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Proceedings of Second International Conference on Electrical Systems, Technology and Information 2015 (ICESTI 2015)

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Introduction

This book includes the original, peer-reviewed research papers from the 2nd International Conference on Electrical Systems, Technology and Information (ICESTI 2015), held during 9–12 September 2015, at Patra Jasa Resort & Villas Bali, Indonesia.

The primary objective of this book is to provide references for dissemination and discussion of the topics that have been presented in the conference. This volume is unique in that it includes work related to Electrical Engineering, Technology and Information towards their sustainable development. Engineers, researchers as well as lecturers from universities and professionals in industry and government will gain valuable insights into interdisciplinary solutions in the field of Electrical Systems, Technology and Information, and its applications.

The topics of ICESTI 2015 provide a forum for accessing the most up-to-date and authoritative knowledge and the best practices in the field of Electrical Engineering, Technology and Information towards their sustainable development. The editors selected high quality papers from the conference that passed through a minimum of three reviewers, with an acceptance rate of 50.6 %.

In the conference there were three invited papers from keynote speakers, whose papers are also included in this book, entitled: “Computational Intelligence based Regulation of the DC bus in the On-Grid Photovoltaic System”, “Virtual Prototyping of a Compliant Spindle for Robotic Deburring” and “A Concept of Multi Rough Sets Defined on Multi-Contextual Information Systems”.

The conference also classified the technology innovation topics into five parts: “Technology Innovation in Robotics, Image Recognition and Computational Intelligence Applications”, “Technology Innovation in Electrical Engineering, Electric Vehicle and Energy Management”, “Technology Innovation in Electronic, Manufacturing, Instrumentation and Material Engineering”, “Technology Innovation in Internet of Things and Its Applications” and “Technology Innovation in Information, Modeling and Mobile Applications”.

In addition, we are really thankful for the contributions and for the valuable time spent in the review process by our Advisory Boards, Committee Members and Reviewers. Also, we appreciate our collaboration partners (Petra Christian

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On behalf of the editors

Felix Pasila

Measuring the Usage Level of the IE Tools in SMEs Using Malcolm Baldrige Scoring System

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Abstract. The amount of Small and Medium Enterprises (SMEs) in Indonesia is larger than large industries but possessed very low competitiveness. In many countries, SMEs have a vital role in supporting the economy so should receive more attention in order to sustain and support the economy of a country. SMEs need to implement the Industrial Engineering (IE) tools from an early stage or planning, process, and marketing that can improve customer satisfaction. Previous researches already done to develop innovative management model to improve SMEs performance using Malcolm Baldrige model but only measured some determinant factors that have effect on performance and not measured the usage level. This study was done to get a measurement models of the usage level of IE Industrial Engineering tools and methods in SMEs. Measurement model is a design of scoring system of usage level at planning and design, operation and control, and quality and productivity improvement stage. Design method was done by determining the tools in each stage and proceed with setting the usage level and score by using the Malcolm Baldrige concept.

Keywords: scoring system, planning and design tools, SMEs, Malcolm Baldrige

1. Introduction

Small and Medium Enterprises (SMEs) have a crucial role for the economy of a region like East Java, Indonesia, where economic growth is contributed by this sector reached 46.37% (Subiyantoro, 2013). According Suttapong and Tian (2012), Small medium enterprises (SMEs), operate a major role in national economies and considered as machine for economic growth all over the world. After the local commercial become to globalization of markets, SMEs will have many opportunities to deal business in integration with large-scale enterprises. Based on the above data, it should be given more attention to the development of SMEs in order to provide greater impact both in terms of economic and social. SMEs are also seen to have great opportunities to increase their contribution and be able to compete with advanced or large industries.

In the process leading to such conditions, SMEs encountered some obstacles, among others, such as difficulty finding potential markets, business legality, simple packaging, lack of capital, technology is still modest, family management, standardized operation is not optimal, innovation is still weak, and the market access difficulties at international level (Subiyantoro, 2013). One effort that can be done for SMEs is to use Industrial Engineering tools and technique (IE tools) in support their performance, in which large-scale industry already implemented it. Nurach *et al.* (2011), has already developed an innovative management model to improve SMEs performance in Thailand using some performance measurement models, like Malcolm Baldrige model, their models only measured some determinant factors that have effect on SMEs performance, but not measured the usage level. Therefore it is necessary to conduct research on how to measure the usage level of IE tools in SMEs. It is intended to be able to have a guide in assessing the implementation and performance of SMEs.

2. Malcom Baldrige Scoring System

Malcolm Baldrige is one of the tools that have been widely applied in measuring the performance of an organization. In United State of America, there are awards for the quality of performance that is named

Malcolm Baldrige National Quality Award (MNBQA) (Baldrige Performance Excellence Program, 2013). Where the purpose of the application of the Malcolm Baldrige is to determine/measure the strength of which has been owned by an organization (Sohn *et al.*, 2007; Baldrige Performance Excellence Program, 2013). The performance of each of these criteria are measured by using a score. Formulation of the score obtained from the collection of the data compiled into a detailed list of criteria that will be searched. Where the criteria by requiring qualitative answers scoring system to quantitatively determine the results (Prawira *et al.*, 2013).

The draft scoring system is divided into several stages, namely: (1) determine the types of tools that correspond to the stages to be measured, (2) the theories that support these tools, (3) the theoretical conclusions based on the entire supporting theory, (4) the operational definition, and (5) the level of usage of each tool based on the concept of Malcolm Baldrige. Usage levels using a score ranging from 0 to 4. The concept of measurement is based on the level of completeness and consistency of processes applied and the quantity and/or quality of the results. Validation of the design is done through focus group discussion (FGD).

3. Design of Industrial Engineering (IE) Tools and Methods

3.1 Product Design

Basic tools of IE is needed in the design of products in SMEs is Quality Function Deployment (QFD) (Germani *et al.*, 2012; Marjudi *et al.*, 2013). QFD is an effective management tool where consumer expectations are used to design a process or to encourage the improvement of product quality (Besterfield *et al.*, 2002). Furthermore, the QFD stages are designing the product characteristics that fit consumer's needs, assess the characteristics that a top priority for consumers to make a product in accordance with consumer demand, as well as conduct tests on products that have been made and improve the quality of existing design. Generally, product design is the process to transform the consumer demand into product design that fits the need and want of customer, as well as testing on such products to improve design quality.

The operational definition of the product design is a process that starts from the identification of requirements and priorities of the consumer, competitor product analysis, technical and economic analysis of the ability of the company in realizing customer requirements, and finally, test the design and market feasibility.

Scoring system to assess the usage level of product design implementation is presented in Table 1.

Tabel 1 Scoring System for Product Design Usage Level

Score	Description
4	Have done the planning, market research, competitor research, technical and economic analysis, and test the feasibility of the design.
3	Most of the activity/stage design has been done
2	Approximately half activity/ stage design is not done or done.
1	Most of the activity/ stage design is not done.
0	Without planning, market research, competitor research, technical and economic analysis, and Test the feasibility of the design. Design is completely determined by the company without regard to consumers, competitors / market.

3.2 Planning and Inventory Control

Basic tools of IE is required in planning and inventory control in SMEs is Material Requirement Planning (MRP), Master Production Schedule (MPS), Bill of material (BOM), Economic Order Equation (EOQ), Reorder Point (ROP) and forecasting (Gel *et al.*, 2010; Kunday and Şengüler, 2015). BOM is a list to identify and count the materials needed to make a product, MPS is a tool to schedule a production process, MRP is a method to plan materials requirement at the right time and place. EOQ is a method to adjust inventory to increase efficiency, so that the production process run well. ROP is a method to compute the reorder point. And, forecasting is a technique to forecast future demand.

Operational definitions for planning and inventory control are SMEs can do the planning and control of raw materials, auxiliary materials, semi-finished goods and finished goods before and after production. Usage level scores for assessment tools can be seen in Table 2.

Table 2 Scoring System for Inventory Control and Planning Usage Level

Score	Description
4	Implement properly and consistently 5 or more tools. Examples using BOM, MRP, MPS, ROP and forecasting.
3	Implement properly and consistently to four tools such as using BOM, MRP, MPS and ROP.
2	Applying 3 using a tool such as BOM, MRP and ROP.
1	Applying only one or two tools, among others, BOM and MRP.
0	Applying only a few tools but inconsistent or no clear standards.

3.3 Planning and Production Control

Operation Process chart (OPC), Process Flow chart, charts Assembly, and the scheduling method is IE the basic tools needed in the planning and production control in SMEs (Kunday and Şengüler, 2015; Kurniawati and Yuliando, 2015). OPC is an operation process map depicting the work steps and checks from beginning to end. Process flow chart shows the process flow chart. Assembly chart is a map that describes the steps the assembly process from beginning to end. Scheduling method is a method to set the order of job / product that will run in a system. So that an operational definition for Planning and Production Control is a production process that aims to produce a product that has stages that must be passed from the start of production until after production, where there is an inspection activity to maintain that no defective products that pass. Scoring system to assess the usage level of Planning and Production Control implementation is presented in Table 3.

Table 3 Scoring System for Planning and Production Control Usage Level

Score	Description
4	Implement properly and consistently to four tools or more. (ex. OPC, process flow and assembly chart, method of scheduling)
3	Implement properly and consistently 3 tools. (ex. OPC, process flow and assembly chart)
2	Implement properly and consistently 2 tools. (ex. using OPC, process flow charts)
1	Applying just one tool. (ex. OPC)
0	Do with inconsistent or no clear standards.

3.4 Quality Control

Seven tools is one of the basic tools needed IE in quality control in SMEs. Seven tool itself consists of checksheet, scatter diagrams, Pareto diagrams, fish-bone diagrams, histograms, control charts, flowcharts, quality plan and sampling (Sokovic *et al.*, 2009; Mahmud and Hilmi, 2014; Kurniawati and Yuliando, 2015; Kunday and Şengüler, 2015).

Table 4 Scoring System for Quality Control Usage Level

Score	Description
4	Has the quality characteristics, noting that the products do not fit the characteristics of quality, knowing the cause of nonconforming product, and determine the root cause.
3	Do 3 points. (ex. has the quality characteristics, determine the cause of nonconforming product, and determine the root of the problem)
2	Do 2 points. (ex. quality characteristics, determine the cause of nonconforming product)
1	Doing 1 point. (ex. only has the quality characteristics)
0	Does not have the characteristics of quality, did not record a product that does not fit with the quality characteristics, not know the cause of nonconforming product and the root of the problem.

Checksheet is a tool to record every product passes and handicapped. Scatter diagram to see the correlation/cause of disability. Pareto diagram is a diagram that illustrates the main problem according to its weight. Fish-bone diagram to see the potential root cause of quality problems. The histogram is a distribution diagram of disability. Control charts are charts acceptance limit. Flow chart is an overview process flow. Quality plan is planning to control the quality of the product. SMEs are also required to keep records of actual disability and examine the existing discrepancy to find the root causes of quality. Usage level scores can be seen in Table 4.

3.5 Cost Control

IE tools needed to control costs are the tools that used to determine the cost of production (HPP) (Ahmad *et al.*, 2012; Moro and Fink, 2013; Kurniawati and Yuliando, 2015). HPP is a calculation of the total cost of a product. The costs are included in HPP production and non-production costs. Production costs include material costs, overhead costs and direct labor cost. Non-production costs include indirect labor. Operational definitions to control costs is to control operating costs in order to avoid swelling, as well as the price for each product can be kept to a minimum. Usage level scores for assessment tools can be seen in Table 5.

Table 5 Scoring System for Cost Control Usage Level

Score	Description
4	Applying standard definition cost, noting the actual production costs, comparing actual costs and standards, and can determine the cause of cost overruns.
3	Just do 3 points. Ex.: Perform only standard definition cost, noting the actual production costs, comparing actual and standard.
2	Just do 2 points. Ex.: Perform only standard definition cost, noting the actual production costs.
1	Only 1 point. Ex.: only consider material costs alone.
0	Not doing standard definition cost, does not record the actual production costs, does not compare with the actual standards, and can not know the cause of the cost overruns.

3.6 Maintenance

IE the basic tools needed in the maintenance of working tools or machines in SMBs is total productive maintenance (TPM) (Ahmad *et al.*, 2012; Mahmud and Hilmi, 2014). TPM is a system of maintenance and repairs on the machine or equipment. TPM is designed to prevent losses due to the cessation of production activities. The purpose of the TPM is to optimize the overall efficiency of production systems through maintenance and repair activities are organized. Operational definitions for maintenance work tools are able to reduce losses due to production activities. In addition, the improvement involving all divisions and employees up to the top management.

Table 6 Scoring System for Maintenance Usage Level

Score	Description
4	Identifying, recording records, analysis, planning improvements and monitor and work tools are always ready to use.
3	Identifying, recording records, analysis, planning and monitoring improvement. However, sometimes working tools ready.
2	Identifying, recording records, analysis. But no improvement planning and monitoring, so that the working tools are sometimes not ready.
1	Identifying, recording records, analysis. But no improvement planning and monitoring, so that the working tools are often not ready.
0	Just to identify it and work tools are very often not ready.

3.7 Product Quality Improvement Tools

Quality improvement is a process that requires unity in the company to be able to develop activities and take decisions for the use of quality tools. The development of quality can be applied to several

aspects, such as the quality of the products produced and the quality of the service to consumers (Sokovic *et al.*, 2009; Roghanian, 2012).

IE the basic tools needed by SMEs in improving the quality of products is the method of DMAIC (define, measure, analyze, improvement, and control) (Mahmud and Hilmi, 2014; Kurniawati and Yuliando, 2015). Define is the first step to identify problems that occur in the production process. Measure the measurement phase is to evaluate the quality level of product quality to the specified goals. Analyze is the stage of identifying the root cause of the problem is based on the measurement results. Improvement is the stage of implementation of an alternative solution to improve product quality. Control is the stage monitoring quality improvement process to fit the purpose. The operational definition of product quality improvement is to improve the quality by identifying problems, perform measurements, analyze, make improvements, and controlling. Usage level scores for assessment tools can be seen in Table 7.

Table 7 Scoring System for Product Quality Improvement Usage Level

Score	Description
4	Doing all stages ranging from determining the quality problems, disability measurements, analyze, and implement improvements, as well as control the results of the improvements made.
3	Determining the quality problems, the measurement of disability, to perform the analysis of disability.
2	Determining the quality problems to the measurement of disability that occurs.
1	Only at the stage of determining or finding product quality problems.
0	Not once did the stages of product quality improvement.

3.8 Service Quality Improvement Tools

IE tools needed basis SMEs in improving the quality of customer service is the Voice of the Customer (VOC), Importance Performance Analysis (IPA), and Service Quality (Zeithaml *et al.*, 1990; Nyeck *et al.*, 2002; Nada and Ali, 2015).

VOC is a tool to capture preferences, reluctance, and customer expectations for a given product. IPA is a research technique to analyze the attitude of the interest or consumer satisfaction with the services received. Service Quality by Parasuraman is an empirical model to compare the performance of quality of service with customer service quality needs. The operational definition of service quality improvement is to figure out or investigate needs and customer response to the product.

These tools also perform the priority of customer needs based on its importance, evaluate products and make improvements. Furthermore, customers will have more confidence in the products produced, this is evidenced by the emergence of a new customer or customer loyalty. Usage level scores for assessment tools can be seen in Table 8.

Table 8 Scoring System for Services Quality Improvement Usage Level

Score	Description
4	Doing all stages of improving the quality of customer service (to find out, prioritizing, evaluation and improvement) by taking into account constraints or limitations that exist, such as employee salaries, facilities company, HR.
3	Doing improvement by finding out the needs of consumers, carry out priority attention to the existing constraints.
2	Doing improvement by finding out the needs of consumers just by observing the existing constraints.
1	Doing improvement without finding out the needs of consumers.
0	Do not do all the stages in an effort to improve the quality of customer service

3.9 Productivity Improvement Tools

IE the basic tools needed to increase productivity of SMEs is the maintenance, increased competence and motivation of employees (Roghanian *et al.*, 2012; Mahmud and Hilmi, 2014; Kurniawati and Yuliando, 2015). This improvement can be done with several functions, namely: (1) the procurement

function is to determine the type or quality of employees and the amount needed. (2) the function of development is to improve the technical skills, theoretical, conceptual, and morale of employees in accordance with the needs of job or position through education and training. (3) the function of compensation is to provide fringe benefits, tangible money or other reward in accordance sacrifice or employee contributions. (4) maintenance function is to maintain or improve the physical, mental, attitude of employees to remain loyal and productive work to support the achievement of corporate objectives. Increased employee productivity can be interpreted in terms of the preliminary determination to recruit, develop skills, provide compensation, and maintain the condition of the employee to support productivity. The operational definition increase employee productivity, namely the recruitment of employees in accordance with the job specification, assessing employee performance, providing special programs or incentives for employees, and provide assurance of safety of employees. Usage level scores for assessment tools can be seen in Table 9.

Table 9 Scoring System for Productivity Improvement Usage Level

Score	Description
4	Recruiting employees in accordance job specification, assessing employee performance, providing special programs, and provide assurance of safety.
3	Recruiting employees in accordance job specification, conduct performance appraisals of employees, and provide special programs for employees.
2	Recruiting employees in accordance job specification and assessing employee performance.
1	Only the recruitment of employees according to job specification.
0	Do not do these four points at all, even without regard to recruitment job specification.

4. Conclusion

This study attempted to obtain usage level assessment scheme of Industrial Engineering (IE) tools and methods at any stage or process that occurs in SMEs. Based on previous theories and researches on IE implementation, from this research can develop nine kinds of schemes like Product Design, Planning and Inventory Control, Planning and Production Control, Quality Control, Cost Control, Maintenance, Product Quality Improvement Tools, and Service Quality Improvement Tools that represent the three major stages (Planning and Design, Operation and Control, and Quality and Productivity Improvement) in the running industry especially SMEs.

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