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Information & Management 39 (2002) 605–624

INFORMATION & MANAGEMENT

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# A model of computerization of manufacturing systems: an international study

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Accepted 22 May 2001

**Abstract**

This paper introduces a model of best practice in the computerization of manufacturing systems, by drawing on the practical experience of senior managers of both manufacturing and information management in Taiwan and the UK. The design used both qualitative and quantitative data analysis techniques to examine the implementation and integration of information systems support for manufacturing (ISSM). The investigation was conducted in three main phases. A series of qualitative case studies was conducted on the use of ISSM in 21 Taiwanese companies and 3 government organizations. Within-case and cross-case analysis showed that the six most important elements of ISSM implementation and integration are: the nature of manufacturing systems, ISSM and related software subsystems, barriers to ISSM, facilitators to ISSM, measured benefits from ISSM investment, and the level of ISSM integration. A preliminary development of a model of ISSM was then used to design a questionnaire for case studies analysis to examine ISSM in Taiwan and the UK. A comparison of ISSM in the two countries suggests that Taiwanese manufacturers have created platforms on which to build advanced manufacturing systems, are aware of the problems, and have plans to overcome them. UK firms had more experience with ISSM, and more organizations had achieved highly integrated manufacturing systems. Both countries appear to be moving toward similar designs for their enterprise resource planning and supply chain management systems. 

*Keywords:* Information technology (IT); Information systems support for manufacturing (ISSM); Computer integrated manufacturing (CIM); Supply chain management (SCM)

## 1. Introduction

Integration of manufacturing systems and supply chain systems in modern industrial enterprises embody complex decisions and systematic actions. In order to operate successfully and profitably in rapidly changing global markets, highly flexible manufacturing systems (FMS), build to order (BTO), configure to order (CTO), optimized distribution modeling (ODM), enterprise resource planning (ERP) and supply chain management (SCM) techniques must be implemented. ISSM involves the application of IT to support these complicated manufacturing and organizational decisions. It systematically tracks relevant attributes, such as speed, response time, accuracy, and customer relationships. This is facilitated through an analysis matrix that relates data units and various system components. Measures of these attributes can then be used to

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0378-7206/02/$ – see front matter 
PII: S0378-7206(01)00118-5

analyze potential improvements to the system under consideration.

This paper is a comparative study of the implementation and integration of ISSM in Taiwan (one of the emerging "little dragons" of southeast Asia) and the UK. The manufacturing performance of southeast Asian economies, where firms appear to be rapidly developing sophisticated manufacturing systems, is of strategic competitive importance to Western manufacturers. The research involved preliminary case study development followed by a postal survey in both Taiwan and the UK, and was conducted in the following phases.

1. An analysis and tentative theory development based on a series of case studies on ISSM development, in 21 Taiwan companies and 3 government organizations.
2. Within-case and cross-case analysis showing that the six most important elements of ISSM implementation and integration are: the nature of production systems, ISSM and related software subsystems, barriers to ISSM, facilitators of ISSM, measured benefits from ISSM investment, and the level of ISSM integration.
3. A model of ISSM implementation was developed from the case study findings, and this model was used to design a questionnaire to examine integration in Taiwan and the UK.
4. A comparison of implementation and integration related to ISSM in Taiwan and the UK, and a refinement of a model of the ISSM implementation process.

## 2. Information systems support for advanced manufacturing

### 2.1. Definitions

The application of IT in manufacturing began with the concept of integrated planning and operations developed by IBM in the early 1960s, when large manufacturers and computer suppliers promoted concepts and developed software for manufacturing planning and control. To effect commercial results, the implementation of ISSM had to be supported by changes in organizational attitude and decision-making. Maull et al. [19] defined ISSM as "a set of policies, procedures, systems and knowledge that surrounds the processing of customer orders, to provide information such as work to lists, job schedules, packing lists, back order, and material orders". Webster and Williams [25] defined ISSM as "the set of software technologies concerned with the planning and control of manufacturing resources".

Further definitions of ISSM found in the literature, include Bessant and Buckingham [2], Hollier and Barber [15], Childe et al. [6], Clark et al. [9], Muhlemann et al. [21], Maull et al. [19], Monniot et al. [20], Cork [10], and Chang [4,5]. ISSM involves not only computers and the manipulation of data but also the various procedures and people who must carry out operations. ISSM can be defined as "a managerial information system that supports manufacturing functions and includes technology management, organization, and customer relationship service procedures".

### 2.2. ISSM computer subsystems

There are many different ISSM packages available for a wide range of applications. Waterlow and Monniot [24] define ISSM software subsystems as including aggregate planning, master production scheduling, purchasing/capacity planning activities, material requirements planning (MRP), inventory control (raw materials, components, end products), work in progress (WIP) control, order monitoring (production progressing), works order paperwork printing, shop-floor scheduling, operation sequencing and shop-floor data collection, production engineering (bill of materials, process planning, tool control). These applications aid in manufacturing management through: design engineering (specifications, modifications), maintenance engineering (coordination monitoring, fault analysis, maintenance scheduling), quality control (inspection, failure analysis), cost control (products, materials, labor), sales order processing, dispatch (scheduling of deliveries, dispatch note printing system), and works payroll.

Childe et al. [6] defined ISSM systems as "the networks of human and computerized elements, which regulate the flow of work, control purchasing and delivery and thereby manage the manufacturing function". To be successful, manufacturers need a top–down integration strategy covering integration of organization, logistics, and information.