Compensation-based incentives, ERP, and delivery performance: analysis from production and improvement perspectives

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Compensation-based incentives, ERP, and delivery performance in manufacturing: analysis from production and improvement perspectives

Abstract

Purpose – This research investigates the role of compensation-based incentives in relationships between Enterprise Resource Planning (ERP) usage and delivery performance in manufacturing.

Design/methodology/approach – We carry out two studies exploring links between ERP, incentives, and performance from alternative perspectives: (i) of incentives tied to regular production activities, and their relationship with delivery performance advantage over competitors, and (ii) of incentives tied to improvement activities, and their relationship with delivery performance improvements. Statistical analysis is carried out on data from 698 metal working manufacturers from 22 countries, giving a broad cross sectional view of a global industry.

Findings – The studies indicate that ERP usage relates positively with both delivery advantage and delivery improvements. Furthermore, incentives tied to improvement initiatives may explain delivery improvements both directly and as moderators in the relationship between ERP and performance.

Research implications – The results suggest that ERP adoption can be framed as a principal-agency phenomenon where performance outcomes are partially influenced by incentives.

Practical implications – The results imply that incentives tied to improvement initiatives may foster employee engagement with the new ERP, leading to stronger delivery performance benefits.

Originality/value – To the best of our knowledge, this is the first research to explore ERP usage as a principal-agency problem, and to analyse its relationships with incentives under alternative performance perspectives. The results may significantly contribute to the knowledge of ERP-performance relationships and the role of incentives.

Keywords – Enterprise Resource Planning; human resources management; process improvement; compensation-based incentives; delivery performance; empirical.

Classification – Research paper

1. Introduction

Enterprise Resource Planning (ERP) systems have become a way of life in organizations whether in manufacturing or services, for-profit or not-for-profit, small or large. This phenomenon has spawned much research into ERP implementation and operation. Yet, there seems to be limited knowledge regarding the organizational aspects of ERP implementation and operations performance. Although the role of compensation-based incentives has been widely explored in studies of implementation of initiatives including information technology (IT) (Bhattacherjee, 1996; Ba et al., 2001; Malhotra et al., 2001; Fullerton and McWatters, 2002; Pliskin and Ben-Zion, 2005; Mele and Colurcio, 2006; Sumukadas, 2006), to the best of our knowledge no empirical research has explored the influence of compensation-based incentives on ERP outcomes in particular.

Most of managerial ERP research appears to focus on factors enabling implementation success (e.g. Al-Mashari et al., 2003; Finney and Corbett, 2007; Masini and Van Wassenhove, 2009) and benefits (e.g. Olhager and Selldin, 2003; Gattiker and Goodhue, 2005). To date, analyses of incentives and ERP effectiveness appear to be limited to theoretical or qualitative studies (McKinley, 2000; Lim et al., 2005; Nah and Delgado, 2006). Given the importance of both ERPs and compensation-based incentives in business research and practice, empirically testing performance relationships with these two constructs seems overdue.

This study investigates relationships between Enterprise Resource Planning (ERP), compensation-based incentives, and delivery performance in 698 manufacturers from 22 countries. It follows on the work of Bhattacherjee (1996) and Ba et al. (2001), among others, who addressed the role of incentives in other types of IT. We use an innovative approach by exploring relationships along two different perspectives, namely (i) of incentives tied to regular production activities, and the associated performance advantage over competitors and (ii) of incentives tied to improvement activities, and the corresponding performance improvements over a three-year period. Using such alternative approaches may help to further qualify the role of ERP usage and compensation-based incentives in subsequent operations performance.

This study makes two main contributions to research and practical implementation of ERP in the operations management context. This appears to be the first research to frame ERP usage as a principal-agency problem, following on work of Bhattacherjee (1996) who developed an IT-agency model. Furthermore, this research explores incentive-delivery performance relationships from two perspectives, namely of associations between incentives for regular production activity and competitive advantage over competitors, and of associations between incentives for improvement activities and performance change.

The results suggest that ERP usage can explain both delivery performance advantage and delivery performance improvements, and that improvement incentives can explain delivery performance improvements. Furthermore, under certain circumstances improvement incentives may positively moderate the relationship between ERP usage and delivery improvements. Organizations embarking on an ERP implementation would be wise to incorporate performance incentives, so that users might have increased motivation to effectively engage with the new ERP system, thus contributing to its success.

2. Background

2.1. Enterprise Resource Planning

Enterprise Resource Planning (ERP) systems are computer software packages that help organizations to manage many of their business processes on a single platform (Mabert et al., 2003). Full-fledged ERPs started appearing primarily in the early 1990s, having evolved from independent systems (Jacobs and Weston, 2007; Christou and Ponis, 2008). The core functionality of ERPs can be attributed to traditional manufacturing-related systems such as Materials Requirement Planning (MRP) (McGaughey and Gunasekaran, 2007; Chang et al., 2008). The intent of a single integrated system is to reduce direct administrative costs, e.g. re-entering and reconciling data from separate systems, and to improve communication between functional areas (Davenport, 1998). The ERP market is considerable in size: a study by Jacobson et al. (2007) forecasted ERP sales at $47.7 billion in 2011 (Wu and Cao, 2009).

Firms may adopt ERPs in different module configurations (Davenport, 1998; Francalanci, 2001; Chung and Skibniewski, 2007; Chang et al., 2008; Hallikainen et al., 2009). As Ranganathan and Brown (2006) indicate, Brown and Vessey (1999) classify ERP modules into two categories: *value-chain* and *support*. The first category is devoted to direct production functions including "materials management, production and operations, sales and distribution." (p. 413). The second category includes business applications in support areas, i.e., "human resources (HR) and or financial/accounting modules." (p. 413).

Benefits of ERP implementation can be extensive (see, for example, Shang and Seddon, 2000). More specifically, operational improvements such as cycle time reduction and improved delivery performance have been indicated (McAfee, 2002; Bendoly and Cotteleer, 2008). Chang (2006), who surveyed 219 companies and conducted interviews with 49 senior managers, found that all managers believed that IT integration was of primary importance for their organization, while Bendoly et al. (2008) found that such views were more common in firms having greater need for organizational integration. Chang's (2006) study found that managers rated on-time delivery the highest among the many potential benefits of ERP, and asserted that ERP "is now generally recognized as an important source of competitive advantage" (p. 286). However, because of the broad reach of ERP implementations, achieving such benefits may often depend on effectively matching the ERP configuration to the firm strategy (Davenport, 1998; Nah and Delgado, 2006; Chou and Chang, 2008; Masini and Van Wassenhove, 2009). Davenport (1998), in particular, cautioned about ERP, stating that their potential high reward comes with equivalently high risk while describing various failed ERP projects at major corporations. He further indicated that ERP failure is typically not a technical issue, but one of reconciling the ERP with the business needs of the organization (p. 122-123).

2.2. Compensation-based incentives

The use of compensation-based incentives is a well-known research issue, although it is less prominent in operations management (OM) than in organizational behaviour and economics. Jensen and Meckling (1976) and Cadsby et al. (2007), among others, define compensation-based incentives as variable money paid by principals to agents based on their actions or performance. Locke (1968), Klein (1973), and Ross (1973) published seminal studies on incentives; however, it was mainly in the 1980s and 1990s that using incentives to influence organizational behaviour started being viewed as a major business phenomenon (Zenger and Marshall, 1995; Bucklin and Dickinson, 2001).

As documented elsewhere (e.g. Bloom and Milkovich, 1998; Prendergast, 1999), relationships between incentives and effort have been significantly explored in studies of agency and related economic-behavioural theories (e.g. Bonner and Sprinkle, 2002; Gibbons, 2005). Honeywell-Johnson and Dickinson (1999), Prendergast (1999) and Bucklin and Dickinson (2001) provided extensive reviews of the incentives literature, yet Prendergast (1999) identified a lack of empirical studies on incentives, a problem we believe is still standing.

Incentives are offered by principals to align the objectives of agents to their own objectives (Jensen and Meckling, 1976; Prendergast, 1999; Gibbons, 2005). Without having a risk component of income, agents might exert inadequate effort or pursue objectives that were different from those of principals (Prendergast, 1999; Knight et al., 2001; Bénabou and Tirole, 2003; Cadsby et al., 2007). As indicated in Klein (1973), Mitchell and Mickel (1999), and Bassett-Jones and Lloyd (2005) among others, similar arguments are proposed in reinforcement and expectancy theories of organizational behaviour.

The OM literature on incentives addresses two alternative objectives with incentives adoption. Some authors view incentives as direct predictors of performance; however, most of them, e.g. Jarimo and Kulmala (2008) and Lu et al. (2009), appear to rely more on mathematical modeling than on empirical evidence. With a model akin to ours, Malhotra et al. (2001) found that "equity of incentives" moderated relationships between the "sophistication" of a CAD technology, and product design flexibility and quality in manufacturing.

Other authors have focused on incentives as leverage for technology or program usage in operations, with differing results. For example, whereas Chen et al. (1996) found no significant relationship between pay incentives and employee involvement with flexible manufacturing systems, Fullerton and McWatters (2002) found a significant association between compensation-based incentives and just-in-time (JIT) adoption. However, research has also shown that evidence of incentives support to a program such as JIT should not be generalized to include IT implementation. Whereas JIT may aim to simplify operations processes (Collins and Schmenner, 1993), IT systems including ERP may have (or may be perceived as having) the opposite effect (Rettig, 2007). In fact, people's aversion to new IT leading to reduced performance benefits is a well-documented phenomenon in management information systems (MIS) (Davis, 1989). Davis et al. (1989) and Davis (1989) found that user' perception about a system's difficulty and lack of utility could lead to underutilization of the new IT. A few studies have explored the role of incentives in IT usage, namely the use of software by experimental subjects (Bhattacherjee, 1996) and of decision support systems, e-business, and knowledge systems from a conceptual perspective (Ba et al., 2001). Overall, the limited literature indicates that there is still need for research to explore the role of incentives in ERP implementation.

3. Hypotheses

This research explores delivery performance relationships with compensation-based incentives and ERP usage. We focus on delivery performance because this appears to be the dimension most often associated with ERP benefits (e.g. McAfee, 2002; Koh and Simpson, 2005; Bendoly and Cotteleer, 2008). As in Malhotra et al. (2001) and Gibbons (2005), incentives are modeled as moderators of technology-performance relationships.

Moreover, the analysis-improvement rationale in operations strategy frameworks (e.g. Platts and Gregory, 1990; Slack, 1994) suggests operations performance may be considered from two different perspectives. The first concerns competitive gaps between a firm's operations and those of their major competitors. The second considers performance improvements over a period of time. Therefore, our first model considers incentives relating to regular production activities, and their association with delivery performance in relation to an organization's main competitors. Our second model considers incentives relating to process improvement initiatives, and their association with delivery performance improvements over a three-year period. These two perspectives lead to six different hypotheses. Hypotheses 1 and 2 relate ERP usage to delivery performance. Hypotheses 3 and 4 relate compensation-based incentives to delivery performance. Finally, hypotheses 5 and 6 address the moderating role of compensation-based incentives in relationships between ERP and delivery performance.

3.1. ERP usage and delivery performance

The literature suggests that ERP usage should positively influence delivery performance. According to Kennerley and Neely (2001), ERP systems increase the availability of data such as production planning and inventory levels, helping producers to reduce delivery times and promise feasible delivery estimates. Koh and Simpson's (2005) study of 64 British manufacturing SMEs suggested that delivery performance improved with ERP usage as it enabled the organization to be more responsive and agile. Mabert et al. (2000) similarly found improvements in on-time deliveries with ERP usage by US manufacturers; this was further confirmed by Olhager and Selldin's (2003) replication study in Sweden. Davenport (1998) also reported that a company increased their ability to respond to changes in customer orders with the ERP. Bendoly and Jacobs (2004) suggested that ERP centralization was positively associated with order processing performance, whereas ERP decentralization (i.e., employing specialized systems used to manage orders) had negative impacts. More recently, Bendoly and Cotteleer (2008) presented two case studies of companies that reduced order lead-times significantly after the ERP implementation. This literature leads to the following hypotheses:

Hypothesis 1. ERP usage relates positively with delivery performance advantage in manufacturing.

Hypothesis 2. ERP usage relates positively with delivery performance improvements in manufacturing.

3.2. Incentives and delivery performance

Several studies found positive relationships between compensation-based incentives and operations performance, even though they mostly focused on productivity and quality rather than on delivery benefits. Reviews can be found in Jenkins et al.'s (1998) meta-analysis and in Bucklin and Dickinson's (2001) literature survey. For example, London and Oldham (1977) carried out experiments indicating that both individual and (well-designed) group incentive plans could explain productivity performance, while Snape et al. (1996) and Maiga and Jacobs (2005) found a significant relationship between incentives and quality performance in manufacturing.

Whereas many studies have explored incentive relationships with either productivity or quality (e.g. Honeywell-Johnson and Dickinson, 1999; Prendergast, 1999; Bucklin and Dickinson, 2001), only a few have focused on delivery performance. Managers interviewed in Snape et al.'s (1996) study of British Steel suggested that a new bonus system led to "... an improvement in on-time deliveries from under '80 per cent to over 90 per cent' following its introduction." (p.13). The positive relationship with delivery can be explained by Zenger and Marshall's (1995) suggestion that incentives might be more effective when tied to performance measures that are "easily discerned" (p. 161), as we consider to be the case with delivery metrics.

As discussed earlier, the link between incentives and performance is often explained by principal-agency theory: as the objectives of agents and principals become misaligned, mechanisms are needed to persuade agents to focus on principals' targets (Jensen and Meckling, 1976; Prendergast, 1999; Knight et al., 2001; Bénabou and Tirole, 2003; Cadsby et al., 2007). Limiting compensation to "constant wages" that are independent of worker's output (Gibbons, 2005) might encourage agents to minimize effort or risk (Bloom and Milkovich, 1998; Bonner and Sprinkle, 2002) or to pursue their own interests (Irlenbusch, 2006). This discussion leads to the following hypotheses:

Hypothesis 3. Compensation-based incentives tied to regular production activities relate positively with delivery performance advantage in manufacturing.

Hypothesis 4. Compensation-based incentives tied to improvement activities relate positively with delivery performance improvements in manufacturing.

Cadsby et al. (2007) hinted at a caveat to the above for highly risk-averse individuals, that their performance (in the particular case, productivity) might in fact drop with incentives. Thus, for H3 and H4 to be accepted, employees from the sample units should, overall, be not excessively averse to risk.

3.3. Moderating role of incentives

Compensation-based incentives have been presented not only as direct drivers of performance, but also as stimuli for labour to positively engage with new technology and organizational improvements (Bhattacherjee, 1996; Mele and Colurcio, 2006; Sumukadas, 2006). For example, Fullerton and McWatters's (2002) survey of US manufacturers indicated that adoption of JIT programs related significantly to the use of compensation systems based on quality and teamwork. In the case of IT, Pliskin and Ben-Zion (2005) pointed out to the importance of "Link[ing] system usage to employee compensation, building incentive plans to motivate employees to use the CRM [Customer Relationship Management] system." (p. 72). Ba et al. (2001) suggested incentives might affect IT performance especially in complex systems that offered more latitude to users' input, required multi-party collaboration, had information that was difficult to corroborate, and were subject to individual preferences. On the other hand, Sumukadas (2006) reported a non-significant relationship between "improvement incentives" and the adoption of "low power sharing practices" such as employee suggestions, although he did find a direct effect of incentives on quality.

Reinforcement theory explains that the link between incentives and program effectiveness is due to the agent's belief that positive behaviour leads to positive outcomes (Brief and Hollenbeck, 1985; Knight et al., 2001). Gibbons's (2005) review of incentive models indicated that performance depended at least partially on an agent's effort, and that principals used variable compensation to influence that effort. In particular, the promise of financial incentives should motivate employees to engage more with a new program or task (Neuscheler-Fritsch and Norris, 2001; Brüggen and Moers, 2007). While Davis et al. (1989) suggested that IT acceptance increased with systems that were more user-friendly and more easily perceived as being effective (Bhattacherjee, 1996; Ba et al., 2001), one should ask whether a third factor, namely the use of compensation-based incentives, might also support user engagement, and subsequent performance with the new ERP.

Thus, our study follows on the work of Bhattacherjee (1996) and Ba et al. (2001) who investigated the role of incentives to support adoption of new IT, and of studies that stressed the influence of human resource factors in ERP success, e.g. Bendoly and Cotteleer (2008), Snider et al. (2009), and von der Weth and Starker (2010). For example, Bhattacherjee (1996) found a significant relationship between incentives and the "behavioural intention" of study subjects to use software, while Bendoly and Cotteleer (2008) suggested that human factors could explain the reduced benefits in order lead time that occurred a few months after ERP implementation in a manufacturing company. More generally, several studies (e.g. Stratman and Roth, 2002; Nah and Delgado, 2006; Snider et al., 2009) that explored the "critical success factors" of ERP performance indicated that benefits from the new technology depended significantly on user traits and attitudes such as compliance to standards, process discipline and ownership, involvement with the ERP design and implementation, and training and education. These arguments lead to the final two hypotheses:

Hypothesis 5. Compensation-based incentives tied to regular activities positively moderate relationships between ERP usage and delivery performance advantage in manufacturing.

Hypothesis 6. Compensation-based incentives tied to improvement activities positively moderate relationships between ERP usage and delivery performance improvements in manufacturing.

It is important to note that Malhotra et al. (2001) found empirical support to an equivalent hypothesis that "equity of incentives" moderated relationships between CAD technologies and product design performance. Compared to our research, their variable measured 'equity' rather than 'intensity' of incentives, and appeared to include both fixed and variable components of remuneration.

4. Data

This research used data from the fourth edition of the International Manufacturing Strategy Survey (IMSS-IV). Even though one of the researchers contributed to survey development and data collection in one country, employment of such a broad international dataset may be considered use of secondary data. Besides providing access to a large representative sample (Houston, 2004), the use of externally available datasets such as IMSS may increase the research reliability by eliminating bias in fieldwork design (Calantone and Vickery, 2009) and enabling replication (Harris, 2001). The following information about IMSS appeared in Voss and Blackmon (1998), Cagliano et al. (2006) and da Silveira and Sousa (2010), among other studies.

IMSS is a general periodic survey of manufacturing strategies, practices, and performance that has been carried out by operations strategy scholars worldwide since 1992. IMSS-IV data were collected between January 2005 and February 2006 in 23 countries. Observations from one of these countries were not used in this research due to a very low response rate. The analysis includes data from 698 manufacturers from Argentina (44), Australia (14), Belgium (32), Brazil (16), Canada (25), China (38), Denmark (36), Estonia (21), Germany (18), Hungary (54), Ireland (15), Israel (20), Italy (45), New Zealand (30), Norway (17), Portugal (10), Sweden (82), The Netherlands (63), Turkey (35), United Kingdom (17), USA (36), and Venezuela (30) (case numbers from each country are in parentheses).

The survey focused on ISIC 3.1 codes 28 to 35 (manufacturers of metal products, machinery, and instruments). Based on the historical link of ERP to manufacturing (McGaughey and Gunasekaran, 2007; Chang et al., 2008), the use of a manufacturing sample may increase research validity due to the existence of “mature” ERP implementations beyond the initial stages of “introduction” and “experimentation” (Sousa and Voss, 2008). The analysis focused on the business unit, which might be a single company, division, or plant. Companies were initially contacted by phone after search in national business databases. Across the 22 countries, 4587 companies were initially contacted. Questionnaires were sent out by post, fax, or email to the Director of Operations, Manufacturing or equivalent in 3051 of these companies. Researchers received 698 valid responses, which is equivalent to 15.2% of the initial contacts. Non-response bias was tested in 12 countries, with no significant differences between respondents and non-respondents on demographics such as company size and ISIC.

Initial inspection of data found no evidence of outliers. However, we found that responses from one of the 22 countries (Hungary) consistently omitted values given to one of the nine ERP items (*ERP5)* available in the survey questionnaire. Following Tsikriktsis (2005), we replaced those missing values by the means (rounded to the nearest integer) of valid values given to the other eight ERP items in each case.

Some of the same IMSS-IV data used in this analysis were used in previous studies, all of which had different research objectives. Batley et al. (2006) provided descriptive statistics for New Zealand respondents only. Vecchi and Brennan (2009) used a nine-item ERP scale to measure innovativeness in different countries. Alas et al. (2009) compared country use across eight ERP items, while Hong et al. (2010) tested the relationship between a five-item ERP scale and mass customization. The delivery improvements scale was validated by da Silveira and Sousa (2010), and also used in da Silveira (2011). Dukovska-Popovska and Boer (2008) and Wang et al. (2008) employed individual items of delivery performance in group-comparison analyses. Demeter and Matyusz (2008) used slightly different scales of delivery performance in a study of large versus small companies. Cagliano et al.'s (2011) study of culture and new organizational systems used a "group incentives" scale incorporating two of the six incentive indicators used in our study.

5. Measures

We built formative scales of incentives and ERP adoption, and reflective scales of delivery performance. The decision to use formative and reflective scales followed theoretical relationships between observed and latent variables (Bollen and Lennox, 1991; Diamantopoulos and Winklhofer, 2001). The items of ERP and incentives were viewed as causes of their latent variables, as they represented different theoretical aspects of the construct and their distributions were not necessarily correlated. For example, companies might use one ERP module such as “marketing and sales” with or without another module such as “inventory and transportation” (Hallikainen et al., 2009), and offer one type of incentives, such as for individuals with or without offering another type such as companywide incentives. Conversely, the items measuring delivery performance were viewed as effects of the latent factor. In other words, improvements in delivery performance (caused by exogenous factors such as better technology or practices) would likely affect multiple delivery metrics.

The IMSS-IV is a large survey from which only a small fraction of variables were used for this study. Questions regarding exogenous (ERP and incentives) and endogenous (delivery performance) variables had great separation in the questionnaire and appeared in reverse order (respectively on pages 8 and 5 of the instrument), which reduces the potential for common method bias (Podsakoff et al., 2003). The procedures for development of the measures are explained next.

5.1. ERP

We built a formative ERP scale assessing the extent of usage of Enterprise Resource Planning in five areas with direct relationship to delivery improvements. A scale including these five items with IMSS-IV data has been recently validated by Hong et al. (2010) for a different study. Respondents were asked, “To what extent are the following management areas supported through the use of Enterprise Resource Planning systems?” The five response items were ERP use in “material management” (*ERP1*), “production planning and control” (*ERP2*), “purchasing and supply management” (*ERP3*), “sales management” (*ERP4*), and “distribution management” (*ERP5*). Responses were given in a 5-point scale with the endpoints “no use” (1) and “high use” (5). Cagliano et al. (2006) using past IMSS-III data validated a scale composed of three of those items, namely "production planning and control, supply management and materials management" (p. 288).

The previous studies built reflective ERP scales with indicators being explained by the latent variable. However, the ERP modularity rationale in Davenport (1998), Francalanci (2001), and Hallikainen et al. (2009) among others suggests that different ERP implementations may include different levels of adoption of each ERP module. This rationale justifies validation using the formative approach in Diamantopoulos and Winklhofer (2001).

From a conceptual perspective, the five items in Hong et al. (2010) covered all aspects of ERP for "value-chain activities" in Brown and Vessey (1999), which may have a direct impact on delivery performance. Following the rationale in Diamantopoulos and Winklhofer (2001), regression of the summated scale on the five items suggested no significant multicollinearity, as the highest VIF was 3.642 (*ERP3*) and the highest CI was 19.215. Further validation was carried out by a MIMIC model including the five formative indicators, the latent scale, and two reflective indicators, similar to the model in Diamantopoulos and Winklhofer's (2001) Figure 2 (p. 272). The reflective indicators assessed on a five-point scale the degree of use of "Information and Communication Technologies and/or Enterprise Resource Planning software" and of "Engineering databases, Product Data Management Systems" [that Watts et al., (2008) found to be associated with ERP adopters]. The *ERP3* item ("Purchasing and supply management") was dropped because of its low standardized regression loading (λ) and because of connections to other items, particularly *ERP1* ("Material management"). The model with four formative indicators had good fit (χ^2/df = 1.011; NFI = .998; TLI = 1.000; CFI = 1.000; RMSEA = .004; RMSEA 90% CI = .000-.064) and all λ were significant or near significant ($p < .10$). The *ERP* scale was given by average responses to *ERP1*, *ERP2*, *ERP4*, and *ERP5*.

5.2. Incentives

Regular (*RI*) and improvement (*II*) incentives were built as formative scales incorporating the three common components of an incentive system, namely individual, team, and companywide incentives (Honeywell-Johnson and Dickinson, 1999; Bucklin and Dickinson, 2001). For example, Kuhn and Yockey (2003) carried out experiments assessing differences in preference for incentives linked to "individual", "team", and "organizational" performance. *RI* was measured by the extent that companies used compensation-based incentives for regular production activities. The items included "individual incentive" (*RI1*), "work group incentive" (*RI2*), and "companywide incentive" (*RI3*). Respondents were asked to, "Indicate the usage of incentives (select all relevant alternatives) – for production activities (based on production performance)". *II* was measured by the extent that companies used compensation-based incentives for improvement activities in the same three spheres (coded *II1*, *II2*, and *II3*). Respondents were asked to, "Indicate the usage of incentives (select all relevant alternatives) – for improvement activities (based on participation on results)". Responses were given in 5-point scales with the endpoints "never" (1) and "very frequently" (5).

Table 1 provides descriptive statistics and correlations between the six incentive indicators. It also includes correlations between incentives and five structural indicators to shed light on contexts where incentives were most likely to be adopted. The structural indicators are the share of output from mass production processes (rather than from one-of-a-kind or batch processes), the share of output made to stock (MTS – as opposed to designed, manufactured, or assembled to order), the share of volume produced in dedicated lines (as opposed to job shop or cells), the share of sales to end users (rather than to integrators, manufacturers, or distributors), and the share of sales to customers outside the continent. The estimates suggest that both regular and improvement incentives had relatively low levels of adoption across the sample, except for regular incentives at company level (μ = 2.41) and improvement incentives at the individual level (μ = 2.33). Nevertheless, there were positive and significant correlations between all six incentives indicators. Correlations with structural indicators were more variegated. Most regular incentives correlated positively with MTS production, use of dedicated lines, and sales to outside the continent. Most improvement incentives correlated positively with mass production and use of dedicated lines. Correlations with the first three structural indicators suggest a greater use of incentives in cases of high volume as opposed to high variety production, perhaps to counterbalance the labour alienation commonly found in Fordism (Grieves, 2000). The analysis above complements that in Cagliano et al. (2011), which identified correlations between "group incentives" only (a composite scale of *RI2*, *II2*) and organizational and cultural variables using most of the same data used in this study.

[Table 1 about here]

Validation of the two formative scales followed the rationale in Diamantopoulos and Winklhofer (2001). Multicollinearity was assessed by regression of each summated scale on its respective indicators. All VIFs were below two, and the maximum CIs were below seven, suggesting no significant multicollinearity. Validation was given by correlations between indicators and a variable having straight theoretical relationship with the latent measure. Because the dataset provided a single objective measure of overall incentives, validation was based on bivariate correlations rather than a MIMIC model. Respondents were asked, "On average, what proportion of your direct employees' compensation is based on incentives? ___% of compensation". This measure correlated positively and significantly ($p < .001$) with all six formative indicators. Thus, the scales were given by the average responses to each of their three corresponding indicators.

5.3. Delivery performance

The delivery advantage (*DA*) scale measured average perceived performance in relation to main competitors in four areas: delivery speed (*DA1*), delivery dependability (*DA2*), manufacturing lead time (*DA3*), and procurement lead time (*DA4*). Respondents were asked, “How does your current performance compare with main competitor(s)? Consider the average performance of the group of competitors that are the direct benchmark for the plant (Relative to our main competitor(s), our performance is [1] much worse, [2], [3] equal, [4], [5] much better)”. Cronbach’s alpha for the scale was .778.

The delivery improvements (*DI*) scale measured average perceptual improvements in those same areas over three years, with items coded *DI1* to *DI4*. Respondents were asked, “How has your operational performance changed over the last three years? (Compared to three years ago the indicator has [1] deteriorated more than 10%, [2] stayed about the same, [3] improved 10%-30%, [4] improved 30%-50%, [5] improved more than 50%)”. The *DI* scale has been validated with IMSS-IV data by da Silveira and Sousa (2010), and was also used by da Silveira (2011). Its Cronbach’s alpha was .811. As noted in the two previous studies, the four delivery items have close correspondence to the five-item scale in Ward et al. (1998), and correspond directly to the four process-based “time-based performance” variables in Jayaram et al. (1999), namely “delivery speed”, “delivery reliability/dependability”, “manufacturing lead time”, and to a lesser extent “customer responsiveness”.

5.4. Control variables

The studies controlled for two factors that might explain variance in predictor and outcome variables: company size and use of organizational programmes in manufacturing. Company size might explain both technology adoption and performance. Larger companies may find it easier to gather resources and knowledge for implementation (Yeung et al., 2006), and to achieve performance improvements (Zenger and Marshall, 1995). For example, Ifinedo and Nahar (2009) found a significant relationship between firm size (measured by employees and revenue) and success with ERP implementation. On the other hand, Stratman (2007) found no evidence that size explained ERP performance benefits. Consistent with the review in Sousa and Voss (2008), we measured size by the number of employees in the company. Following Yeung et al. (2006), *SIZE* (μ = 601.71, σ = 1619.35, n_{valid} = 693) was ln-transformed to improve normality.

The second control variable was a composite scale assessing the use of organizational programmes in manufacturing. These programs, i.e., labour empowerment, lean organization, continuous improvements, and labour flexibility have been associated with incentives (e.g. Walsh et al., 2002; Daniel et al., 2009), ERP implementation (e.g. Nah and Delgado, 2006; Finney and Corbett, 2007; Snider et al., 2009), and delivery performance improvements (e.g. Lockamy, 1994; Wu, 2003). We measured organizational programs (*ORGPRO*) by a reflective scale averaging answers to four items in the IMSS-IV questionnaire. Respondents were asked to, "Indicate degree of the following action programs undertaken over the last three years:" "delegation and knowledge of your workforce"; "Lean Organisation Model"; "Continuous Improvement Programs"; "workforce flexibility".

Responses were given in a five-point Likert scale for "Degree of use – last 3 years" with the endpoints 1 (None) and 5 (High). Yang et al. (2011) recently used responses on the first two items to build a reflective scale of "employee involvement". We similarly validated the four-item scale from a reflective perspective because many aspects such as teamwork, autonomy, and skills development characterized more than one program, turning the items potentially "interchangeable" (Diamantopoulos and Winklhofer, 2001: 271). The Cronbach's alpha was .727; exploratory factor analysis (EFA) of the four items generated a single factor with eigenvalue greater than one, and accounting for most (55.13%) of the components variation. Individual factor loadings ranged from .687 to .771. *ORGPRO* (μ = 2.89, σ = .80, n_{valid} = 660) was given by average responses to the four items.

6. Study 1: Delivery Performance Advantage

Similar procedures were used in the two studies. We first built the measurement model in IBM® SPSS® Amos 19.0.0 (Arbuckle, 2010) to assess psychometric attributes of predictor and outcome variables. Then, we tested hypotheses using hierarchical regression analyses in IBM® SPSS® Statistics 19.0.0 (SPSS, 2010).

6.1. Measurement model

The first measurement model included two formative scales (*ERP*, *RI*), and one reflective scale (*DA*). The two formative scales were entered as latent variables with paths leading to their single observed variable, and the variance of error terms set to zero (Brown, 2006: 139). The initial model had poor fit ($\chi 2$/d.f. = 7.118; NFI = .910; TLI =.790; CFI =.920; RMSEA =.094; RMSEA 90% CI =.072-.117). One *DA* indicator (*DA4* – "procurement lead time") had a low λ (.548) and was dropped. The refined model had good fit estimates ($\chi 2$/d.f. = 1.588; NFI = .986; TLI =.980; CFI =.995; RMSEA =.029; RMSEA 90% CI =.000-.069) (Bagozzi and Yi, 1988; Hair et al., 2010). All λ were close to or above .6 (Bagozzi and Yi, 1988) (Table 2). Average variance extraction (AVE) of the *DA* scale was .54, and its square root was larger than pairwise correlations with the other scales, suggesting convergent and discriminant validity (Fornell and Larcker, 1981; Bagozzi and Yi, 1988). The composite reliability (CR) was .77, exceeding the .7 recommendation (Kandemir et al., 2006).

[Table 2 about here]

We assessed the chances of common method bias (CMB) in the model through two versions of the Harman's one-factor test (Podsakoff et al., 2003). Note that as indicated by Siemsem et al. (2010) CMB might inflate direct relationships but not the moderated relationships addressed in hypotheses H5 and H6: "Similar to our previous discussion, CMV [common method variance] cannot create an artificial interaction effect" (p. 469). We carried out the first test through exploratory factor analysis (EFA) of the five observed variables in IBM® SPSS® Statistics 19.0.0 (SPSS, 2010) and identified two factors with eigenvector greater than one. The first factor included the two independent scales (*ERP*, *RI*) and the second factor included the three delivery items (*DA1*, *DA2*, *DA3*). This result suggests that respondents treated dependent items separately from independent items. This could be attributed to the great distance (three pages) and inverse order of dependent and independent scales in the survey (discussed earlier), which appear to have significantly reduced the chances of contamination between their values. Fit estimates from CFA of a model with a single latent scale were worse than with the original model ($\chi 2$/d.f. = 4.263; NFI = .953; TLI = .888; CFI = .963; RMSEA = .068; RMSEA CI = .040-.100), and standardized regression weights of *ERP* (λ = 177) and *RI* (λ = .056) were very low. Both the EFA and CFA one-factor tests suggested no significant risk of CMB.

6.2. Hypothesis tests

The first study model is presented in Figure 1. Study 1 hypotheses (H1, H3, H5) were tested with hierarchical regression of delivery performance advantage on ERP usage, regular production incentives, their interaction, and the two control variables. The model was specified as

where b_j was the unstandardized regression coefficient of predictor j.

[Figure 1 about here]

The hierarchical regression was carried out in four blocks following Cohen and Cohen (1983) and Aiken and West (1991). The first block included the control variables (LN(*SIZE*), *ORGPRO*). The following blocks added in succession the two direct predictors (*ERP*, *RI*) and their interaction term (*ERP* x *RI*). Cases with missing data were deleted listwise. Little's (1988) test on the five individual variables with the EM/Missing Value Analysis procedure in IBM® SPSS® Statistics 19.0.0 (SPSS, 2010) yielded a non-significant χ^2 (p = .268), so data could be considered to be missing completely at random (MCAR).

Following Jaccard et al. (1990), the values of *ERP* and *RI* were mean-centered before calculating the interaction term. Thus, multicollinearity was not problematic (VIF_{max} = 1.222; CI_{max} = 12.453). Also, the histogram and normal p-p plot of standardized residuals suggested an approximately normal distribution.

The results (Table 3) support H1, but not H3 or H5. The *ERP* coefficient was positive and significant ($p < .05$), suggesting that companies with greater ERP usage had greater advantage in delivery performance. On the other hand, delivery performance had non-significant relationships with production incentives and their interaction with ERP. Regarding control variables, the *ORGPRO* coefficient was significant ($p < .001$) indicating that companies that had greater implementation of organizational programs such as lean, continuous improvements, and labour flexibility outperformed competitors in delivery.

[Table 3 about here]

7. Study 2: Delivery Performance Improvements

7.1. Measurement model

The second measurement model included the *ERP* and *II* predictors, and the three *DI* performance indicators (Table 4). The initial model had poor fit ($\chi 2$/d.f. = 12.652; NFI = .900; TLI = .753; CFI = .906; RMSEA = .129; RMSEA CI = .107-.152), even though all *DI* items had λ > .6. To improve model fit and to achieve symmetry with the previous study, the *DI* item relating to “procurement lead time” (*DI4*) was dropped from the scale (this item had the lowest λ at .637). The resulting model had satisfactory fit ($\chi 2$/d.f. = .985; NFI = .994; TLI = .1.000; CFI = .1.000; RMSEA = .000; RMSEA CI = .000-.057) (Bagozzi and Yi, 1988; Hair et al., 2010), and the three reflective indicators had λ close to or above the .6 requirement (Bagozzi and Yi, 1988). AVE of the *DI* scale was .57, and correlations with the formative scales were low, indicating acceptable convergent and discriminant validity (Fornell and Larcker, 1981; Bagozzi and Yi, 1988). The scale CR was .79, which is above the reliability threshold (Kandemir et al., 2006).

[Table 4 about here]

As in study 1, Harman’s one-factor tests (Podsakoff et al., 2003) suggested no significant CMB. EFA with the two reflective scales and the three *DI* items yielded two factors with eigenvalues greater than one; the first factor accounted for just 44.15% of the total variance. Just like in study 1, *ERP* and *II* loaded separately from the three *DI* items, suggesting clear separation between independent and dependent variables in the survey. Fit of a one-factor model ($\chi 2$/d.f. =

3.295; NFI = .975; TLI = .947; CFI = .982; RMSEA = .057; RMSEA CI = .028-.089) was worse than with the full model, and the two formative indicators had low λ (λ_{ERP} = .160; λ_{II} = .213).

7.2. Hypothesis tests

Figure 2 presents the second study model. Hypotheses H2, H4, and H6 were tested with a hierarchical model specified as

[Figure 2 about here]

Variables were entered in blocks just as in study 1 (Cohen and Cohen, 1983; Aiken and West, 1991). Little's (1988) test χ^2 was non-significant (p = .224), so we proceeded with listwise deletion of cases with missing data. Predictors associated with coefficients b_9, b_{10}, and b_{11} were mean centered following Jaccard et al. (1990). Multicollinearity indicators were low (VIF_{max} = 1.221; CI_{max} = 12.661). Histogram and p-p plot of residuals suggested a normal distribution.

Table 5 presents the results. Both the *ERP* and *II* coefficients were positive and significant (p < .01), supporting H2 and H4. They indicate that companies with higher ERP usage and improvement incentives had greater delivery improvements. The interaction term (*ERP* x *II*) was nearly significant (p = .068), providing some degree of support to H6 that improvement incentives moderated the ERP-delivery relationship. Regarding co-variants, company size was not significantly related to the dependent variable. However, as in study 1, organizational programs were strongly associated (p < .001) with delivery performance gains.

[Table 5 about here]

To illustrate the effect suggested by the interaction term coefficient, we built a plot of the association between *ERP* and *DI* at different levels of *II*. The plot (Figure 3) was built following recommendations in Aiken and West (1991) and Beaujean (2008). The regression was carried with all predictors (including in this case the two co-variants) centered by – where was variable ’s average response for all valid cases. Plots were created for values of *Y* (*DI*) on *X* (*ERP*) at three levels of *Z* (*II*). As Figure 3 shows, companies with higher improvement incentives (*Z*) reported higher marginal gains in delivery performance (*Y*) as ERP implementation (*X*) increased.

[Figure 3 about here]

8. Robustness tests

Whereas results regarding H1, H2, and H4 were supported by significant or highly significant coefficients, we were cautious with the near significant (p = .068) interaction term coefficient (H6) in study 2. Thus, we carried out robustness tests with two alternative specifications. In the first case we dropped all control variables to assess their influence on predictor and moderation coefficients. In the second case we entered the full (i.e., four-item) reflective scales of delivery advantage (*DA4*) and delivery improvements (*DI4*) in regressions that also included the two co-variants [recall that previous studies using this dataset (da Silveira and Sousa, 2010; da Silveira, 2011) employed the four-item scale of delivery improvements, and that the four-item scales had arguably better content validity than the three-item scales].

The test without co-variants supported H6. Whereas results regarding H1 (p < .01), H2 (p < .001), and H4 (p < .001) were similar as before, the moderation coefficient in study 2 changed from near significant (p < .10) to significant (p < .05) after dropping the co-variants. Given the significant coefficient of *ORGPRO* in study 2, it is likely that this variable was confounding the moderation effect. To test this conjecture, we carried out cluster analysis of the sample on *ORGPRO* in two steps [see for example Leask and Parker (2007) for previous use of this procedure]. We first carried out hierarchical cluster analysis using Ward’s method [following

Ferreira and Hitchcock (2009)] based on squared Euclidean distances. Ward's cluster means were used as seeds to a non-hierarchical (*K*-means) verification in step 2 (all cluster memberships were confirmed in step 2). Cluster 1 had high *ORGPRO* (μ = 3.38, σ = .52, n = 415) and cluster 2 had low *ORGPRO* (μ = 2.06, σ = .39, n = 245); the group means were significantly different ($p < .001$).

The regression analysis (including co-variants) with Cluster 1 yielded significant coefficients for both *ERP* and *II*, but not for their interaction. However, the same equation with Cluster 2 yielded a significant ($p = .011$) coefficient for the interaction, but non-significant coefficients for *ERP* and *II*. These results suggest that in the absence of organizational programs, the interaction between ERP and improvement incentives had a significant relationship with delivery improvements.

The tests with four-item dependent variables yielded similar results regarding H1 ($p < .05$), H2 ($p < .01$), and H4 ($p < .01$). However, and consistent with the previous tests, the moderating coefficient in the *DI* model changed from nearly significant to significant ($p = .044$).

Overall, robustness tests confirmed previous findings that (i) delivery advantage related positively with ERP usage and (ii) delivery improvements related positively with ERP usage and with improvement incentives. However, whether the ERP and incentives altogether had additive or moderated relationships with performance improvements might depend on the extent of organizational programs developed by the company.

9. Discussion

The results in H1 (that ERP usage explains performance advantage) and H2 (that ERP usage explains performance improvements) confirm previous findings that ERP usage supports delivery performance. Having an ERP allows real time data availability which in turn helps with making better decisions as suggested in Lawrence et al. (2005) and Stratman (2007). This result corroborates Stratman and Roth (2002) who found that the integrated nature of ERP could indirectly help employees in decision making because they were more likely to understand the business processes. Ranganathan and Brown (2006) stated that ERPs "are designed to support cross-functional business processes, not just transaction processing for a single business function" (p. 146). Koh and Simpson (2005) and Bendoly and Cotteeler (2008) found that ERPs allowed the organization to improve delivery performance. So it appears that ERP modules help managers not only to make decisions faster but also to avoid 'silo' based decisions that may be detrimental to supply chain measures such as delivery reliability. The key is to ensure that users are able to take advantage of the decision support capabilities of the ERP system.

Results in H4 (that incentives tied to improvement activities explain performance improvements) and H6 (that incentives tied to improvement activities moderate the relationship between ERP and performance improvements) indicate that offering compensation-based incentives tied to improvement activities might help in achieving delivery performance improvements. They imply that benefits from compensation-based incentives are twofold. First, incentives motivate employees to maximize performance. Clearly, if employees understand that they can personally gain financially by achieving better supply chain performance, they are likely to work harder toward that goal. In the case of delivery performance, managers may be fortunate that metrics such as lead times are often available and can be quantitatively measured for risk-compensation purposes. As mentioned by Zenger and Marshall (1995), "easily discerned" measures (a characteristic we associate with delivery metrics) are more easily linked to individual employees or groups. This enables companies to design compensation-based incentives for delivery performance that are viewed as fair by employees and motivate them to perform better. Delivery performance is a critical measure as the customer often experiences it directly, which in turn influences the company's reputation.

Secondly and more importantly, our results imply that under certain circumstances improvement incentives might help users to engage effectively with the ERP. This finding is of major importance as it represents the identification of an indirect success factor for ERP implementations. Consider for example Snider et al. (2009), who found that employees might not use ERPs effectively and in extreme cases could even try to subvert an implementation should they perceive it as ineffective or even career-threatening, and Bendoly and Cotteleer (2008) who indicated that users in some cases might "circumvent" the formal operational procedures of the ERP. Simply put, the existence of such incentives could help mitigate those risks by encouraging the use of the ERP. Whereas previous research supported the role of incentives in implementations such as JIT (Fullerton and McWatters, 2002), IT (Bhattacherjee, 1996; Ba et al., 2001) and improvement programs in general (Knight et al., 2001; Neuscheler-Fritsch and Norris, 2001), to the best of our knowledge this relationship had not yet been supported empirically for ERPs. In particular, we provide evidence that incentives might influence performance of an ERP. Given that ERP adoption is growing rapidly (Jacobson et al., 2007) while at the same time presenting implementation challenges (Huang and Palvia, 2001), organizations embarking on ERP implementations would be wise to also concurrently implement compensation-based performance incentives.

10. Conclusions

The results indicate (i) that ERP adoption relates positively with delivery performance advantage and improvements in manufacturing, (ii) that improvement incentives relate positively with delivery performance improvements and (iii) that, in the absence of organizational programs, improvement incentives may positively moderate the ERP-delivery improvement relationship.

Our results have important practical implications primarily in the identification of performance incentives as an indirect success factor for ERP implementations. While not often mentioned in ERP studies, it is important that attention be paid to compensation-based incentives to encourage proper usage of new system. Further, since delivery performance measures are often recorded and can be linked back to specific employees or groups (see Zenger and Marshall, 1995), equitable incentive systems may be especially effective in motivating employees to apply the new IT to help improve delivery performance.

The study has limitations that are common to survey-based analyses. As we used cross-sectional data, we could not measure the performance effects of ERP usage and incentives within the same organization over time. Also, a study of this nature is not able to explain in detail the nature of the relationships between research variables. Further research could involve case studies to clarify such issues. Finally, in our study, ERP usage considered only direct operations modules, and excluded support modules such as accounting and finance.

This appears to be the first empirical study to explore the role of incentives in support of ERP-led performance benefits in manufacturing. We hope our results will motivate further investigation to understand the role of organizational initiatives in the implementation of manufacturing and information technologies.

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Table 1 Correlations between incentives and structural indicators

	μ	σ	*Valid n*	*RI1*	*RI2*	*RI3*	*II1*	*II2*	*II3*	*MASS*	*MTS*	*DED LINE*	*END USER*
RI1	2.19	1.33	627										
RI2	2.17	1.39	623	.395** (617)									
RI3	2.41	1.41	628	.218** (613)	.305** (609)								
II1	2.33	1.32	610	.569** (601)	.436** (596)	.267** (596)							
II2	2.04	1.24	606	.433** (599)	.612** (599)	.343** (594)	.598** (599)						
II3	2.07	1.30	607	.302** (593)	.318** (590)	.565** (600)	.351** (595)	.516** (592)					
MASS	21.77	33.89	690	.036 (620)	.058 (616)	.072 (620)	.082* (602)	.065 (599)	.086* (599)				
MTS	20.03	29.68	689	-.002 (620)	.096* (616)	.085* (620)	.075 (602)	.095* (599)	.012 (599)	.105** (684)			
DEDLINE	38.24	38.84	682	.030 (614)	.105** (610)	.083* (615)	.114** (599)	.109** (595)	.057 (596)	.338** (677)	.143** (676)		
ENDUSER	28.12	36.43	665	.008 (603)	-.046 (598)	-.096* (602)	.037 (586)	-.035 (583)	-.057 (582)	-.152** (660)	-.076 (658)	-.130** (652)	
OUTCONT	21.75	26.79	677	.110** (614)	.096* (611)	.077 (614)	.056 (597)	.021 (595)	.050 (593)	-.071 (670)	-.038 (669)	-.092* (662)	-.015 (658)

Estimates obtained with IBM® SPSS® Statistics 19.0.0 (SPSS, 2010). Cases with missing values deleted pairwise (pairwise *n* is in parentheses below Pearson correlations). * $p < .05$; ** $p < .01$.

Table 2 Measurement model estimates – study 1

	Descriptives					*Correlations*			
	μ	σ	*n*	λ	*CR*	*AVE*	*ERP*	*RI*	*DA*
1. ERP (value chain modules)	3.44	1.02	644	--	--	--	--		
2. RI (regular production incentives)	2.22	1.00	607	--	--	--	.17	--	
3. DA (delivery advantage)	3.33	.64	510	--	.77	.54	.18	.04	(.73)
DA1 (delivery speed)	3.41	.77	538	.92					
DA2 (delivery dependability)	3.37	.80	536	.65					
DA3 (manufacturing lead time)	3.22	.73	519	.58					

AVE square root (*DA* scale) in parentheses on main diagonal. All variables on 1-5 point scale. Valid *n*, μ, and σ obtained with IBM® SPSS® Statistics 19.0.0 (SPSS, 2010). Correlations and λ (n = 698) obtained with maximum likelihood estimates in IBM® SPSS® Amos 19.0.0 (Arbuckle, 2010).

Table 3 Hierarchical regression - study 1[b]

Variable (Hypothesis)	*b*	*t*-value	*b*	*t*-value	*b*	*t*-value	*b*	*t*-value
Intercept	2.787***	17.591	2.922***	17.047	2.926***	16.906	2.927***	16.853
LN(SIZE)	.022	.937	.011	.461	.011	.444	.011	.428
ORGPRO	.140***	3.527	.115**	2.797	.114**	2.753	.115**	2.751
ERP[a] (H1)			.064*	2.013	.063*	1.976	.063†	1.935
RI[a] (H3)					.006	.187	.006	.179
ERP[a] x *RI*[a] (H5)							-.004	-.113
R^2	.035		.044		.044		.044	
Adj. R^2	.030		.037		.035		.033	
R^2 change	.035		.009		.000		.000	
F-change	7.517***		4.052*		.035		.013	

n = 422; unstandardized coefficients reported; analysis carried out with IBM® SPSS® Statistics 19.0.0 (SPSS, 2010). [a]Mean-centered variables. [b]Dependent variable = *DA*. *** $p < .001$. ** $p < .01$; * $p < .05$; † $p < .10$

Table 4 Measurement model estimates – study 2

	Descriptives						*Correlations*		
	μ	σ	*n*	λ	*CR*	*AVE*	*ERP*	*II*	*DI*
1. ERP (value chain modules)	3.44	1.02	644	--	--	--	--		
2. II (improvement incentives)	2.11	1.03	589	--	--	--	.18	--	
3. DI (delivery improvements)	2.93	.77	661	--	.79	.57	.16	.21	(.75)
DI1 (delivery speed)	2.98	.93	675	.90					
DI2 (delivery dependability)	3.02	.95	673	.72					
DI3 (manufacturing lead time)	2.80	.87	673	.60					

AVE square root (*DI* scale) in parentheses on main diagonal. All variables on 1-5 point scale. Valid *n*, μ, and σ obtained with IBM® SPSS® Statistics 19.0.0 (SPSS, 2010). Correlations and λ (*n* = 698) obtained with maximum likelihood estimates in IBM® SPSS® Amos 19.0.0 (Arbuckle, 2010).

Table 5   Hierarchical regression - study 2[b]

Variable (Hypothesis)	*b*	*t*-value	*b*	*t*-value	*b*	*t*-value	*b*	*t*-value
Intercept	2.475***	13.999	2.655***	14.056	2.817***	14.435	2.797***	14.344
LN(SIZE)	-.012	-.446	-.030	-1.085	-.043	-1.546	-.040	-1.438
ORGPRO	.188***	4.260	.159***	3.529	.127**	2.750	.124**	2.699
ERP[a] (H2)			.091**	2.604	.084*	2.435	.098**	2.779
II[a] (H4)					.101**	2.980	.098**	2.887
ERP[a] *x II*[a] (H6)							.060†	1.830
R^2	.034		.047		.063		.070	
Adj. R^2	.031		.042		.056		.060	
R^2 change	.034		.013		.016		.006	
F-change	9.146***		6.783**		8.883**		3.349†	

n = 515; unstandardized coefficients reported; analysis carried out with IBM® SPSS® Statistics 19.0.0 (SPSS, 2010). [a]Mean-centered variables. [b]Dependent variable = *DI*. *** $p < .001$. ** $p < .01$; * $p < .05$; † $p < .10$

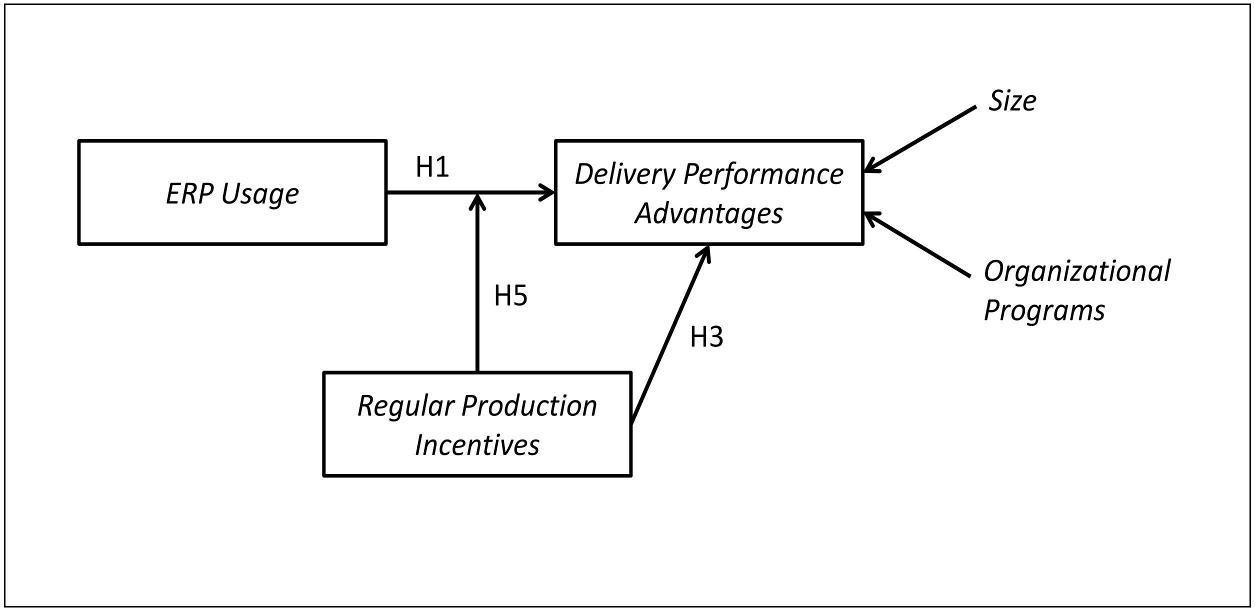

Figure 1. First study model.

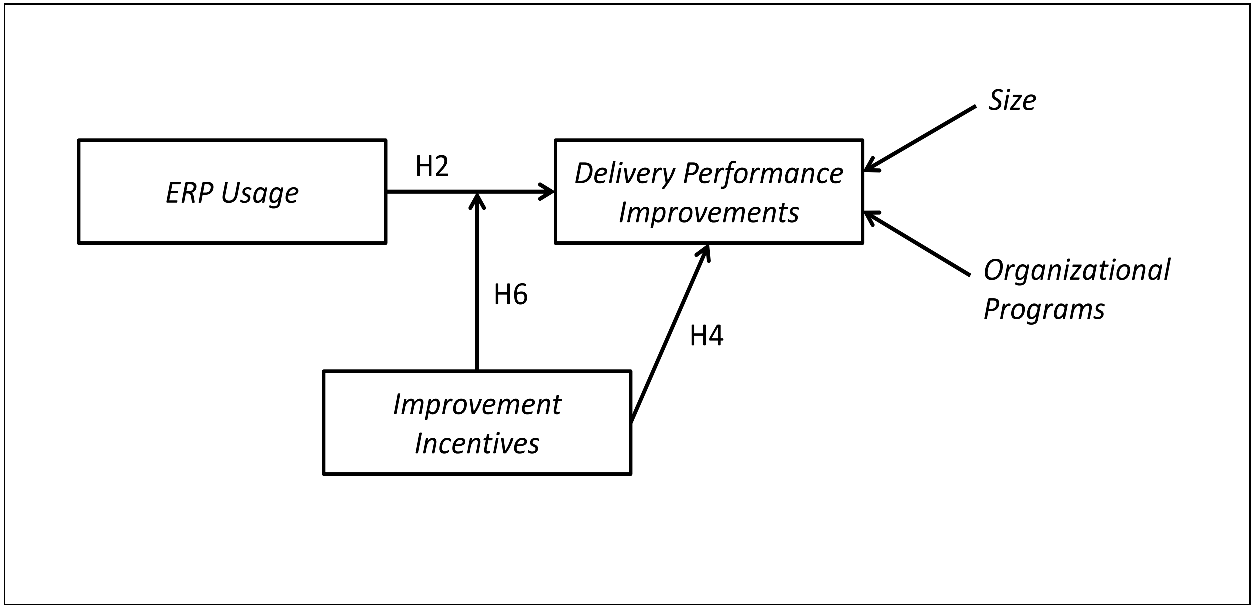

Figure 2. Second study model.

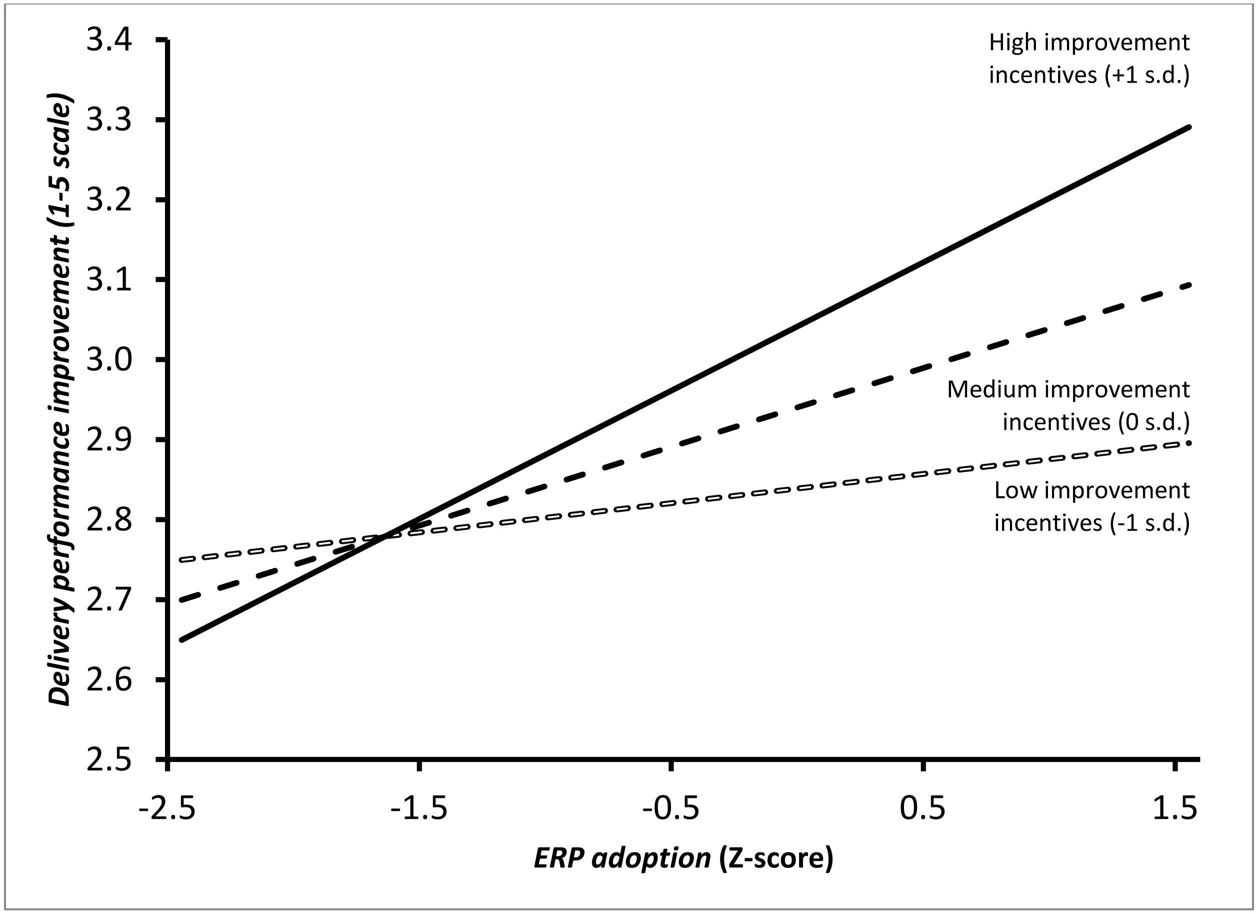

Figure 3. Moderation plot. Regression equation is DI_i = 2.940 - 0.040 LN($SIZE_i$) + 0.124 $ORGPRO_i$ + 0.098 ERP_i + 0.098 II_i + 0.060 (ERP_i x II_i). All control and predictor variables were centred before regression. Centred LN(*SIZE*) and *ORGPRO* were set to zero for calculating intercepts.