International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:1, No:9, 2007

Investment Prediction Using Simulation

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***Abstract*—**A business case is a proposal for an investment initiative to satisfy business and functional requirements. The business case provides the foundation for tactical decision making and technology risk management. It helps to clarify how the organization will use its resources in the best way by providing justification for investment of resources. This paper describes how simulation was used for business case benefits and return on investment for the procurement of 8 production machines. With investment costs of about 4.7 million dollars and annual operating costs of about 1.3 million, we needed to determine if the machines would provide enough cost savings and cost avoidance. We constructed a model of the existing factory environment consisting of 8 machines and subsequently, we conducted average day simulations with light and heavy volumes to facilitate planning decisions required to be documented and substantiated in the business case.

***Keywords*—**Investment cost, business case, return on investment, simulation.

I. Introduction

THE total investment cost for the equipment would be about 4.7 million dollars and annual operating costs would be about 1.3 million dollars for the new technology. We needed to determine if the technology would provide enough cost savings and cost.

Our specific task was to develop a business case with an ROI projection for the procurement of new equipment. Different tools and techniques have been proposed for industry reengineering, and simulation has been identified as an extremely useful tool for this purpose. Despite the availability of these tools, it has been reported that manufactories are usually facing significant practical problems when trying to model in detail the way they operate (Hansen 1994) or to implement changes in existing environments. Many reasons can be attributed to this difficulty, the primary ones being:

a) the complexity of most real-world manufacturing processes because of their stochastic and usually unpredictable behavior and the interdependencies between individual tasks.

Manuscript received May 9, 2007. This work was supported in part by the Arab Academy for Banking and Financial science.

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b) the informal nature of many tasks which makes their analysis and documentation profoundly problematic.

Such modeling problems can become very significant in large, complex manufacturing settings.

A description of the advantages of using simulation for ROI analysis, the simulation packages and implementation is given in section 2. In section 3 we discuss the modeling and simulation objectives as well as the characteristic measures and its mapping that would be the basis for the simulation study. Section 4 briefly summarizes the simulation experiments and the results. Finally, section 5 provides conclusions.

II. Modeling and Simulation

A. Advantages

We decided on a modeling and simulation approach because of the advantages that the technology offered:

1) Simulation provides a controlled environment for evaluating performance [2].
2) Changes can be made easily to the model and results evaluated quickly.
3) It is cost effective to model the entire manufactory environment.
4) Extrapolation is supportable because of the ability to simulate light and heavy volume days by changing a minimal number of model inputs [3].
5) Simulation and modeling provides an easy way to control other influencing factors conduct sensitivity analysis. Consider these example questions. What happens when orders volume is higher than expected? What happens when the no. of orders handled entirely automation increases? Each question can be analyzed by modifying inputs to the model and running a simulation [4].
6) Simulation is a formal and robust technique. It does not rely heavily on mathematical abstraction therefore it is suitable for modeling even complicated environments [5].
7) Simulation is basically a numerical technique; therefore it can be used to generate quantitative output data on various parameters that influence a business system performance. Output Data Analysis, Experimental Design, and can be employed to ensure a significant degree of mathematical robustness at every stage of a simulation project [6].

B. Simulation Packages

To meet the modeling and simulation requirements of a particular environment, appropriate simulation tool needs to be selected with the considerations of simulation performance such as efficiency, accuracy, and speed, etc. Popular existing packages are MATLAB which is a PC based system simulation with medium to high system complexity, and spreadsheets software. At the end of the evaluation, spreadsheets were selected as the tool to support our model. Spreadsheets is a Pc-based simulation tool [7] with built-in software Functions and reporting features that can be easily tailored for measuring the effectiveness of modeled manufacturing environment. Because spreadsheets can be used as discrete event simulation technique [8], a large number of simulations can be performed at the busy hour, busy day, and even seasonal level. This capability was a primary consideration in our selection because of our need to obtain results that could be annualized for ROI analysis.

C. Initialization and a Persistent Storage for Simulation Data

The simulation package statically store the simulation configurations, simulation results, analysis results, and dynamically keeps tracks of the parameter modifications of the simulation data set. The initial parameters of a given problem are entered manually. The simulation models and configurations are stored in the input data set file, and from the file, the program extract the whole set of information as the input of the simulation program. The outputs of the simulation program are stored in the output file in order to conduct analysis, query or visualization. Four files used to store all required data and information's about resources, administrative and production costs as a reference.

III. Define Modeling and Simulation Objectives

A concurrent task that influenced our tool selection, was defining what we needed and expected to get as part of our results. We identified the following simulation objectives:

1) Provide objective measures of production machines performance that could be represented in terms of cost.
2) Provide a cost comparison of two competing situations.
3) Provide results that could be annualized for ROI analysis.

A. Mapping Characteristics into a Corresponding Indicators

The three objectives discussed in previous section drove many of the subsequent decisions that would affect the modeling effort [9]. We considered five characteristics that would be the basis for the simulation study. Those characteristics are listed in the first column of Fig. 1.

We mapped each characteristic into corresponding cost factors that could be used in a simulation analysis as shown in Fig. 1. We subsequently developed the formula for production cost on a per-day basis as shown in Fig. 2.

IV. Simulation Experiments and Analyzing Results

The model is simulated and many experiments are carried out. We begin simulations with a simple approximation of the situation and gradually refine the model as our understanding of the process improves, which enable us to achieve a good accuracy approximation. Simulation is based on traditional queuing models, using statistical and experimental methods to generate an internal picture of the system from which we gather the (statistical) data for performance analysis [10].

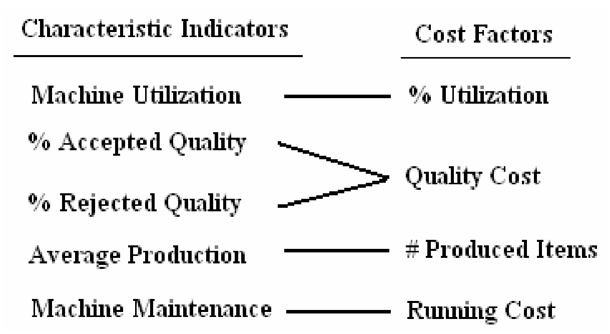

Fig. 1 Mapping characteristics to cost factors

The modeling and simulation enabled us to estimate [11] and compare production cost per day for new equipment.

Production costs were calculated using the formula contained in (1). Once the production costs were determined on a per-day basis, then the costs were annualized. The investment and production costs of the new technology were estimated at about 5.7 million dollars. The production costs subsequently figured into the Benefits part of the equation for calculating ROI (ROI = Benefits ÷ Investment). Preliminary results obtained for ROI including production costs, based on the modeling and simulation effort, were 2.3.

$$\text{Production Cost} = \frac{\text{Quality Cost} + (\text{Running Cost} * \%\,\text{Utilization})}{\#\,\text{Produced Items}} \quad (1)$$

V. Conclusion

The modeling and simulation enabled us to estimate and compare production cost per day for each machine, and as a result for all machines. It was interesting to note that the projected savings from using new machines varied significantly depending on order and production volume. The simulation validated findings that had been observed on a limited basis. As a result, the management is now considering any decision regarding the procurement process.

Acknowledgment

This work was made possible by a grant from Arab Academy for Banking and Financial Science.

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