



# The applicability and impact of Enterprise Resource Planning (ERP) systems: Results from a mixed method study on Make-To-Order (MTO) companies



Bulut Aslan <sup>a,\*</sup>, Mark Stevenson <sup>b</sup>, Linda C. Hendry <sup>b</sup>

<sup>a</sup> Istanbul Bilgi University, Department of Industrial Engineering, Kazim Karabekir Cad. No: 2, 34060 Eyup, Istanbul, Turkey

<sup>b</sup> Lancaster University, Department of Management Science, Lancaster University Management School, LA1 4YX, UK

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## ABSTRACT

The effect of a Make-To-Order (MTO) production strategy on the applicability and impact of Enterprise Resource Planning (ERP) systems is investigated through a mixed method approach comprised of an exploratory and explanatory survey followed by three case studies. Data on Make-To-Stock (MTS) companies is also collected as a basis for comparison. The exploratory data demonstrates, for example, that MTO adopters of ERP found the system selection process more difficult than MTS adopters. Meanwhile, a key reason why some MTO companies have not adopted ERP is that it is perceived as unsuitable. The explanatory data is used to test a series of hypotheses on the fit between decision support requirements, ERP functionality, and company performance. In general, a poor fit between the decision support requirements of MTO companies and ERP functionality is identified, although certain modules can lead to performance improvements – most notably for Customer Enquiry Management (CEM). MTS companies make more use of planning tools within ERP systems, and it is concluded that production strategy is an important contextual factor affecting both applicability and impact. Follow-up cases with two MTO adopters and one MTO non-adopter develop a deeper understanding of the survey results. For example, in one adoption case, a system was rented to minimise the consequences of making a poor selection decision. Future research could explore how more MTO-specific planning concepts can be embedded within ERP systems to improve alignment.

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## 1. Introduction

Many vendors of Enterprise Resource Planning (ERP) systems claim that their software is universal – configurable to the needs of any business. Yet the academic literature suggests that contextual factors, such as company size (e.g. [1–3]) and location or nationality (e.g. [4–6]), play important roles in the system selection and adoption process. The production strategy of a company is also likely to be influential [7]. For example, whether a company is a low-volume/high-variety Make-To-Order (MTO) producer or a high-volume/low-variety Make-To-Stock (MTS) producer may have a significant bearing on its internal decision making processes and, therefore, on any functionality it requires from an ERP system. Although the applicability of ERP systems to MTO companies has been questioned (e.g. [7–9]), the empirical research which investigates this is limited (e.g. [10]). Deep et al. [10] conducted

a case study on the ERP selection process by a MTO company and concluded that more research is required to assist firms in determining the applicability of ERP. In addition, the impact of ERP on MTO company performance has not been investigated. Hence, even for those companies that have adopted ERP, research is needed to identify the extent to which adoption has had a positive impact on performance. Most recently, Aslan et al. [7] presented a literature review on the applicability of ERP systems to MTO companies – this questioned the fit between ERP systems and MTO company requirements before the authors outlined a future research agenda, including gathering empirical evidence on the applicability and impact of ERP systems on MTO companies.

We take a contingency-based approach (e.g. [11,12]) to investigate the effect of a MTO production strategy on the applicability and impact of ERP systems through a mixed method study, consisting of an exploratory and explanatory survey followed by three case studies. Thus, we provide empirical evidence which responds to the research agenda outlined by Aslan et al. [7]. While our primary focus is on MTO companies, we also include MTS firms in our survey frame as a basis for

\* Corresponding author. Tel.: +90 2123117440.

E-mail address: [bulut.aslan@bilgi.edu.tr](mailto:bulut.aslan@bilgi.edu.tr) (B. Aslan).

comparison. Furthermore, we include both ERP adopters and non-adopters. Although non-adopters tell us very little about the impact of ERP, they are important for understanding applicability. Despite this, many previous studies have neglected non-adopters – for example, they represented only 16% of respondents in Olhager and Sellidin [4], while Stratman [13] focused exclusively on ERP adopters.

We take a detailed and systematic approach to assessing the applicability and impact of ERP systems by examining the fit between the decision support requirements of MTO companies and specific ERP modules and add-ons, e.g. for Supply Chain Management (SCM). In doing so, we also build on Bendoly and Jacobs' [45] study on the alignment of ERP solutions with operational needs. The authors showed that overall company performance/satisfaction becomes weaker if the operational strategy of a firm is misaligned with its ERP adoption strategy, but they did not identify which modules within ERP solutions show adequate fit with which operational needs. Moreover, the functionality of ERP systems has continued to evolve since Bendoly and Jacobs' [45] study meaning it is important to take an up-to-date view of the current fit between ERP functionality and company requirements.

In the next section of this paper – Section 2 – we seek to align decision support requirements with the functionality of ERP systems by using the literature to identify the key planning and control stages of relevance to MTO companies. For example, one planning and control stage is the Customer Enquiry Management (CEM) stage where a due date (or lead time) and price are quoted. This suggests certain decision support requirements, e.g. support for due date setting. We also use the literature to identify key ERP modules and add-ons that are potentially helpful. For example, decision making at the customer enquiry stage may be aided by product configurator or CEM software. Section 3 builds a theoretical framework based on three constructs – company decision support requirements, ERP functionality, and company performance – and uses these to develop a set of hypotheses. The research method is described in Section 4 before Section 5 presents the results of the survey, including the results of testing the hypotheses to assess the applicability of ERP system functionality to MTO companies and the impact of ERP systems on company performance. Three follow-up case studies are then presented in Section 6 to dig deeper into the survey findings. Two of the cases are MTO adopters of an ERP system, the other is a MTO non-adopter. Finally, conclusions are drawn in Section 7, where the limitations of the study are also acknowledged and future research directions suggested.

## 2. Literature review

Sections 2.1–2.5 do the following: (i) define the five key planning stages of relevance to MTO companies (see e.g. [7,9,14]), thereby identifying the key decision support requirements of MTO companies; and, (ii) link these requirements to the functionality of ERP systems and add-ons. This approach is in accordance with the concept of fit [11,15], which is conceptualised in the contingency theory literature (e.g. [12]). In addition, decision support requirements and ERP functionality for Customer Relationship Management (CRM) and Supply Chain Management (SCM) tasks are outlined in Section 2.6. Note that generic aspects like financial modules are ignored as we assume that production strategy would not affect whether a firm is able to use or benefit from such functionality. Finally, Section 2.7 provides an assessment of the literature and presents our core research question. For a more comprehensive review of the literature on MTO companies and ERP, see Aslan et al. [7].

### 2.1. MTO requirements and ERP functionality for Customer Enquiry Management

The CEM stage is where a customer provides an invitation-to-tender for a particular product to prospective suppliers, requiring the determination of a price and due date. This may involve the estimation of lead times, the archiving and retrieval of product data, the assessment of available design/production skills and facilities, the estimation of costs/profit margins, and require effective coordination and communication between departments (e.g. [16–19]). This is a key planning stage for MTO companies as orders can vary greatly from one to the next, hence standard or default lead times cannot be quoted [20].

According to the literature, there are potentially four aspects of ERP functionality that are relevant to the CEM stage. First, the CEM tools contained in many ERP systems have been used by MTO companies for entering orders and automating certain transactions [21]. In addition, Available-To-Promise (ATP) and Capable-To-Promise (CTP) functionality may be used. ATP determines the amount of 'uncommitted' finished goods inventory available, and CTP identifies slack capacity after available capacity has been matched to committed orders [22]. Finally, Product Lifecycle Management (PLM) software combines estimating and product development with a product database to enable a company to bring innovative products to market effectively [23]. PLM software has been shown to have promise for helping manufacturers of highly customised products [24], but there remains doubt about how effective it can be when enquiries/products are truly bespoke and lifecycles extremely short.

### 2.2. MTO requirements and ERP functionality at the design and engineering stage

This stage is where detailed design and engineering planning takes place. It is of particular relevance to Engineer-To-Order (ETO) companies – which we consider to be 'extreme cases' of a MTO strategy – yet little research has been conducted into this stage despite its impact on the total lead time (Land and Gaalman [14]). Wortmann [25] highlighted an ability to document aspects of product development throughout the order processing cycle as a key feature required from an ETO-compliant system. In addition, Rudberg and Wikner [26] indicated that forecasting and order fulfilment mechanisms are needed when designing and specifying products.

At this stage, both product configurator (or variant generator) and, again, PLM software may be relevant. PLM software was briefly discussed above, hence the following focuses on product configurator software. Product configurator software is described as combining well-defined building blocks governed by rules and constraints into a product [27]. Olsen and Sætre [28] conducted an action research project to identify an appropriate ERP system for a growing ETO company. A suitable system could not be found, with a key reason being the degree of product customisation offered by the company at the design and engineering stage. A vendor offered to provide product configurator software, but the company developed its own in-house solution. In Deep et al.'s [10] case study, product configurator software was similarly judged as ineffective for the firm's bespoke production activities.

### 2.3. MTO requirements and ERP functionality at the order entry stage

The order entry stage is where the production of a confirmed order is planned, including material requirements, purchasing and shop floor routing. Here, the ability to incorporate the effect of forecasts on actual plans is essential, given that many MTO companies deal with a mix of not only repeat but also one-off

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