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Assessing the impact of quality determinants and user characteristics on successful enterprise resource planning project implementation

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ABSTRACT

As barriers to transnational trade and investment have been lowered due to globalization, and information and communication technologies have improved, multinational firms can conduct operations with increased ease. Enterprises can also utilize cost-advantageous production resources and export products to expand their global market. Enterprise resource planning (ERP) systems serve the purpose and have become useful instruments for managing multinational operations. Notably, ERP systems integrate information platforms to reflect operations at each operation point in real time and generate information as a basis for decision-making and resource allocations. Thus, ERP systems are essential to global logistics management and collaboration. However, vertical and horizontal evaluations of information systems are necessary to determining the effectiveness and success of project implementation. This study examines the impact of quality determinants from literature in assessing benefits using an information systems success model. The cause-and-effect relationships between model constructs are tested using structural equation modeling. An empirical study of leading manufacturers adopting ERP systems is used to investigate corporate benefits related to information quality, system quality, service quality, system use, and user satisfaction. The analytical results can be a reference for practitioners and researchers evaluating the effectiveness of management information systems.

1. Introduction

Information technology (IT), which has advanced markedly in recent years, plays an important role in corporate globalization, effectively reducing geographic barriers and improving operational efficiency [1]. Furthermore, IT indirectly accelerates business globalization and intensifies the competition within industries. Faced with global competition, companies, particularly manufacturing firms, must control operational costs and optimize business processes to achieve competitive advantage.

Enterprise resource planning (ERP) systems are regarded as one of the best information management systems [2]. In addition to automation and increased operational efficiency, the core benefit of an ERP system is that business processes are streamlined. The codes in an ERP system incorporate accumulated management wisdom into an overall operational process. This creates operational synergy and automates daily administration of business practices. Consequently, effective ERP implementation means that managers spend reduced amounts of time on routine tasks and can focus on specific and relatively more valuable tasks [3–6].

A common information platform creates consistency and reflects local operations in a timely manner. This is the foundation for efficient decision-making and resource allocations. An official report by Ministry of Economic Affairs (2005) indicates that 91.4% of Taiwanese companies in the manufacturing industry have implemented an ERP system [7]. However, most head offices and branches do not regularly assess the success of ERP system implementation. Thus, the effectiveness and efficiency of ERP implementation for manufacturing firms must be investigated using a systematic approach.

Although most ERP studies focused on factors affecting implementation [1,3,6,8–12], dearth of studies measure the quantitative effects of quality evaluation dimensions (system–information–service) correlated with system use (SU), user satisfaction (US), and corporate benefits (CBs), let alone prioritizing ERP system success evaluation indicators particular for the manufacturing industry.

The degree of ERP information system success directly affects information timeliness, the extent to which business processes are combined, and the efficiency of organizational cooperation [13]. Two years are typically required after implementing an ERP system to realize benefits [5,11,14]. Consequently, corporations should collect relevant business intelligence data before continuous

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process improvements, and repeatedly review and correct operational objectives.

This study examines and determines the empirical effects of ERP systems, information quality (IQ), and service quality (ServQ) on SU, US, and CBs *via* a structural equation model (SEM). Specifically, the ERP evaluation model was applied to manufacturing companies using the most recent ERP system developed by Taiwan's leading provider to investigate the potential benefits and impacts two years after ERP system implementation. The tasks utilized to acquire managerial strategies and implications include a review of studies of confirmatory factors affecting the above constructs in constructing an ERP implementation evaluation model. Additionally, an SEM is employed to identify the cause-and-effect relationships among constructs, determine how indicators fit constructs, and to fine tune the evaluation model based on validity and reliability indices.

The remainder of this paper is organized as follows. Section 2 reviews literature to identify confirmatory constructs and evaluation indicators for ERP system implementation. Section 3 applies SEM theory and describes research methodology of reliability and validity analyses. A case study and analytical results are presented *via* a proposed structural equation model in Section 4. Finally, conclusions and recommendations are given in Section 5.

2. Literature review

2.1. Evolution of the ERP system

Modern ERP applications are based on material requirement planning (MRP) [15]. By the 1980s, companies primarily competed to improve quality and focused on improving workflow management and on-site control, and then generated detailed cost reports. Subsequently, MRP evolved into manufacturing resource planning (MRP II), which integrates manufacturing resources. However, intense competition has shortened product lifecycles, and clients typically have diverse real-time requests. Particularly, timing, which is crucial to operational success, has led to the development of ERP systems.

The principal difference between the ERP and MRP II systems is that the MRP II system is a material- and manufacturing-oriented information system and cannot respond to rapid changes to globalized operations. Conversely, the ERP system is based of client demands and integrates internal trading information and combines internal workflows, thereby optimizing overall operational efficiency [15]. In the early 1990s, the Gartner Group developed an ERP system inspired both researchers and practitioners.

In response to environmental changes and actual needs, ERP system is applicable to, say, supply chain management [16,17], customer relationship management [17,18] and data warehousing [9,10,19], in which the ERP system is embedded to increase its comprehensiveness.

2.2. Motivation and benefits of ERP systems

The major motivations for implementing an ERP system are characterized as *push* and *pull*, where *push* refers to any change in an external environment that increases pressure on a company. Consequently, companies implement an ERP system when facing new challenges, including globalized operations and rapid changes in market conditions [3]. Conversely, *pull* refers to actual benefits generated by implementing an ERP system, including integration, flexibility, and the ability to respond rapidly to clients and customers [20].

The motivations for ERP system implementation can be divided into three categories based on the strategies used and firm interests [8,15]. Operational motivations include improved database capacity and speed, upgraded information systems, production site automation, improved transparency, and business efficiency [10]. Managerial motivations are typically to reengineer a business process, enhance administration and control of operational information, improve operational flexibility, integrate the information systems of different units, and combine application systems that have differing functions [15,21]. Strategic motivation is characterized by the need to define the business mission, achieve strategic goals, adjust the internal organizational structure and roles, enhance organizational ability to innovate, and improve the business culture and organizational climate [8,15,22].

The value of an ERP system does reside in the system itself, but rather in system benefits and efficiencies [20]. The American Association for Operations and Management (APICS) determined that on average, ERP systems reduce business inventory by 30–50%, delivery delays by 80%, work suspensions due to lack of materials by 60%, and production cost by 12%, while increasing productivity by 10–15%, and simplifying the purchasing process [23].

An ERP system has both explicit and implicit benefits. The explicit benefits of an ERP system include reduced inventory, manpower, and transportation and logistics costs, and increased production capacity. Implicit benefits are increased transparency of business information, improved workflows, rapid responses to client needs, efficient information sharing, and an overall improvement in operational performance.

Chalmeta et al. (2001) identified the following benefits by integrating the information system and enterprise resources [24]: strategic benefits (increased strategic advantage in competition and integrated resource allocations); tangible and quantitative benefits (efficient product development schedule and production schedule, and decreased materials costs and direct/indirect labor costs).

Ross (1999), in examining 15 manufacturing firms, identified the following five stages in the ERP implementation process: design; implementation; stabilization; continuous improvement; and, transformation [25]. Further, Deloitte Consulting and Benchmarking Partners (1999) deconstructed the application of an ERP system into two stages. The first stage represents the period from initial implementation to activation. The second stage represents the period from activation until an ERP system generates synergy, which is comprised of three stages [26].

The first stage in synergy emphasizes system stabilization at roughly 3–9 months after an ERP system is activated. Since companies are typically unfamiliar with ERP operations, the focus is on operational flows and information accuracy. The second stage begins once a company has familiarized itself with operations in the first stage. This stage generally occurs at approximately 6–18 months after system implementation. Synthesis is key in the second stage. The focus of this stage is to combine IT, create new organizational efficiencies, and integrate business flows. The third stage, typically 12–24 months after implementation, emphasizes synergization and focuses on reengineering and vitalizing a company.

2.3. ERP quality evaluation determinants

Sigwart et al. (1990) deconstructed system quality (SysQ) into the following 15 measurement items: correctness, efficiency, consistency, understandability, usability, reliability, maintainability, modifiability, portability, testability, robustness, structuredness, compactness, compatibility, and integrity [27]. DeLone and McLean (2003) assessed SysQ using the following 18 measurement items [28]: data accuracy; data currency; database content; use ease; learning ease; access convenience; human factors, realization of user requirements; usefulness of system features and functions; system accuracy; system flexibility; system reliability; system