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Enterprise Resource Planning systems: An assessment of applicability to Make-To-Order companies

Bulut Aslan *, Mark Stevenson [1], Linda C. Hendry [2]

Department of Management Science, Lancaster University Management School, Lancaster University, LA1 4YX, UK

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ABSTRACT

Many vendors of Enterprise Resource Planning (ERP) systems claim their products are widely applicable–configurable to meet the needs of any business, whatever the product or service offering. But Make-To-Order (MTO) companies, which produce high-variety and bespoke products, have particularly challenging decision support requirements and it remains unclear whether ERP systems can meet their needs. This paper takes a contingency-based perspective of ERP adoption, assessing the fit or alignment between ERP functionality and a MTO production strategy. MTO features considered include: decision support requirements at critical Production Planning and Control (PPC) stages, idiosyncratic market-related features, typical company size and supply chain positioning, and shop floor configuration. It finds a substantial gap or misalignment between ERP functionality and MTO requirements; for example, between decision support provided by ERP systems and the decision support required by MTO companies at the customer enquiry and design & engineering stages. A research agenda for improving alignment is outlined, with implications for academics, MTO managers and ERP software developers. This includes: developing decision support tools that reflect the customer enquiry management activities of MTO companies; embedding MTO-relevant PPC concepts within ERP systems; and, conducting an in-depth empirical study into applications of ERP systems in MTO companies, assessing their performance impact.

1. Introduction

When implemented effectively, Enterprise Resource Planning (ERP) systems can provide business benefits such as real-time data availability, improved visibility, and increased task automation [1–3]. Many ERP vendors claim that such benefits can be accrued by any organisation, as their systems are generic, i.e. configurable to meet the needs of any business, whatever the product or service offering. But the literature suggests that Make-To-Order (MTO) companies, which produce high-variety and bespoke products, present particular challenges [e.g. 4–6]. Thus, despite the claims of ERP vendors, it remains unclear whether ERP can cater sufficiently for the needs of MTO companies. This paper takes a contingency-based perspective [7] to assess the alignment between the functionality of contemporary ERP software modules and the requirements of MTO companies.

The alignment of ERP solutions with operational needs has been studied previously by [8]. The authors showed that overall performance/satisfaction becomes weaker if the operational strategy (context) is misaligned with the ERP adoption strategy. However, no further in-depth studies have been conducted to identify which modules within ERP solutions show adequate fit with which operational needs. In addition, few reviews of planning and control concepts or information systems have focussed specifically on the needs of MTO companies. One exception was provided by Bertrand and Muntslag [4] who presented a review of the applicability of MRP-II to bespoke production environments, specifically the Engineer-To-Order (ETO) sector; however, an update of this work is required. A second was provided by Stevenson et al. [5] who suggested that ERP may be a suitable solution for MTO companies but that further research is required. The paper reviewed and assessed a wide range of concepts and, therefore, did not go into great depth on any one concept. More recently, Deep et al. [6] conducted a case study investigation of the factors affecting the selection of an ERP system by a MTO company. The authors demonstrated that more research is required towards assisting firms in determining the applicability of ERP. The paper itself did not provide a sufficiently comprehensive review of the available literature or consider the full range of MTO company

* Corresponding author. Tel.: +90 536 512 7990.
E-mail addresses: bulutaslan@gmail.com (B. Aslan), m.stevenson@lancaster.ac.uk (M. Stevenson), l.hendry@lancaster.ac.uk (L.C. Hendry).
[1] Tel.: +44 1524 593847.
[2] Tel.: +44 1524 593841.

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characteristics that are likely to affect ERP adoption. Other reviews which focus specifically on ERP include those by Esteves and Pastor [9], Al-Mashari et al. [10], Jacobs and Weston [11], and Moon [12]. While these studies provide greater depth, they do not either: take a contingency approach based on production strategy; seek to assess the applicability of ERP systems; or give sufficient attention to recent developments in this fast-moving industry (e.g. the emergence of ERP add-ons for supply chain and customer relationship management).

Therefore, a contemporary assessment of the applicability of ERP to the MTO industry is required. In response, this paper contributes by assessing this fit with the aim of conceptually, identifying MTO decision support requirements, the functionality of widely available ERP modules, and gaps between the two. A systematic literature review assists this assessment and a research agenda is proposed. We do not seek to focus on broad implementation issues or to provide a detailed historical description of the evolution of ERP systems. For an overview of implementation issues, see Umble et al. [13]; for a detailed historical perspective on ERP, see Rashid et al. [14] and Jacobs and Weston [11].

The remainder of this paper is organised as follows. Section 2 explains the methodology followed to systematically select papers to review and to assess the applicability. Section 3 defines the characteristics and decision support requirements of MTO companies before Section 4 provides an overview of the functionality of ERP systems, including recent extensions to their core functionality. Section 5 assesses the fit between the requirements of MTO companies and the functionality of these systems. Section 6 identifies gaps in the literature in need of further research before the paper concludes in Section 7.

2. Methodology

The research methodology described below consists of two parts. Section 2.1 explains the process used to systematically identify literature on ERP functionality and MTO requirements before Section 2.2 describes how the fit between the two is assessed.

2.1. Systematic review process

The principles of conducting a systematic literature review have been followed in selecting papers [15,16]. International peer-reviewed journal articles were sourced from the ABI/Inform (ProQuest), Business Source Premier (EBSCO) and Science Direct (Elsevier) academic databases. No constraint was applied on the date or journal of publications. The use of search strings "Enterprise Resource Planning" and "Make-To-Order" (limited to titles, keywords and abstracts) separately revealed more than 10,000 hits for each. The two phrases were also searched together and combined with several sub-category phrases such as "Advanced Planning and Scheduling" and "Engineer-To-Order"; which helped to narrow down the results but the number of articles was still unmanageable. We further decreased this to a final list of 144 studies using systematic search criteria [15]. We excluded studies with no particular focus on the contingency factor of production strategy on critical success factors and transactional functionality of ERP systems (e.g. accounting or financial control); and focused instead on studies with a high citation index which focus on MTO-specific needs and decision making stages through case studies; surveys; mathematical or conceptual models.

The final 144 articles are classified in Table 1. At a high level, they are grouped into those that focus on ERP research, those that focus on MTO decision requirements, and those that address both topics. There are 9 papers in the third category, for which the primary topic is one of review and assessment and, hence, no further subcategories were determined. The studies focusing on ERP research were further divided into those that reviewed and classified ERP research; and those that looked at: future concepts; ERP extensions, ERP such as Supply Chain Management (SCM) and Advanced Planning and Scheduling (APS) (as defined in Section 4);

Table 1
List of literature reviewed in this paper.

Categories	References
ERP Research	
Review and Classification	Davenport [2]; Gupta [115]; Klaus et al. [116]; Esteves and Pastor [9]; Mabert et al. [68]; Rashid et al. [14]; Shehab et al. [117]; Botta-Genoulaz et al. [72]; Jacobs and Weston [11]; Moon [12]
Future Concepts	Davenport [71]; Markus et al. [118]; Chen [88]; Rashid et al. [14]; Al-Mashari [10]; Jacobs and Bendoly [119]; Davenport and Harris [120]; Jacobs and Weston [11]; Koh et al. [3]
Extended ERP (SCM, APS, CRM and others)	Davenport [71]; Stratman [121]; Bose [86]; Rigby et al. [122]; Stadtler and Kilger [78]; Tarn et al. [123]; Wiers [124]; Akkermans et al. [76]; Fleischmann and Meyr [80]; Kovács and Paganelli [125]; Ptak and Schragenheim [126]; Addison [127]; Davenport and Brooks [73]; Rigby and Ledingham [128]; de Búrca et al. [129]; Møller [91]; Stadtler [97]; Hendricks et al. [77]; Watts et al. [130]; Lee et al. [131]; Ou-Yang and Hon [132]; Hicks [93]; Hvolby and Steger-Jensen [133];
National and Cultural Perspectives	Adamand O'Doherty [134]; Mabert et al. [107]; Olhager and Selldin [69]; Baki and Cakar [135]; Koh and Simpson [136]; Morabito et al. [108]; Lee et al. [137]; Argyropoulou et al. [110]; Chien et al. [138]; Laukkanen et al. [109]; Ketikidis et al. [139]; Snider et al. [70]; Bayraktar et al. [140]
SME ERP Adoption	Van Everdingen et al. [141]; Mabert et al. [107]; Muscatello et al. [142]; Buonanno et al. [113]; de Búrca et al. [129]; Koh and Simpson [136]; Olsen and Sætrea [60]; Raymond and Uwizeyemungu [106]; Koh et al. [143]
Sector/Industry Application	Wiers [124]; David et al. [99]; David et al. [84]
MTO Research	
Customer Enquiry	Tobin et al. [102]; Hendry and Kingsman [33]; Hendry and Kingsman [144]; Hill [145]; Hendry and Kingsman [20]; Kingsman et al. [146]; Kingsman et al. [21]; Easton and Moodie [147] Moodie [22]; Cakravastia and Nakamura [23]; Olhager [148]; Stevenson et al. [5]; Stevenson and Hendry [39]; Hendry et al. [114]; Stevenson and Silva [149]; Zorzini et al. [26]; Hendry [105]
Design & engineering	Wortmann [30]; Lampel and Mintzberg [150]; Amaro et al. [56]; Spring and Dalrymple [151]; Rudberg and Wikner [32]; Hvam et al. [152]
Job Entry, Job Release and Dispatching	Hendry and Kingsman [33]; Bertrand and Muntslag [4]; Enns [47]; Oosterman et al. [48]; Kingsman [42]; Kingsman and Hendry [27]; McKay and Wiers [153]; Stevenson et al. [5]; Hendry et al. [114]; Stevenson and Silva [149]; Soepenberg et al. [154]; Boulaksil and Fransoo [155]; Olhager [156]
Non-PPC	Muda and Hendry [104]; Wikner and Rudberg [157]; Dekkers [158]
ERP and *MTO Research*	
Review and Assessment	Bertrand and Muntslag [4]; Wortmann [30]; Jonsson and Mattsson [103]; Stevenson et al. [5]; Koh and Simpson [112]; Olsen and Sætrea [60]; Olsen and Sætreb [94]; Deep et al. [6]; Hicks and McGovern [93]