SYSTEMS
AND INDUSTRIAL ENGINEERING SERIES

E-Enabled Operations Management

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First published 2015 in Great Britain and the United States by ISTE Ltd and John Wiley & Sons, Inc.

ISTE Ltd
27-37 St George's Road
London SW19 4EU
UK

www.iste.co.uk

John Wiley & Sons, Inc.
111 River Street
Hoboken, NJ 07030
USA

www.wiley.com

Library of Congress Control Number: 2015937503

British Library Cataloguing-in-Publication Data
A CIP record for this book is available from the British Library
ISBN 978-1-84821-840-6

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Preface

Although the theory of operations management has been presented in many textbooks published over the last two decades, the subject of e-enabled operations management is rather short on literature which is easily accessible to students. When they want to gain some understanding of what it is all about, students are obliged to search journals and select papers from a large number of books. Even then they will find it difficult to arrive at a uniform view of the matter.

The objective of this book is to expound the subject at an "intermediate" level. By "intermediate", it is not assumed that students are specialists in mathematics and statistics, but it is supposed they have a working knowledge of calculus, algebra, probability and statistics.

The approach to operations management described in this book is unusual with respect to what is found in standard textbooks. Information and communication technologies (ICTs) impact the ways firms are organized and managed, and, as a result, change the practical means used to conduct business operations.

The features of this book are threefold.

– *system approach to business modeling*

Business activities, controlling functions and associated information systems are described within a coherent analytical system framework enabling a clear understanding of the various current control and costing concepts. Operations costing is not usually included in textbooks as part of

operations management, but it should be. Cost targeting has become an integral part of good practice of business management.

– *validity of models*

Apparently simple models are analyzed in detail. Students must be completely aware of the assumptions made when models are formulated and of their conditions of validity. Applying a model automatically implies that assumptions of a particular type are taken for granted.

– *logistics, procurement and quality management*

These three business functions are critical key success factors for managing e-enabled supply chains from suppliers to customers. That is why their main tools are introduced in this book.

Jean-Pierre BRIFFAUT
May 2015

PART 1

Modeling of Business Structures

1

System Approach to Business Operations and Information Engineering

1.1. System approach to conduct business operations

1.1.1. *General considerations*

The system approach is instrumental in tackling complexity in the managerial as well as technical worlds. The system concept is a modeling tool based on interacting entities. Its purpose is to understand complex structures by (de)composing them into entities having specific functions and interacting with each other.

The "composition" approach is implemented when designing a real or virtual object. The "decomposition" approach is implemented when analyzing some existing part of the world.

In both approaches, systems are constructed with a view to identifying certain function capabilities perceived by the users to be desirable. Examples of function-based systems include: defending the country, transmitting messages, transporting people and goods, manufacturing goods, exchanging products and services, etc.

In general, users are known not to be able to articulate all their requirements and expectations. Therefore, at the planning stage, there always exists a considerable uncertainty about many aspects of the system to be built, or, in other words, the system behavior. That explains why prototypes

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have to be built for checking whether the users' requirements are adequately fulfilled.

Systems do not exist in isolation. Each operates within a definite environment. But the ways a system interacts with its environment may prove to be of a wide variety. In other words, how and when some types of interaction take place have to be ascribed to uncertain or random events. As a result in certain circumstances, the system behavior can run out of control. These circumstances refer to events or sequences of events which have not been taken into account at the design stage of the system.

1.1.2. System description

Describing a system implies:

– describing its constituent entities as attributes;

– describing the inter-entity relationships;

– describing the relationships between entities and the environment.

Each entity can be a system in itself.

When a business unit is described as a system, the purpose is to control its business operations. Three entities have to be identified, i.e. the controlled system, the controlling system and the information system (IS). The controlled system, often called the transformation system, because it converts inputs into outputs, is modeled generally as a process. The relationships between these three entities are shown in Figure 1.1.

It is noteworthy to elaborate on Figure 1.1 for understanding the features of the system approach to business description. What is meant by direct and indirect control? Direct control refers to the direct action on the controlled process to maintain or change its state. Indirect control resorts to some entity external to the system for influencing the state of the controlled process by means of inputs.

Let us take an example to explain how the messages exchanged between the entities involved are articulated and how their contents trigger decisions. The controlled process is assumed to be a manufacturing process made of

storage and production activities. A message coming from the market place (environment data) is captured and processed by the IS. The message content says that a market slump is forecast. It is directed to the production scheduler in an appropriate format (control data). As a consequence, the scheduler decides to reduce the production level by releasing orders to the manufacturing shops (direct control) on the basis of inventory levels (process data) and to send orders to suppliers to decrease the number of deliveries (indirect control).

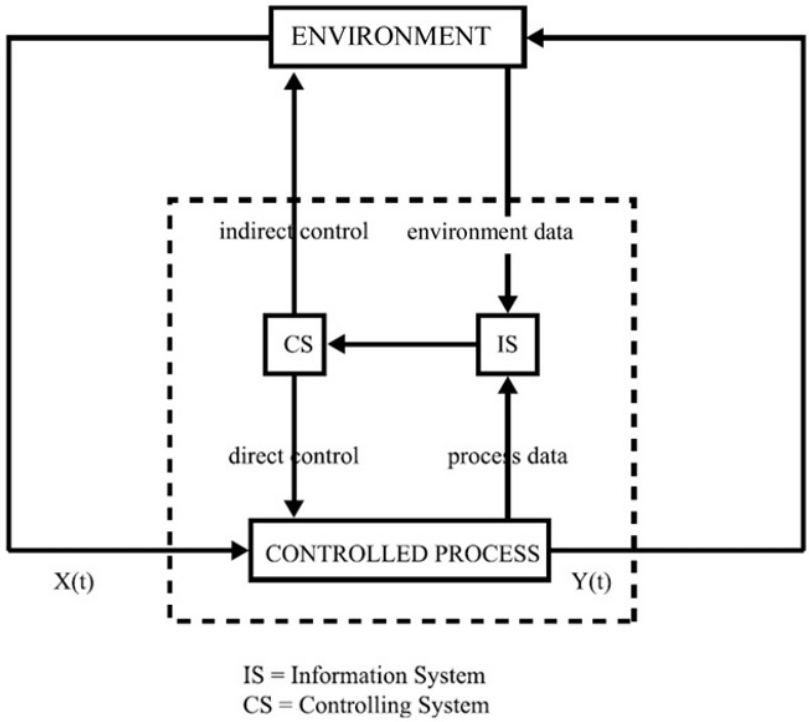

Figure 1.1. *Relationships between the various entities of a business unit within the framework of a system approach*

Describing any business organization as a system means:

– identifying and modeling the system to be controlled (WHAT);

– identifying decision-making functions (WHO) and defining management rules (HOW);

– producing the IS requirement.

1.2. Information engineering

1.2.1. *Information as a resource*

Central to any human activity is the process of *decision-making*, i.e.:

– defining a goal;

– identifying a number of alternative *actions* which may lead to the goal;

– evaluating the consequences of each action;

– selecting the action which is most likely to lead to the desired goal.

The decision maker, in general, faces uncertainty mainly about the results of the envisaged action. Decisions vary in uncertainty associated with their outcomes. The greater the uncertainty, the greater the risk of a negative outcome. This uncertainty can be reduced or even completely removed by obtaining the relevant information about the courses of action in progress. It follows that information is defined as a resource by means of which uncertainty is reduced.

For large systems, as a rule, a part of the required information on the behavior of system environment becomes available only after the system has been put in operation. For this reason, there is a need for incorporating a control function of a sort into the very system. The role of control is to make decisions on the system behavior effective. When some deviation from the set goals is detected corrective control action is engineered to reach the set goals.

1.2.2. *Explicit and implicit information*

Information may be explicit or implicit. Implicit information or know-how is that piece of information which is an integral part of skill and can be gained only by apprenticeship from an expert. The term “expert” is used here to denote a person who knows how to perform an activity without

necessarily understanding why his/her methods work. In contrast, explicit information or know-how exists independently from any skill. It can be readily represented, stored and made available for general use.

1.2.3. *Clarification of some terms*

The body of knowledge, methods and established practices related to the handling of information as well as the associated devices will be called *information technology*. Systems of artifacts, the purpose of which is to handle information will be called here *information systems*. The engineering discipline concerned with the design, production, installation, operation and maintenance of ISs will be called *information engineering*.

1.2.4. *Characteristics of information systems*

It is quite clear that no organization could operate without some type of IS. The main functional capabilities an IS must fulfill are:

– capturing data;

– processing data;

– memorizing data.

These are followed in order to support the decision makers to conduct business operations.

– *Contents of an information system*

Even if users are not aware of this fact, IS designers posit that ISs are a modeled vision of the business universe. Whatever the assumptions made about the chosen representation of the business universe, IS constructs reflect how the enterprise is organized and operates. It implies that business information systems contain, in a way or another, a description of the enterprise's organizational structures, functioning mechanisms and deliverables. The contents of business information system include:

– static properties of operations and controls;

– description of deliverables (products or services);

– dynamic behavior of operations.

Several types of ISs are considered in businesses.

– *Transaction processing systems*

A transaction is a business operation modifying the state of the enterprise. Whenever a transaction occurs, data describing the transaction is created. Capturing, storing, processing, distributing and reporting of transaction data is the objective of transaction processing systems.

Let us consider an example. When a client places an order, an order form is created where the order content is described in terms of items, quantities and delivery dates and payment conditions. This order triggers updating of the inventory, sending an invoice, launching the manufacturing of new items, recording provisional income in the balance sheet, etc.

Somehow transaction processing systems are the front office of management information systems (MISs)

– *Management information systems*

MISs must give a relevant, accurate, significant and updated image of business activities and incoming and outcoming goods flows. Today, this is achieved by means of artifacts (software programs and databases) modeling the activities and goods flows involved.

1.2.5. *Information system content for a manufacturing company*

The IS content comprises the models representing the business from different points of view (processes/functions/organization). As an example, the products/services delivered, the control pattern and the infrastructure can be modeled for a manufacturing company as shown in Figure 1.2.

1.3. System approach to describing inventory-controlled storage

Storage is a buffer activity decoupling inflows of materials from outflows. Materials consist of raw materials, finished products, goods in progress and any type of supplies held by business firms. Inflows and outflows are usually controlled by different business functions.

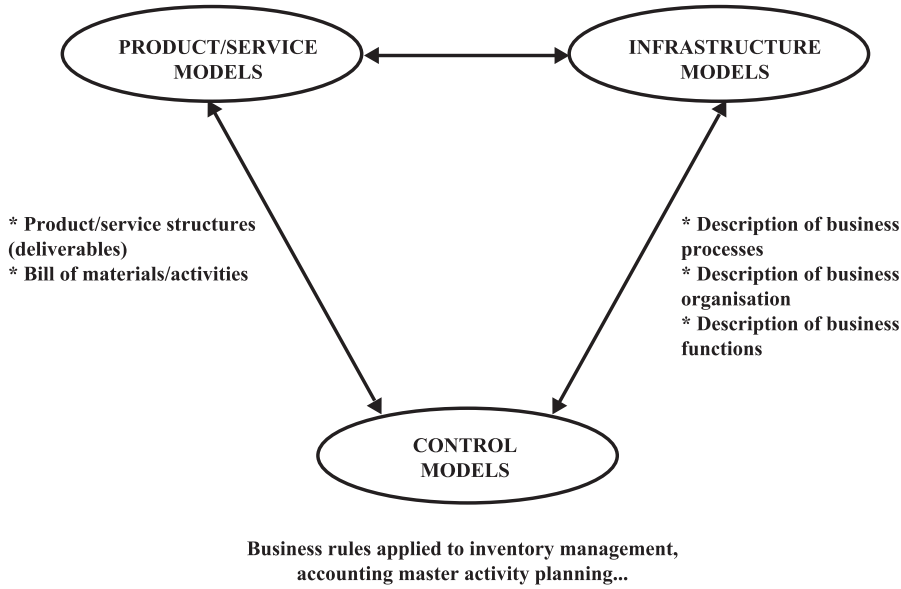

Figure 1.2. *Content of an information system for a manufacturing company*

Despite costs incurred when holding stocks, multiple motives to carry inventories justify their presence in businesses.

– *Cover of stockout situations*

If suppliers are not reliable, buffer stocks facilitate clients to be provided with the materials they require on time. In other words, it ensures a chosen service level of deliveries to clients. At the same time, if demand is stochastic it gives the possibility of sustained deliveries to clients over a period of time within limits derived from the chosen service level.

– *Economies of scale in supply*

When orders of large quantity are placed, reduced prices are obtained (quantity discount) and some fixed costs (transportation, ordering costs) are portioned out to a larger quantity reducing the unit cost as a consequence.

Consider a storage activity receiving raw materials from suppliers and dispatching them to manufacturing shops when called off.

– Identify the sequence of activities from suppliers to the manufacturing shops.

– Identify the controlling functions.

– Describe the requirements of the associated information system.

The safest procedure to identify the sequence of activities involved is to follow the goods flow from suppliers to clients (here the manufacturing shops). In this case under consideration, three sequenced activities are identified, i.e. receiving, storage and distribution to manufacturing shops.

The controlling functions are found by answering this question: who triggers the activities? The receiving unit becomes active because the procurement function has released delivery orders to suppliers. The distribution unit becomes active when the manufacturing scheduler releases requisition lists of materials to be picked up from storage and delivered to the manufacturing shops.

It is worth noticing that inflows of materials are controlled by the procurement function whereas outflows are controlled by the production scheduling function. This feature stresses the decoupling role of storage.

Inflow and outflow transactions have to be recorded by the IS so that the on-hand inventory for each material is known at every moment. It is assumed that inflows are controlled with the inventory control system (ICS) concept. When the on-hand inventory level comes to a threshold, a replenishment order is released. The reorder level depends on the replenishment lead time and the depletion rate. In fact, it is the demand size during lead time.

The whole system is described in Figure 1.3.

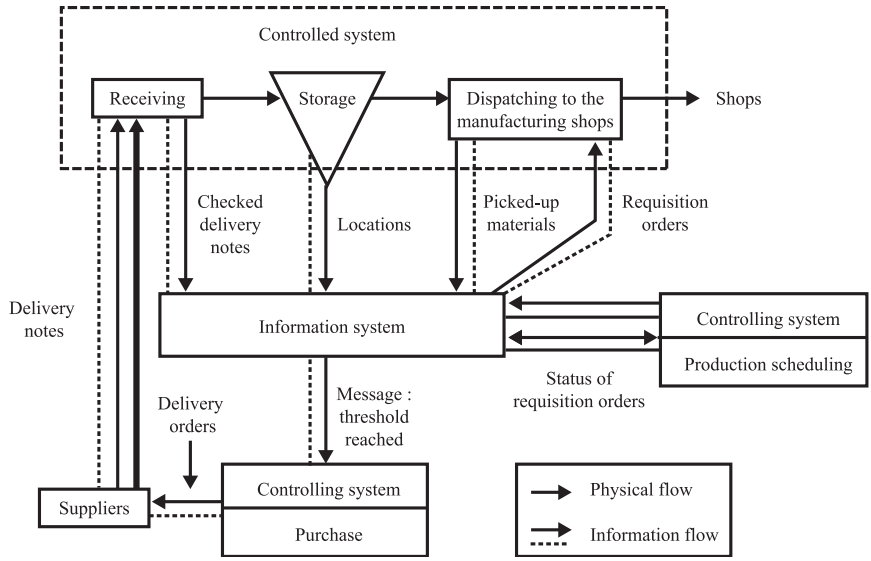

Figure 1.3. *System description of an inventory-controlled storage*

2

Business Modeling by Process and Management Applications

2.1. Process definition and control

2.1.1. *Definition*

Process has a Latin origin "processus" meaning "having progressed". It strongly connotes the dynamics of tasks. It was widely used to describe non-stop manufacturing industries such as steel mills, glass mills, oil refineries, etc.

The use of this wording in the management arena is now widespread. In order to avoid any misunderstanding, definitions have been given by standardization bodies or other institutions and will be commented on hereafter.

A process is a set of means and activities converting input into output (ISO 8402 and 9004).

A definition was given by IBM in an in-house journal of IBM research center at La Gaude/France in 1987 and provides a telling insight. It can be summarized as follows.

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