IMPROVEMENT OF THE PRODUCTIVITY BY INCREASING CUSTOMER OUTPUTS AT CAFETERIA ON CAMPUS VIA SIMULATION METHOD IN WITNESS

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Report submitted in partial fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering with Manufacturing Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2009

ABSTRACT

In this thesis, the importance of productivity improvement was displayed by conducting a research in a company to increase the company's output. The whole project was carried out by using simulation method as a tool to mimic the actual layout which then productivity improvement strategies could be determined. The simulation software used in this project is WITNESS simulation software which could display the current performance of outputs and the service floor layout. The main objective of this project is to evaluate existing service floor performance, then design and improve floor layout by using simulation software and followed by measuring performance such as output quantity by using cost effectiveness analysis. In this project, the study is conducted at Sarikim Enterprise which is also known as the Café Executive in Universiti Malaysia Pahang. The process flow was observed once the customer enters the system until the customer purchase the food and beverages before leaving the system. Initially, a simulation model is built to study the existing actual floor layout and found out there are stations that are taking too much time for process. After that, a total of 3 options were proposed to solve the problem and at the same time increase the customer outputs. Non parametric Kruskal-Willis test were conducted and the results showed there is a significant difference between the layouts. In order to choose the best layout, one way ANOVA test with multiple comparison was used and the best option is Option 3 which is addition of Dishes station and merging of the Plate and Rice station provided and extra costs of RM720 were needed. However, by conducting the cost effectiveness analysis, although extra costs are needed for the new layout, the cost estimated for 1 customer is less than the actual layout. This also proved that Option 3 is the most suitable propose layout to increase the productivity.

ABSTRAK

Dalam tesis ini membentangkan kepentingan peningkatan produktiviti dengan menjalankan kajian dalam sebuah syarikat untuk meningkatkan pengeluaran syarikat itu. Keseluruhan projek ini telah dijalankan dengan menggunakan cara simulasi yang dapat menyalini situasi yang sebenar dan masalah dalam sistem yang sebenar dapat ditentukan dan strategi untuk menyelesaikan masalah tersebut dapat ditentukan. Selain itu, persisian simulasi WITNESS telah digunakan sepanjang projek ini. Objektif utama projek ini adalah menilai prestasi susun atur system yang sebenar, mereka susun atur yang baru dan dapat meningkatkan prestasi system yang sebenar dengan menggunakan cara simulasi, dan menilai prestasi dengan mengambil berat keberkesanan kos. Syarikat yang dikaji yang bernama Sarikim Enterprise juga merupakan kafe eksekutif Universtiti Malaysia Pahang. Aliran proses itu telah diperhatikan sekali pelanggan itu memasuki sistem itu sehingga pembelian pelanggan makanan dan minuman sebelum meninggalkan sistem. Pada mulanya, satu model simulasi telah dibina untuk mengkaji susun atur yang sebenar dan salah satu masalah dalam system itu merupakan masa yang terlalu panjang untuk diproses pada hentian yang tertentu. Selepas itu, sejumlah 3 kaedah telah dicadangkan untuk menyelesaikan masalah dan pada masa yang sama meningkatkan pengeluaran. Ujian Kruskal Wallis telah dilakukan terhadap keputusan yang didapati dan keputusan ujian itu menunjukkan bahawa terdapat sedikit perbezaan diantara tiga kaedah baru ya dicadangkan berbanding dengan model yang sebenar. Ini diteruskan dengan ujian ANOVA satu hala dengan pelbagai perbandingan bagi memilih susun atur yang mempunyai keputusan yang terbaik. Keputusan untuk ujian is telah memilih Kaedah 3 yang dapat meningkatkan pergeluaran. Walaupun penambahan kos sebanyak RM 720 diperlukan, analisa kos keberkesana menujukkan bahawa Kaedah 3 mempunyai kos seorang pelanggan yang lebih sedikit daripada susn atur yang sebenar. Oleh itu, Kaedah 3 merupakan susun atur yang paling sesuai untuk meningkatkan produktiviti di syarikat itu.

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LIST OF SYMBOLS

α	Significant value
σ	Standard deviation value
$\approx$	Approximately equals to
$\sum$	Sum or total value

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
UMP	Universiti Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In the recent years, Cafe Executive on campus of Universiti Malaysia Pahang (UMP) had faced low productivity problems where they work very hard to run their business, but in the end of the day the amount of income they received which only enough to cover their overhead. Therefore, some cafeterias did not last long in the business because of continuously having a problem due to lower productivity where the cafeteria cannot cope with the bigger amount of customers especially during peak hours. One of the problem may caused by the floor layout in the workplace. The design of the floor layout is not considered and analyzed because of employers wish to save cost and they think that floor layout designing is not necessary in their small workplace.

In order to overcome the lower productivity problem, a thorough understanding and research of the process in the existing cafeteria and restaurants is necessary so that an efficient improvement can be generated to increase the productivity in the researched cafeteria. There are many Industrial Engineering tools that had been utilized by engineers to solve low productivity problems in the industry such as Total Quality Management (TQM), Just-In-Time (JIT) and etc. Furthermore, it plays an important role in assisting engineers to analyze current layout and find out the problems occurred in the production floor so that engineers can come out with a solution to improve the production floor.

To be able compete in the market, constant improvement in the layout is needed. Moreover, current processes needed to be observed and reviewed to suite the current

market trends that are rapidly change. It is a challenging task to select and predict the outcome of a new improved production floor design for it is highly risky that may affect the whole company. Fortunately, this challenge can be eased by constructing a simulation model using simulation software to analyzed and evaluate the performance of the every newly layout designs. In other words, simulation is not only a great way to solve all kinds of industrial problems and improve productivity but it also reduces cost of production and increases revenue for the company.

1.2 PROBLEM STATEMENT

In a service sector, especially in a cafeteria, production floor layout involves the selection and the arrangement of equipments such as tables, plates, utensils and etc. Nowadays, there are several methods available to design, analyze and amend the design to improve productivity of a management process.

Today, many simulation software such as ARENA, Quest, ProModel and WITNESS were developed to allow users to model current existing production floor layout, it also can be used both as an analysis tool for predicting the effect of changes to existing systems and as a design tool to predict the performance of new systems under varying sets of circumstances. The availability of special-purpose simulation languages, of massive computing capabilities at a decreasing cost per operation, and of advances in simulation methodologies have made simulation one of the most widely used and accepted tools in operations research and systems analysis.

This study would illustrate the process flow of the current existing production floor layout to evaluate the current production performance. Designs of a few more alternatives were proposed to assist the company to improve the productivity maintaining or even reducing the operating cost.

1.3 OBJECTIVES

The objectives of this study are to:

1. Evaluate existing service floor performance.
2. Design and improve floor layout by using simulation software and by observation during the collection data of cycle time.
3. Measure performance such as output quantity by using cost effectiveness analysis.

1.4 SCOPES

The scopes of this study are:

1. Simulation modelling will be constructed and evaluated through personal computer using WITNESS software.
2. Limited to customers dining-in at Cafe Executive University Malaysia Pahang only.

1.5 ARRANGEMENT OF REPORT

This study is delegated into seven chapters. In the first chapter, the introduction of the title was discussed. Besides, the problem statement of the study is provided and the objectives of the study were reviewed. Lastly, the overall scopes of the study were discussed in this chapter.

Next chapter consists of a detailed literature review of simulation study in improving the productivity of a cafeteria. The chapter begins with the introduction to the cafeterias in Malaysia. Then, the definition of productivity and simulation are discussed in general. Moreover, this chapter continues with briefly stating the general procedure in conducting a simulation project. Furthermore, the advantages and the disadvantages of utilizing simulation method are revealed and the importance of modelling via simulation is discussed. Finally, overviews of previous research that are related to this study are briefly discussed.

Thirdly, discussion of the methodology used in conducting this study from the starting until the study is completed. This chapter started with identifying the company to be researched followed by collecting related data and information to be analyzed. Then, the simulation study is also discussed in general.

In the following chapter consists of the analyzing the data and constructing the simulation model of the production line studied. Firstly, a conceptual model is discussed and explained in general. Then, the performance measure and the decision variables are discussed. Furthermore, it proceeded with the discussion of method that the data would be analyzed. Moreover, the model description, model assumption and model construction are discussed in general. Then, the verification and validation of the model is briefly discussed.

In this following chapter, the explanation of data analysis and constructing of simulation model for the actual system studied. Initially, a description of conceptual model and performance measure and decision variables is discussed in brief. After that, the steps on how the data were being analyzed will be explained in general. The chapter continues with model description, model assumption and model construction are discussed. This proceeds with model verification, model validation. Finally, the chapter ends with number of replication determination.

The next chapter is the discussion of the actual existing layout performance and the proposed alternatives layout results will be discussed. In order to improve the existing layout productivity, 3 alternatives have been suggested. The results generated by using WITNESS simulation software were tested using Minitab statistical software. Nonparametric tests were being conducted to identify whether there were a significant differences when comparing the results for the actual layout with the proposed alternative layouts. Finally, the best layout would be proposed to the company based on the test results using one way ANOVA with multiple comparisons and by comparing the cost using cost effectiveness analysis.

The final chapter is the conclusions and the project recommendations were discussed. Then, the chapter continues with project summary, project findings and further recommendations to further improve the project in the future.

1.6 CONCLUSIONS

In the initial part of the chapter, cafeteria is introduced and the problems facing by the industry and ways to solve it are discussed. The objectives and scopes of the project are stated to specify the boundary of the study to avoid any deviation from the title of the project. Lastly, the arrangement of report displayed the summary of each chapter discussed in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discussed about literature review of simulation study in improving the productivity of a Cafe Executive Universiti Malaysia Pahang. It began with the introduction to cafeteria. Then, the definition of productivity and simulation are discussed in general. Moreover, this chapter continues with briefly stating the general procedure in conducting a simulation project. Furthermore, the advantages and the disadvantages of utilizing simulation method are revealed and the importance of modelling via simulation is discussed. Finally, overviews of previous research that are related to this study are briefly discussed.

2.2 INTRODUCTION TO CAFETERIA

According to the The Oxford Pocket Dictioney of Current English (2009), cafeteria is a restaurant or dining room in a school or a business in which customers serve themselves or are served from a counter and pay before eating. In Malaysia, cafeteria can be considered as a small medium industry based on the number of employees or annual sales turnover.

For wider coverage and applicability, definitions of SMEs will be based on two criteria (National SME Development Council, 2005), namely:

i) Number of employees; or
ii) Annual sales turnover.

Therefore, an enterprise will be classified as an SME if it meets either the specified number of employees or annual sales turnover definition. Moreover, the definitions will apply for primary agriculture, manufacturing which includes agro-based, manufacturing-related services (MRS), and also services including information and communications technology.

In this research, the cafeteria is categorized as a small enterprise with full-time employees of between 5 and 19 or with annual sales turnover of between RM200,000 and less than RM1million.

2.3 INTRODUCTION OF PRODUCTIVITY

Productivity as a technical term is output per unit of direct labour; productivity is efficiency when the relevant resource is labour. Productivity more broadly means production rate per unit of input, especially per unit of labour, for goods or services. (Young & Murray, 2005)

In order to improve the productivity, inputs can be reduced while output is kept constant or increase the output while the inputs are kept constant. In other words, improving productivity means improving efficiency. Efficiency means doing the job well with a minimum of resources and waste.

2.3.1 Productivity Measurement

The use of just one resource input to measure productivity, as shown in Eq. (2-1), is known as single-factor productivity. However, a broader view of productivity is multifactor productivity, which includes all inputs, such as capital, labour, material, energy, and etc. Multifactor productivity is also known as total factor productivity and is calculated by combining the inputs units as shown in Eq. (2-2). (Heizer and Render, 2008)

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Labour hours used}} \quad (2\text{-}1)$$

$$\text{Productivity} = \frac{\text{Output}}{\text{Labour+ Material+Energy+Capital+Miscillaneous}} \quad (2\text{-}2)$$

By using Eq. (2-2) productivity measurements, it aids the managers in determining the production performance. However, the results from the two measurements can be expected to vary. This is because if labour productivity growth is entirely the results of capital spending, measuring just labour distorts the results. Thus, multifactor productivity is usually more suitable to use for evaluation but more complicated. The multifactor productivity measures provide better information about the trade-offs among factors, but substantial measurement problems remain. According to Heizer and Render (2008), the measurement problems are quality may change while the quantity of inputs and outputs remains constant, external elements may cause an increase or decrease in productivity for which the system under study may not be directly responsible, and also the precise units of measure may be lacking.

2.4 INTRODUCTION TO SIMULATION

Jerry et al. (2005) defined that simulation is the imitation of the operation of a real-world process or system over time. Whether done by hand or computer, simulation involves the generation of an artificial history of a system and the observation of that artificial history to draw inferences concerning the operating characteristics of the real-system.

Heizer and Render (2008) described simulation as an attempt to duplicate the features, appearance, and characteristics of a real system. The idea is to imitate a real-world situation mathematically, then to study its properties and operating characteristics and finally to draw conclusions and make action decisions based on the results of the simulation.

The behaviour of a system as it evolves over time can be studied by constructing a simulation model. This model usually takes the form of a set of assumptions

concerning the operation of the system. These assumptions are expressed in mathematical, logical, and symbolic relationships between the entities, or objects of interests, of the system (Jerry et al., 2005). Once the model is developed and validated, a model can be used to investigate a wide variety of "what if" questions about the real-world system. Simulations can also be used to study systems in the design stage, before such systems are built. Thus, Jerry et al. (2005) described that simulation modelling can be used both as an analysis tool for predicting the effect of changes to existing systems and as a design tool to predict the performance of new systems under varying sets of circumstances.

2.4.1 Areas of Simulation Application

Russell and Taylor (2005), described that simulation is one of the most popular of all quantitative techniques because it can be applied to operational problems that are too difficult to model and solve analytically. Surveys indicate that a large majority of major corporations use simulation in such functional areas as production, planning, engineering, financial analysis, research and development, information systems, and personnel. Following are description of some of the more common applications of simulation:-

(i) **Waiting lines/ service**

For complex queuing systems, it is not possible to develop analytical formulas, and simulation is often the only means of analysis. (Russell and Taylor, 2005)

(ii) **Inventory management**

Product demand is an essential component in determining the amount of inventory a commercial enterprise should keep. However, Rusell and Taylor (2005) explained that demand is rarely known with certainty. Companies use simulation to see how effective and costly the inventory systems would be in their own manufacturing environment without having no implement the system physically.

(iii) **Production and manufacturing systems**

According to Rusell and Taylor (2005), simulation is often applied to

production sequencing, assembly line balancing (of in-process inventory), plant layout, and play location analysis.

(iv) Capital investment and budgeting

Capital budgeting problems require estimates of cash flows, often resulting from many random variables. Simulation has been used to generate values of the various contributing factors to derive estimates of cash flows. Simulation had also been used to determine the inputs into rate-of-return calculations, where the inputs are random variables such as market size, selling price, growth rate, and market share.

(v) Logistics

Logistics problems typically include numerous random variables, such as distance, different modes of transport, shipping rates, and schedule. Simulation can be used to analyze different distribution channels to determine the most efficient logistics system.

(vi) Service operations

The operations of police departments, fire departments, post offices, hospitals court systems, airports, and other public service systems have been analyzed using simulation. Typically, such operations are so complex and contain so many random variables that no technique except simulation can be employed for analysis.

(vii) Environmental and resource analysis

Simulation models have been developed to ascertain the impact of projects such as manufacturing plants, waste-disposal facilities, and nuclear power plants. In most cases, these models include to analyze the financial feasibility of such projects. Other models have been developed to simulate waste and population condition. (Rusell and Taylor, 2005)

2.4.2 Advantages and Disadvantages of Simulation

Simulation is intuitively appealing to a client because it mimics what happens in a real system or what is perceived for a system that is in the design stage. The output data from a simulation should directly correspond to the outputs that could be recorded from the real system. In addition, it is possible to develop a simulation model of a system without dubious assumptions of mathematically solvable models. Simulation has many advantages, but there are also consist of some disadvantages.

Some of the advantages are (Jerry et al., 2005):-

(i) New policies, operating procedures, decision rules, information flows, organizational procedures, and so on can be explored without disrupting ongoing operations of the real system.

(i) New hardware designs, physical layouts, transportation systems, and so on can be tested without committing resources for their acquisition.

(ii) Hypothesis about how or why certain phenomena occur can be tested for feasibility.

(iii) Time can be compressed or expanded to allow for a speed-up or slow-down of the phenomena under investigation.

(iv) Insight can be obtained about the interaction of variables.

(v) Insight can be obtained about the importance of variables to the performance of the system.

(vi) Bottleneck analysis can be performed to discover where work in processes, information materials, and so on is being delayed excessively.

(vii) A simulation study can help in understanding how the system operates rather than how individuals think the system operates.

(viii) "What if" questions can be answered. This is particularly useful in the design of new systems.

Some disadvantages are:

(i) Model building requires special training. It is an art that is learned over time and through experience. Furthermore, if two models are constructed by different competent individuals, they might have similarities, but it is highly unlikely that they will be the same.

(ii) Simulation results can be difficult to interpret. Most simulations outputs are essentially random variables (they are usually based on random inputs), so it can be hard to distinguish whether an observation is a result of a system interrelationship or of randomness.

(iii) Simulation modelling and analysis can be time consuming and expensive. Skimping on resources for modelling and analysis could result in a simulation model or analysis that is not sufficient to the task.

(iv) Simulation is used in some cases when an analytical solution is possible, or even preferable. This might be particularly true in the simulation of some waiting lines where closed-form queuing models are available.

2.4.3 Steps in Simulation Study

There are about 14 steps in a simulation study, and according to Jerry et al. (2005), the steps in a simulation study are shown in Figure 2.1.

2.4.4 Problem Formulation

According to Jerry et al. (2005), every study should begin with a statement of the problem. If the statement is provided by the policymakers, or those have the problem, the analyst must ensure that the problem being described is clearly understood. If a problem statement is being developed by the analyst, it is important that the policymakers understand and agree with the formulation. Although not shown in Figure 2.1, there are occasions where the problem must be reformulated as the study progresses. In many instances, policymakers and analyst are aware that there is a problem long before the nature of the problem is known.

2.4.5 Setting of Objectives and Overall Project Plan.

The objectives indicate the questions to be answered by simulation. At this point, a determination should be made concerning whether simulation is the appropriate methodology for the problem as formulated and objectives as stated. Assuming that it is decided that simulation is appropriate, the overall project plan should include a statement of the alternatives. It should also include the plans for the study in terms of the number of people involved, the cost of the study, and the number of days required to accomplish each phase of the work, along with the results expected at the end of each stage.

2.4.6 Model Conceptualization

The art of modelling is enhanced by an ability to abstract the essential features of a problem, to select and modify basic assumptions that characterize the system, and then to enrich and elaborate the model until a useful approximation results. Thus, it is best to start with a simple model and build toward greater complexity. However, the