

# A hybrid performance measure system for e-business investments in high-tech manufacturing: An empirical study

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Received 23 December 2004; received in revised form 28 June 2005; accepted 13 August 2005  
Available online 14 February 2006

## Abstract

For over a decade, empirical studies on the organizational performance of IT investment have been far from conclusive, and one major issue that has led to an ongoing debate is whether inadequate methods are applied in measuring IT values. Traditional measures have primarily been financial: return on investment and return on sales. Researchers have suggested a need to use other measures, although there has been little agreement on which precisely to use. Moreover, empirical studies showed limitations in using only a single organization-level measure, whereas a more complete assessment could involve measures from several levels. In addition, benefits from IT investments are normally realized over time. This study used an integrative assessment framework with a three-level structure of organizational hierarchy: corporate strategies, manufacturing decisions, and operational activities, along with a time-lag effect. Different levels of performance measures were examined over different time periods. The framework was verified by survey data. Our results indicated that time tag had positive impact on the performance measures of corporate strategies and that they were significantly correlated with operational activities.

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*Keywords:* Productivity paradox; e-Business; IT investment; Performance measure

## 1. Introduction

Today, it is still necessary to consider traditional manufacturing processes and relationships with suppliers and customers, enhancing them by using information technology (IT) to aid collaboration with trading partners in real time. The first wave of Internet procurement focused primarily on automation of internal workflow. The next phase must offer applica-

tions that provide decision support as well as reporting and analysis tools. The online marketplace will aid both buyers and suppliers by serving as a single point for their interaction, eliminating the constraints inherent in connecting trading partners [29]. However, the transformation from the traditional to e-business in manufacturing requires large investments in IT.

For over a decade, empirical studies have also attempted to quantify the benefits realized from IT investments. Although, much of this has shown positive relationships between IT investment and economic performance (e.g., profits and productivity), the results, especially those related to the contribution of IT to productivity, have been mixed, finding little or no

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improvement in productivity despite massive investment [15,8,17]. One possible reason for this is inadequate methodology in researching IT value. The measures used to evaluate an organization's performance have historically been financial ones, such as the monetary value of sales and profits or percentage return on investment. These financial measures are regularly classified as internal rather than external (e.g., market share and growth). In fact, they are mostly defined in terms of more concrete business activities within organizations and can be considered as operational measures. For manufacturing activities, the objectives traditionally have been to minimize cost, increase labor efficiency, and improve machine utilization [49].

Perhaps the most serious issue in measuring organizational performance resulting from IT has been that its payoff has been considered in isolation, separate from other organizational activities. Similarly, there have been suggestions that different performance measures should be used at different levels of the organizational hierarchy [34]. Although many authors have agreed on the need to use more non-financial measures, there has been little agreement on which ones. We decided to study the strategic potential of IT in implementing a firm's business strategy to achieve competitive advantage, particularly in the current major e-business streams of supply chain management, enterprise resource planning, and customer relationship management [14]. This has not been discussed in earlier research on organizational performance measures. Also, defining performance measures in manufacturing should be linked to organizational strategy, as reflected by the manufacturing decisions [51,52,39]. Although different authors have selected different sets of manufacturing decisions, the more common ones include efficiency, dependability, quality, and flexibility [30,2]. Because an organization is a complex system, when one factor is changed, meaningful evaluation may need to go beyond immediate, isolated outcomes, to consider long-term change. More specifically, the values of e-business investments may be realized over an extended period of time, in particular in dealing with non-financial measures [10].

Therefore, we investigated a hybrid performance measure system based on three levels of the organizational hierarchy, with corporate strategies, functional decisions, and operational activities, and a time-lag effect for e-business investment in manufacturing industries. Furthermore, because high-tech industries are more likely to have this kind of

experience, firms from high-tech industries were good subjects for empirical examination in the framework.

## 2. Literature review

### 2.1. Traditional performance measures and limitations

Because of the strong emphasis on financial reporting, internal performance measurement systems of companies were normally based on management accounting systems. Thus, productivity has been considered the primary indicator of a technology's contribution [53]. Although the so-called *productivity paradox* was originally defined at the economy level, most MIS researchers have addressed the productivity question at the firm level [16]. Several have tried to produce hard evidence of productivity gain as a result of IT investments. Studies have often led support to IT productivity paradox [12]. Many researchers have discussed the limitations of traditional performance measures, and the most commonly cited ones are that [38]:

1. As they are based on traditional management accounting systems, labor is the major cost driver and others are de-emphasized by grouping them in one category—overhead. However, today the typical labor cost seldom exceeds 12%, while overhead is 50–55% of manufacturing cost. Thus, labor is no longer a significant portion.
2. New technology investment may not have immediate impact and can take several years to show results. These lags may be of 2–3 years duration, because users may require learning and adjustment before becoming proficient in the new technology.
3. Benefits of aggregated IT investments are often redistributed within or across the organization and, as a result, improvements may not be reflected in the IT table of accounts. More specifically, traditional financial reports are inflexible, since they have a predetermined format. Thus, performance measures used in one department may not be relevant for others.
4. Cost reduction has always been considered an effective weapon to achieve competitive advantage. However, customers' demands have changed and low cost is no longer the most important factor in most markets. Skinner [48] argued that a manufacturing firm should instead concentrate on quality, reliable delivery, short lead times, customer service, product innovation, flexible capacity, and efficient capital deployment.

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