DESIGN AND ASSESSMENT OF THE INTEGRATED INFORMATION, BUSINESS PROCESS AND PRODUCTION SYSTEM BY SIMULATION

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ABSTRACT

The objective of this study is to integrate information, business and production systems of a powder coating manufacturing via computer simulation. Previous studies consider only conventional customer lead-time, which is defined as customer lead-times to receive goods or services. The integrated approach of this study is capable of evaluating customer lead-times in six different dimensions. Furthermore, the integrated simulation approach considers conventional customer lead-time (from when the customer places an order) in addition to five other customer indices. This is the first study to consider the integrated modeling of information, business and production systems. Previous studies mostly consider distinct simulation modeling of production system, information system or business system in various settings. It is claimed that by integrating information and business systems and production systems through simulation, major and minor organization and production issue become visible. This study also shows perceived improvements through integration of information and production system modeling. In summary, the unique features of this study are three fold. First, the integrated approach of this study identifies major bottlenecks of production and information system and business process concurrently. Second, the integrated approach models and produces several dimensions of customer satisfactions. Finally, the integrated approach allows the effects of new technologies such as business process re-engineering and information technology to be evaluated before actual implementation. In addition, by integrated modeling of this study the hidden and concurrent effect of business and production processes are identified and improved.

KEY WORDS: *Integrated, information system, production system, IT, BPS*

1. Introduction

The behavior of both tangible (for example, material and machines) and intangible (for example, information, policies, and roles) components of an organization can be incorporated in a simulation model. Furthermore, simulation allows the decision-makers to obtain a "system wide" view of the effects of "local" changes in a system and allows for the identification of implicit dependencies between parts of the system. Managers can often gain insights into the potential solution of problems if they have the opportunity to experiment and test out new trends in business and technology. Furthermore, experimenting with actual production and information systems concurrently could be highly risky and harmful. Integrated computer simulation modeling of business process (known as BPS) and production process can certainly facilitate this shortcoming for managers. Computer simulation modeling of business processes or BPS is relatively new and emerging. Some of the most important simulation studies in the areas of BPS, IT and MIS are categorized in Table 1.

2. Integrated Model

This is the first study to model consolidated performance of production, business and information systems as a whole in a manufacturing organization via computer simulation. Furthermore, business process simulation (BPS) approach and conventional production simulation approach are integrated to achieve the objective of this study.

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Table 1: Some of the recent literatures in BPS and MIS and IT simulation

Business Process Simulation (BPS)	Year	Author
A simulation of business process to select among the information technologies investigation.	1994	Nissen
Present the development of an object- oriented simulation model that was applied for a real- life telecommunications project in Telecom Italy.	1995	Bruno, Briccarrello & Gavazzi
The simulation of re-engineering process on wide spread communication industries (communication on west America) to recognize the opportunity (change) for change, to forecast the quantity effects on re-engineering efforts.	1996	Lee & Elcan
The simulation of business process in the setting of process design inside the organization of paramedical industry	1997	Giaglis, Paul &Doukidis
Two examples of business process simulation: First example: related to a model in a production organization to forecast the ordered time. Second example: a detailed model of an organization to forecast the effects of product redesign on business profits.	1998	Hlupic & Robinson
An integrated simulation on organizations design studies, the effect of simulation in companies design processes.	1999	Giaglis, Paul & Hlupic
MIS Simulation	**Year**	**Author**
Analysis the flow of work in the insurance company for collisions and assessment analysis.	1965	Fetter & Thompson
A system to support the operation analysis of software with high throughput.	1991	Ammar
Methodology for the simulation of database architectures for performance evaluation.	1992	Eich, Fan, Sun & Rafiqu
A simulation for organizational modeling.	1992	Humphreys, Berkeley & Quek
An approach in which the inter organizational dynamics are represented in terms of layered actors in network and entities.	1992	Sol & Streng
A graphical environment for modeling the organizations based on task/actors.	1992	Bots& Dur
Simian, the official simulation language is used for information system strategy simulation.	1992	Evans& Jorban
The simulation models based on probabilistic discrete events of a data flow diagram warehouse and the information which describe the run of system components.	1992	Warren, Norcio & Stott
The experimental evaluation of decision support value of a simulation environment for the process of information system design.	1996	Warren, Norcio, Stott & Canfield
Accounting information system and organization learning: A simulation.	1997	Ouksel , Mihavics & Chalos
Discrete simulation is presented as an efficient tool to find useful solution in office management.	1997	Proctor
IT Simulation	**Year**	**Author**
Simulation of network access method is applied in system. The function measurement is the main benefit of this study.	1984	Erdbrugger & Boxnin
The component of analyzing the communication systems is expressed by simulation application with the use of SLAMII processor. A general simulation model is extended for the determination of network function.	1985	Garcia
A graphical environment for simulation and a quick sample of distributed networks and network protocols.	1990	Schwartz, Yemini & Bacon
To access the expected benefits of inter- organizational changes made possible by the use of information technology. The authors have developed a model that simulations trading between a number of companies along a value chain, and they used it as an introduced by the use of electronic data interchange applications in different industry sectors.	1995 & 1996	Mylonopoulos, Doukidis &Giaglis
Present the development of an object-oriented modeling environment to facilitate the use of industry simulation models.	1995 & 1998	Ninios,Vlahos & Bunn
An object- oriented simulation environment designed and built to specifically support simulation of organizational networks.	1996	Hyatt, Contractor &Jones

The results of this study can lead to acquire the required knowledge of existing information, business and production systems in order to design and test managerial and technological changes and its interaction. Also, integrated modeling of information, business and production systems can examine the impact of electronic data interchange (EDI), information technology (IT) and management information systems (MIS) on production organizations. Hence, real issues attached to the system may be identified and total rather than local optimizations are achieved because of the integrated approach. In the integrated simulation model, entities exist in two forms: information entities (IE) and production entities (PE). Information entities are classified into three categories which are: 1) arrival of orders entity, 2) business process entity which is the result of arrival entity transformation or an information entity into another information entity3) transformation of production entity into information entity. Production entities are only formed by transformation of information entities. The transformation process concept of production and information entities utilized in the integrated simulation model is shown in Figure 1.

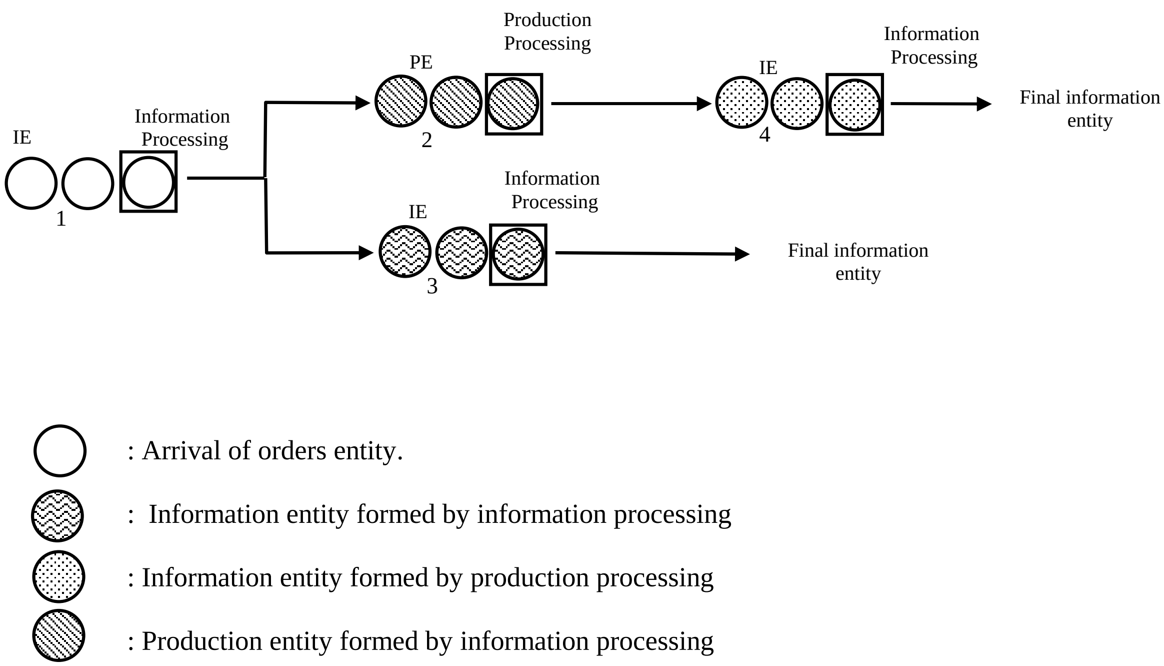

Figure 1: Transformation of information and production entities in the integrated model

Arrival and output entities are only in the form of information entities, whereas arrival entity is the state of customer request and output entity is flowed and modeled as it relates to production process or information process. This is why there four types of entities in the integrated model, namely, arrival of orders entity, information entity formed by information processing, information entity formed by production processing and production entity formed by information processing. Furthermore, in the integrated model each order entity arrives to the system in the form of information. Second, business information processing is conducted on the arrival entity. Entity flows in the system in the form of transformed information entity or it is transformed into production entity. It is transformed into production entity when arrival entity needs to be converted into production entity (necessary condition) and transformation is possible (sufficient condition). If the entity is transformed into production entity then production processing is required and achieved on the production entity. The production entity is then terminated from system due to order completion or it is transformed into information entity and feed backed to system due to order incompletion and/or system requirements. If the production entity transforms and remains in the form of information entity then, required information processing is conducted on information entity. The information which is needed and related to each of above conditions will be collected the integrated simulation model. Figure 2 represents related work procedure.

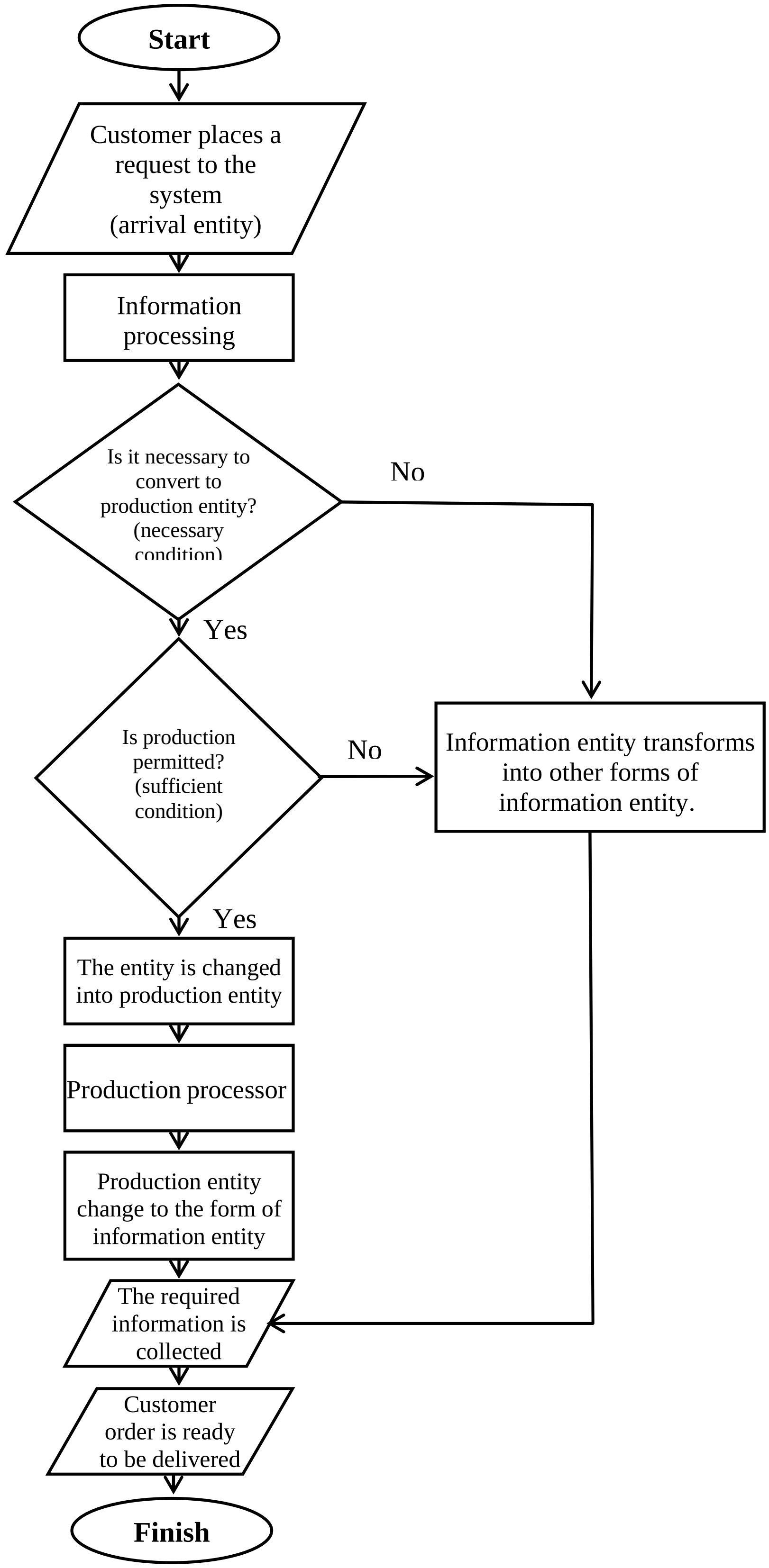

Figure 2: General logical chart of the integrated simulation model

3. The Case Study

The system being studied is a small order-based powder coating manufacturer. The company produces eight different coatings by three parallel machines. The customers contact the company to either: 1) place orders, 2) request samples or 3) make complaints about a particular product. The customers (local and out of state) contact the general manager or his assistant to place any of the above requests. If an order is placed by the customers, the inventory level is checked against the order and a permission form is issued given there is sufficient amount of finished products in the inventory. The order is then released to the customers by warehouse supervisor. Otherwise, the production manager is informed and issues a production order form to initiate the order in the production department. When customers request samples with special technical specifications, it is forwarded to the lab where a prototype is produced. The prototype is then evaluated and accredited by the customer for mass production. In the event of a complaint by the customer, the lab is informed of possible defects and lab manager reports the results to the general manager. If the complaint is verified, the warehouse supervisor is informed of accepting the return of sold products by the customers.

Production operation starts as soon as an order is received. Customer orders are classified into eight categories. Spray coatings orders numbered 1 and 2 are handled by machine 1, spray coatings numbers 3 to 6 are handled by machine 2 and spray coatings numbers 7 and 8 are handled by machine 3. Priority is with the arriving entity (new order) which has identical number as the entity being serviced. Also, if the arriving entity has higher number than entity being serviced and there is no identical order as the entity being serviced in the queue, then the arriving entity occupies the first place in the queue. For example, if machine 2 is completing order number 5 and order numbers 4, 4 and 3 are waiting in the queue, respectively and order number 6 is received, order number 6 occupies the first place (priority) in the queue and the queue priority would be 6, 4, 4, 3. Otherwise, FIFO discipline is used for as long as the arriving order has lower number than the entity being serviced. Also, if the order of service changes the queue discipline would be changed according to the above format. The production facility utilizes a pre-defined service time priority discipline. Service time priority discipline means that a machine is only allowed to service identical orders up to a limited period that is defined as t_a. For example, if machine 2 has been servicing product number 6 for the last two hours due to high demand, the remaining allotted time if required would be $t_a - 2$. In addition, the services turn over moves clockwise. A new operation is initiated according to queue priority after completion of the operation for product number 6, which would be greater than or equal to t_a. The conceptual models of the system were developed by data flow diagram (DFD) approach. This type of modeling approach will facilitate the integrated computer simulation development of information, business and production systems. The business information and production systems process has been divided into seven modules to facilitate modeling process of the system being studied.

All related production and business functions were stop-watched and time studied or quantitatively identified from existing documentations. The distribution functions of those processes and activities were then identified by Chi-Square or Kolmogrov-Smirnov goodness of fit tets. Six performance measures were modeled to forsee the effects of various alternatives: 1) Customer lead-time due to customer being rejected; 2) Customer lead-time given the order is available in inventory; 3) Customer lead-time given order is not available in inventory; 4) Customer lead-time due to accepted after sales services; 5) Customer lead-time given customer complaint is not accepted and 6) Customer lead-time for a particular product sample. There are three types of customer requests (orders) which are customer complaints, sample request and production request. Customer complaint and sample request do not require production processing and only proper information processing is performed on them. It should be noted that only in case of unavailability of final products in inventory (necessary condition) and availability of raw material (sufficient condition), a production request process is achieved. Furthermore, in case of order availability in inventory or shortage of raw material, no production is required and initiated.

4. IT Implementation

Information technology is usually assumed to provide customer and company accessibility and faster interaction between units within an organization. To simulate the effect of IT the following changes were made in the simulation model. There is no need to contact general manager or his assistant. In addition, due to existence of an integrated database the entity (customer) is not routed to the warehouse and is rejected. Also, warehouse and production managers are directly responsible for handling orders and production initiation. After an order is produced only the production manager is responsible for handling the order. The lab supervisor is directly responsible for handling complaints and only if there is a default with the product the general manager is informed to request and accept the return of the products by customers. The request for a sample is first handled by general manager or his assistant and from then the lab supervisor is directly responsible for handling the request. Therefore proper modifications were modeled into the model to forecast the effects of IT in business and production processes. The results of IT implementation in the actual system with respect to the six performance measures are shown in Table 2.

Table 2: The results of IT implementation in the actual system with respect to the six performance measures (in minutes)

Performance measure	Existing system	Existing system with IT	Percent improvement with IT
1	87.6	29.5	66.34
2	121.7	59.8	50.84
3	5492.1	4872.9	11.27
4	365.5	264.9	27.54
5	405.5	340.8	15.97
6	997.3	798.7	19.92

5. Conclusion

Previous studies mostly consider simulation modeling of production system in various settings. Moreover, recently simulation of information and business systems have been discussed and highlighted by several researchers. Simulations of information and business systems have been considered in context of business process simulation (BPS), computerized network simulation (CNS) and conventional information simulation. It is claimed that by integrating information and business systems and production systems through simulation major and minor organization and production issues become visible. This study also shows perceived improvement through integration of information, business and production system modeling. In summary, the unique features of this study are three fold. First, the integrated approach of this study identifies major bottlenecks of production, business and information systems concurrently. Second, the integrated approach produces several dimensions of customer satisfactions. Finally, the integrated approach allows the effects of new technologies such as business process re-engineering and information technology to be evaluated before actual implementation. In fact, conventional simulation models of business and production processes were developed separately and compared with the integrated model. Table 3 shows features of the integrated model compared with that of non-integrated business and production simulation models. It further proves the superiority of the integrated approach with non-integrated approaches.

Table 3: The distinct features of the integrated model

Considerable results	Performance measures					
	1	2	3	4	5	6
Integrated model	*	*	*	*	*	*
Production process model			*			
Business process model	*	*				

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