div 0.7) + 0.25 * (0.65 \div 0.8) + 0.25 * (0.4 \div 0.6) + 0.25 * (0.67 \div 0.75) = 0.7931$,

Other issues, $(PI)_{vu} = 0.75 * (0.6 \div 0.8) + 0.15 * (0.45 \div 0.5) + 0.1 * (0.25 \div 0.4) = 0.76$,

Hence, for PI for Ergonomics sub-system became:

$(PI)_u = 0.3 * 0.5568 + 0.5 * 0.7931 + 0.2 * 0.76 = 0.7156.$

Table 6. Analysis of PI for Ergonomics KPAs and the subsystem itself.

Sub-System	KPAs	Relative Weight	Performance Objectives	Relative Weight	OO	PV
Ergonomics	Levels of personal fineness to the work	30%	Does the mgt consider work-experience for the job?	40%	0.6	0.4
			Does the feeling of the workers goods for the job they are assigned?	10%	-	-
			Do the recruited staffs trained before using the available machines?	45%	0.82	0.53
			Do the workers fit the physical requirements of the working-environment?	5%	-	-
	Workplace environment	50%	Do the supporting-facilities timely delivered to workers to aid the staffs in doing the job?	25%	0.7	0.56
			Do working-tools advanced?	25%	0.8	0.65
			Does the workplace-environment at satisfying level?	25%	0.6	0.4
			Doe work-load distribution is balanced throughout the workers?	25%	0.75	0.67
	Other issues	20%	Are there rules, regulations and policies to shape the work culture	75%	0.8	0.6
			Is there any solution mechanism to solve problems emanate and disrupt the working environment from workers?	-	Not Detected	
			Is work-schedule & rotation fairly implemented?	15%	0.5	0.45
			Is there any staffs cased in unusual environmental stress	10%	0.4	0.25

*Source: from the respected personnel of production sub-system & management staff.

As we see from *Table 7* each key performance area has its own performance objectives. Using relative weight, OO, and PV of the performance objectives as an input PI of each key performance area have been determined. Once PI of each KPAs have been calculated, using the KPAs namely design and development and R&D/innovation and their respective relative weight the PI of the technology sub system have been calculated.

$(PI)_{vu} = \sum_{y=1} W_{yvu(\frac{O_{yvu}}{O'_{yvu}})}$, using this formula PI of KPAs for technology subsystem in *Table 7* became:

Products planning and development: $(PI)_{vu} = 0.1 * (0.83 \div 0.9) + 0.2 * (0.84 \div 0.87) + 0.6 * (0.75 \div 0.8) = 0.8478,$

Research and development: $(PI)_{vu} = 0.25 * (0.7 \div 0.75) + 0.3 * (0.6 \div 0.67) + 0.25 * (0.95 \div 1) = 0.7395,$

Hence, for PI for technology sub-system became: $(PI)_u = 0.45 * 0.8478 + 0.55 * 0.7395 = 0.7882.$

Table 7. Analysis of PI for technology KPAs and the subsystem itself.

Sub-System	KPAs	Relative Weight	Performance Objectives	Relative Weight	OO	PV
Technology	Products planning and development	45%	Is the yarn and thread manufacturing unit uses locally available low cost technology?	10%	When necessary	
			Is yarn and thread manufacturing unit equipped with Ethiopian Machineries?	10%	0.9	0.83
			Is the design getting approved before production run?	20%	0.87	0.84
			Is there any CAD facility?	-	-	-
			Is there local planning practice next to final design?	-	-	-
			Are there any process of verification and validation of design?	60%	0.8	0.75
			Is there department assigned to search new available technologies?	-	-	-
	R&D/innovation	55%	Is there a system to do gap analysis in the meantime and future regarding technology?	25%	0.75	0.7
			Does the company ready to take measure when costumer requirement is not fulfilled?	30%	0.67	0.6
			Is there quality-manual to guide mfg department?	25%	1	0.95
			Is the mfg department uses strength, weakness, opportunity and threat analysis to direct the future?	20%	Not available	

*Source: from the respected personnel of technology sub-system & management staff.

Table 8. Analysis of PI for production KPAs and the subsystem itself.

Sub-Systems	Relative Weight	KPAs	Relative Weight	PI of KPAs	PI of Subsystems
Production	12%	Labor Usage	25%	0.9232	0.7379
		Tangible Assets Usage	15%	0.8471	
		Levels of Defects	40%	0.95	
		Other issues	20%	-	-
Technology	40%	Products planning and development	45%	0.8478	0.7882
		Research and Development	55%	0.7395	
Marketing	20%	Sales related issues	30%	0.7362	0.6661
		Market Analysis	50%	0.8903	
		Marketing mix (promotion)	20%	-	
Ergonomics	16%	Levels of personal fineness to the work	30%	0.5568	0.7156
		Workplace environment	50%	0.7931	
		Other issues	20%	0.76	

*Source: own rearrangement from *Table 2* and results of *Table 4*, *Table 5*, *Table 6* and *Table 7*.

Using *Table 8* Now is the time to determine the productivity of the systems in general with the consideration of the potential sub stems identified by the combination of paired comparison analysis and Pareto curve. In other words, it meant that using the relative weight of each potential subsystem and their respective PI the, the PI of the case company can be calculated.

Therefore, using PI of components/subsystems in *Table 8* the overall productivity of the system, Edget Yarn and Sewing Thread Share company can be calculated, using the formula, and became 0.12*0.7379+0.4*0.7882+0.2*0.6661+0.16*0.7156 = 0.652.

4 | Conclusion and Recommendation

Productivity of the system, Edget Yarn and Sewing Thread Share Company, has been measured by using the aggregate productivity measurement approach called PO-P approach. Using the model the overall productivity level of the case company is developed by considering the productive of potential sub systems/opponents those mage the case company. PI of components/subsystems again developed from the productivity indices of the KPA's of that component/subsystem.

In this research, using PO-P approach and Pareto, potential areas namely technology subsystem, production subsystem, ergonomics subsystem, and marketing subsystem have been identified. Finally, the productivity level of the case company have been assess based on the result we got from subsystems.

In general, the researcher suggested that any team(s) and/or individual(s) for future improvement of the overall productivity of their company should utilize the output of this research. In particular the case company business owner(s) should focus on the identified potential subsystems namely marketing subsystem, ergonomics subsystem, production subsystem and technology subsystem for improvement of the system productivity with the consideration of the performance objectives with in them.

Acknowledgements

I would like to take a moment to express my gratitude to those who have supported and encouraged me along this study. First of all, I would like to thank the Almighty GOD for giving me the inspiration to start and patience to finalize this work. Furthermore, I want to express my genuine gratefulness to all the people in the case company specially Ato Mezgebe Assefa (Manager), Ato Minilik, and shop floor workers for their support and remarkable hospitality. Their cooperation in providing data, filling out questionnaire, availed themselves for interviews and provided very valuable information were inspirational.

References

[1] ABA Rule of Law Initiative. (n.d.). *Case study: Ethiopian textile industry*. Retrieved from https://verite.org/wp-content/uploads/2017/12/ABA-ROLI-Case-Study-Ethiopia-Aug-2017.pdf

[2] Perdana, S., & Saroso, D. S. (2019). Implementation of repairing production machine productivity of spare parts speaker based on OEE value achievement. *Journal of applied research on industrial engineering*, *6*(1), 26-32.

[3] Fallah, M. (2020). Efficiency, effectiveness and productivity of personnel's health in petrochemical companies. *Journal of applied research on industrial engineering*, *7*(3), 280-286.

[4] Hosseinzadeh Lotfi, F., & Jahanbakhsh, M. (2015). Assess the efficiency and effectiveness simultaneously in a three-stage process, by using a unified model. *International journal of research in industrial engineering*, *4*(1 (4)), 15-23.

[5] Halder, P. K., Karmarker, C. L., Kundu, B., & Daniel, T. (2018). Evaluation of factors affecting the productivity of RMG in Bangladesh: A fuzzy AHP approach. *International journal of research in industrial engineering*, *7*(1), 51-60.

[6] Gunasekaran, A., Forker, L., & Kobu, B. (2000). Improving operations performance in a small company: a case study. *International journal of operations & production management*, *20*(3), 316-336.

[7] Umar Javed Jarral, M. A. (2010). *To study how to improve the productivity of yarn and fabric production in a production mil (Master Thesis,* Swedish school of textiles, University of BORÅS). Retrieved from https://www.diva-portal.org/smash/get/diva2:1312261/FULLTEXT01.pdf

[8] Wagaye, B. T., & Walle, G. A. (2018). Overview of Ethiopian textile industry. *Journal of textiles and polymers*, *6*(2), 117-120.

[9] Vrat, P., Sardana, G. D., & Sahay, B. S. (1998). *Productivity management-a system approach*. Narosa Publishing House.

[10] Prasad, K. D., Jha, S. K., & Singh, R. K. (2013). Productivity assessment of utensils manufacturing unit: a case study. *International journal of innovative research in science, engineering and technology*, *2*(6).