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A REVIEW ON THE INTEGRATION OF MAHALANOBIS-TAGUCHI SYSTEM AND TIME-DRIVEN ACTIVITY-BASED COSTING ON PRODUCTION ENVIRONMENT

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Abstract

Identifying research gap is a fundamental goal of literature review. While it is acknowledged that literature reviews should identify research gaps, there are no methodological guidelines of the integration of Mahalanobis-Taguchi System (MTS) and Time-Driven Activity-Based Costing (TDABC) on production environment. MTS is used for optimization of the process in workstation while TDABC is used time as criteria or key measurement variable for the allocation costs. The aim of this study is to explore the strategic of integration of MTS and TDABC on the product in production area. In this study, published works was taken related to MTS and TDABC from the period 2000-2018 are analyzed 40 papers. The study reported only 3 papers out of 40 papers show that integration of MTS with others methods. However, there is no paper show that the methodology use integration of MTS and TDABC. This integration indicates better process in each workstation on production and provide more accurate cost because all cost involves the time.
Keywords: Research gap, mahalanobis-taguchi system, time-driven activity-based costing

1.0 INTRODUCTION

Integration of MTS-TDABC are the new method on production environment. These integration is not found based on reseach gap that published from previous papers. By having this method, the production has the smooth process in the workstation and accurate costing.

As mention by [1], MTS is a method to predict and dianogsis the system performance that use the multivariate data to make a quatitative decision with construction whose proposed by Genichi Taguchi. In multivariate system, decision making can be analyze when the information providing one or more variable. However, the system is incomplete when evaluation of variables is not related to each other. In a rapid growth technology, MTS is received a wide acceptance in the poduction environment.

Subsequently, MTS is a famous system that have many advantages to the production environment which are MTS select the important factors to improve the quality of the product and process [2], MTS is suitable method to decide and evaluate the appropriate criteria [3], and also MTS combine all the methods according the variables into one index [4].

[5] stated that MTS can be divided into nine categories. These category including in area of healthcare, manufacturing, agriculture, information technology, academic, finance, automotive, and others. Figure 1 shows the iillustration of pie chart that show the percentage of distribution of nine categories. Based on pie chart, the information of percentage can be stated as the highest percentage that applied MTS in area of manufacturing, 32% followed in area automotive, 18%, information technology and others area sharing

same percentage, 14%, healthcare, 11%, academic, 8%, agriculture, 3% while finance area is 0% which not found in paper review. Based on the percentage, it is clearly stated that manufacturing area has the highest percentage that applied method of MTS. For example, manufacturing area that applied MTS method such as in process industry, spine care, and rolling bearing application.

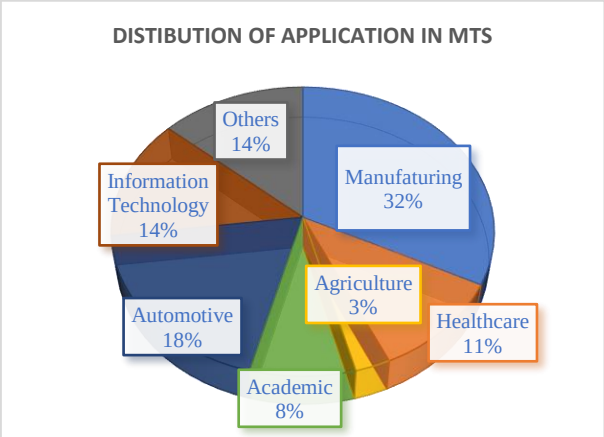

Figure 1 Pie chart of distribution of MTS

A concept of Mahalanobis Distance (MD) was established by a famous statistician, P.C Mahalanobis at India. This concept is used to calculate in calculation of two unknown is similar with spatial orientation which far apart located [6]. The data sets can be divided into healthy data sets and unhealthy data sets. Consequently, the healthy data sets use to calculate and scale of MD. The scaling of the MD can be analysed by dividing the number of features used in MD calculations, so the average length for the scaled MD is approximately close to the one while scaled MD for unhealthy data sets suppose larger than one. The important feature is good when MTS is starts approach with a large number of features in each multivariable data set. So, the important features have large scaled MD of unhealthy data. As mention by [7], Figure 2 shows the concept of MTS that consist of four phases which are construction of Mahalanobis Space (MS), validation of MS, identification of useful variables, and prediction of future diagnosis.

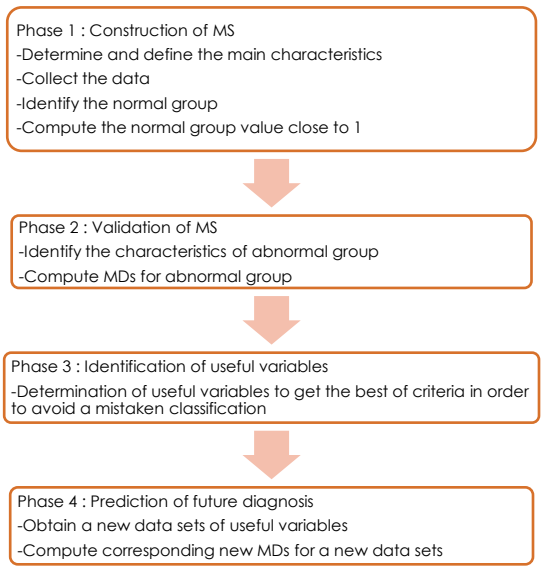

Figure 2 Concept of MTS

Another method is TDABC that can describe as a costing model that consider a time which known as inducer time. This method is provided the cost the cost of activities with base that consume of time per activities. As mention [8], TDABC is a costing that show the differences between the total time needed to carry all activities that performed in each department. Consequently, this method also provided the total amount time of employees that performed in the department

The advantages of TDABC are costing of all activities perform is more accurate [9], providing more reliable of information for decision making process [10], and get quick knowledge, easy and dissemination of application [11].

The application of TDABC can be categorized into nine application which are manufacturing, healthcare, automotive, retail trade, information technology, agriculture, academic, and others [5]. Figure 3 is shows the pie chart of distribution the percentage of TDABC. Based on pie chart, the highest percentage that applied TDABC is healthcare, 62%, and the lowest percentage belongs to information technology, 2%. The manufacturing application and and academic are sharing the same percentage which are, 14%, followed by retail trade, 5%, and the others, 3%. Although, in TDABC is famous method to apply in healthcare application, this method also suitable to apply in manufacturing sector.

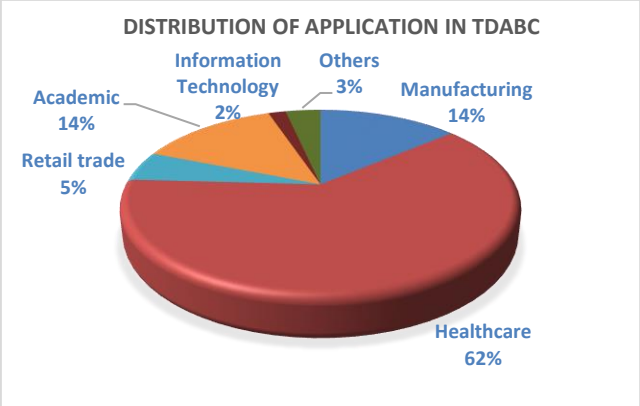

Figure 3 Pie chart of distribution of TDABC

Generally, according to [12], TDABC has developed eight steps that illustrates in Figure 4. Step 1 is used to analyze and identify the activities taking place and understand the scope and specific sequence while step 2 explains if the resources used all fall under the same activity, costs can be allocated directly to the but if the resources has different activities, so the cost use method based on cost driver. Then, step 3 is estimating the practical capacity for an employee or a piece of equipment must be straightforward and step 4 is used to drive departmental resource cost to cost objects by estimating the demand for resource capacity that each cost object requires. Time equation capture the principal factors that create demands for process capacity, changes in process efficiencies, product volume and mix, customer order patterns, and channel mix. Capacity is required to perform the activity such as performing a production run, processing an order

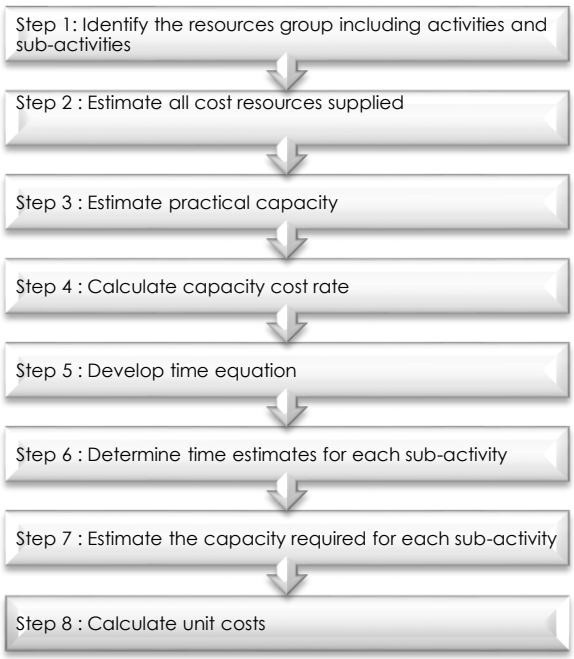

Figure 4 Concept of TDABC

2.0 METHODOLOGY

In this section, MTS consider 40 papers which published from 2011-2018 to analyze based on types of different journals publications. Table 1 shows classification of MTS papers based on journals publications.

Table 1 Classification MTS papers based on journal publication

Journal publication	Quantity of papers
International Journal Expert system with applications	4
International Journal of Quality & Reliability	6
Journal of Mechanical System and Signal Processing	4
International Journal of Precision Engineering and Manufacturing	1
Journal of Automotive Software Engineering	1
Journal of Industrial Engineering International	2
Journal of Sound and Vibration	2
Journal of Industrial and Production Engineering	1
Journal of Economics and Finance	1
Journal of Neuroscience Method	1
International Journal Advance Manufacturing Technology	5
International Journal Quality Engineering & Technology	1
Journal of Personality and Individual Differences	1
Journal of Digital Technology	1
Journal of Information Technology and Engineering	1
Total Quality Management Journal	1
Sustainability Journal	1
Neurocomputing Journal	1
Journal of Mechanical Engineering	1
Journal of wear	1
International Journal of Naval Architecture and Ocean Engineering	1
International Journal of System Science	1
Material Science and Engineering Journal	1

TDABC consider 54 papers which published from 2011-2018. These papers analyze according types of different publications. Table 2 shows the classifications of TDABC papers based on journal publication.

Table 2 Classification TDABC papers based on journal publication

Journal publication	Quantity of papers
Evidence Based Library and Information Practice	1
Journal of Applied Accounting Research	1
International Journal of Logistic Research and Application	1
Journal of Research and Innovation	1
Engineering Management Journal	1
Procedia Social and Behavioral Sciences	1
Journal of Engineering Manufacture	1
International Journal of Contemporary	1

Hospitality Management	
Journal of the Association of European Research Libraries	1
Journal of Surgical	1
Journal of Health Organization and Management	1
Journal of Spatial Science	1
Journal of American College of Surgeons	1
Journal of Pediatric Urology	1
The Knee	1
International Journal of Annals of Emergency Medicine	2
Journal of Cancer Surgery	2
Journal of Pediatric Pedorthopaedics	1
Journal of Library Management	1
Journal of Industrial Management	1
Journal of European Laryngological	1
International Society for Pharmacoeconomics and Outcomes Research	1
International Journal of Health Care Quality Assurance	1
Journal of Pediatric Surgery	3
Journal of Sustainability	1
Journal of Intelligent Manufacturing	1
International Journal of Radiation Oncology	3
International Journal of Physical Distribution and Logistics Management	2
Journal Devoted to the Problem of Capital Investment	1
Journal of Arthroplasty	1
Journal of Diabetes Science and Technology	2
Journal of Production	2
Journal of Academic Librarianship	1
International Journal of Colorectal Disease	1
Journal of Clinical Apheresis	1
International Journal of Clinical Pharmacy	2
Academic Radiology Journal	1
Clinical Orthopedics and Related Research	1
Collection building	1
Procedia CIRD	1
Foot & ankle International	1
Healthcare Research	2
Seminars in spine surgery	1

After classified MTS papers and TDABC papers based on journals publication, research gap can be done in details in results and discussion. In research gap, there are two filtrations which MTS based on classification and focus only one criterion according objective of MTS and TDABC classified into advantages and focus of unused capacity which related to objective.

3.0 RESULTS AND DISCUSSION

According to [13], MTS can be classified into seven categories. Figure 5 illustrates the pie chart of classification of MTS that shows the percentage of comparison with other method, threshold establishment, construction of MS, case study, introduction to the method, and dimensional reduction or optimization. Based on the pie chart, we had focused the classification of MTS based on dimensional reduction or optimization, 18%. The dimensional reduction is very important to identify the significant parameter in a workstation. So, the result will be more precise and accurate.

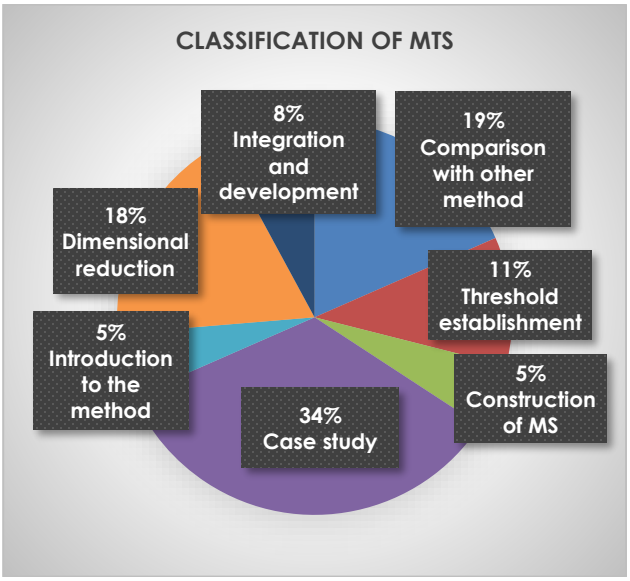

Figure 5 Pie chart of classification of MTS

Table 3 shows the elements of dimensional reduction that shows only 7 papers out of 40 papers that used dimensional reduction. The elements of MTS consist of threshold MD that has reference MD and abnormal group of MD while dimensional reduction must have the detail of number of sample(from), reduction (to), and orthogonal array (OA).

Table 3 Elements of dimensional reduction

Author	Area	Threshold MD		Dimensional reduction		
		Reference (MD)	Abnormal group (MD)	From	To	OA
(Flores et al., 2018)	Automotive	✓	✓	✓	✓	x
(Carlos, Gutierrez, & Flores, 2018)	Automobile motor-head machining process	✓	✓	x	x	x
(Sikder, Panja, & Mukherjee, 2017)	Intense global competition	✓	✓	✓	x	✓
(Peng et al., 2017)	Tablet PC production	x	x	✓	✓	✓
(Deepa & Ganesan, 2016)	Agriculture crop	✓	✓	✓	x	✓
(Jobi, Taiwo, & Cudney, 2015)	Steel plate	✓	✓	x	x	x
(John, 2014)	Splined shaft	x	x	✓	✓	x

Firstly, according to Flores et al., (2018), the work was not stated the OA that very important to identify the important parameter in the process. Secondly, as mention by Carlos, Gutierrez, & Flores, (2018), the work was not stated all the parameters in reduction dimension from that shows the number of data, if we do not know the exactly the value of data, it cannot show the results of reduction and also cannot identify the important parameter by OA. Thirdly, Sikder, Panja, & Mukherjee, 2017, the work was not stated the exactly of reduction value. Fourthly, according to Peng et al., (2017), the work was not stated the value of reference MD and the abnormal MD that are very important of value in order to qualify the results of healthy data and unhealthy data. Fifthly, according to Deepa & Ganesan, (2016), the work was not stated the exactly of reduction value. Then, Jobi, Taiwo, & Cudney, (2015), the work was not all the parameters in reduction dimension from that shows the number of data, if we do not know the exactly the value of data, it cannot show the results of reduction and also cannot identify the important parameter by OA. Lastly, according to John, (2014), the work was not stated the reference MD and abnormal MD are very important of value in order to qualify the results of healthy data and unhealthy data and cannot identify the important parameter by OA. This paper will be including all the parameters in dimensional reduction to get more accurate result.

According to [14,15], advantages of TDABC consist of less cost implementation, accurate unused capacity, capturing business complexity, survey avoidance, focus on production time, and transparency. Figure 6 illustrates the pie chart of advantages of TDABC that only focus for an accurate unused capacity that belong 4%. Accurate unused capacity to get the accurate costing in production.

Figure 6 Advantages of TDABC

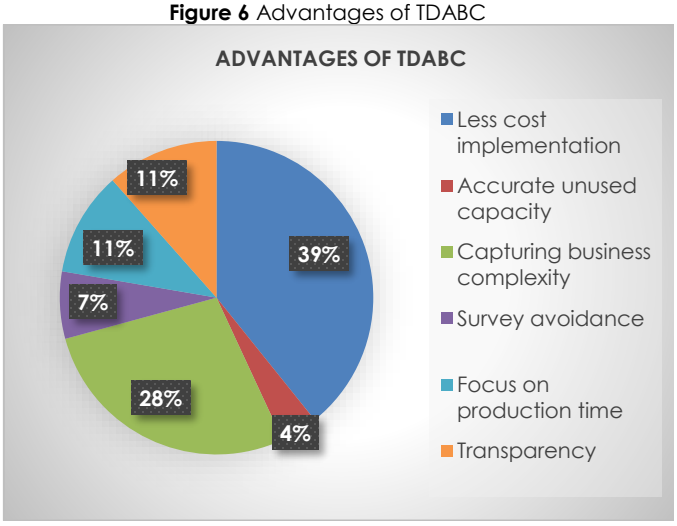

Table 4 shows the methodology of TDABC that shows only 5 papers out of 54 papers that focus for advantage accurate unused capacity.

Table 4 Methodology of TDABC

Author (year)	Process mapping	Time Equation	Capacity Cost Rate		Unused Capacity	Forecasting
			Resources	Practical		
(Erhun et al., 2018)	✓	x	✓	✓	✓	x
(Gonzalez, Nachtmann, & Pohl, 2017)	x	✓	✓	✓	x	x
(Afonso & Santana, 2016)	x	✓	✓	✓	✓	✓
(Sarokolaei et al., 2013)	x	x	✓	✓	✓	x
(Bagherpour et al., 2013)	x	x	✓	✓	✓	x

Firstly, according to Erhun et al., (2018), the work was not stated time equation that developed to calculate the estimated production time, and forecasting is very important to predict the costing in the future. As mention by Gonzales, Nachtmann, & Pohl, (2017), Sarokolaei et al., (2013), and Bagherpour et al., (2013), the work was not stated the process mapping that important to show a detail process in a workstation and can analyzed to improve the process, an unused capacity is very important to eliminate the unneeded costing in terms to increase the profit, and forecasting also important to predict the future costing. As mention by Afonso, & Santana, (2016), the work was not the process mapping that show a detail process in a workstation and can analyzed to improve the process. This paper will be including all the methodology to get more accurate result.

4.0 CONCLUSION

In this study, integration of MTS and TDABC is a new system able to apply in a production environment in order to get better process in each workstation and also the time will be more accurate in each activity or sub-activities of a product. This integration method is also able to increase the profit for organizations because the unused capacity of the product also will be count in this method. More unused capacity is known, more profit will get by an organization.

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