A Study on Relationships Among Software Engineering Capabilities in Japan Using Panel Analysis

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ABSTRACT

To understand how software engineering capabilities relate to IT vendors’ business performance and business environment, the author designed social research on software engineering excellence (SEE) and administered it in 2005, 2006 and 2007 with the Japanese Ministry of Economy, Trade and Industry. The author measured the SEE survey results with regard to seven factors including service science characteristics: deliverables, project management, quality assurance, process improvement, research and development, human development, and contact with customers. This paper integrates 233 responses to the SEE surveys into a new database and identified 151 unique IT firms. Based on the results of the panel analysis, most SEE factors for a year had significant positive influences on the same factors the next year. Three paths existed to improving the level of deliverables through project management, quality assurance and research and development. Some SEE factors had significant positive influence on different factors in the following year diagonally. Some negative paths existed, implying that effort put toward a particular factor did not pay off during the research. These efforts may have longer-term effects on other SEE factors. In comparison to the overall structure, stratified analysis on the relationships among the seven factors suggested that year-to-year relationships of the independent vendors tend to be strengthened due to enhancement of series correlation.

Keywords: Management of Technology, Panel Analysis, Service Science, Social Research, Software Engineering

1. INTRODUCTION

The information service industry is a 10.5 trillion yen market in Japan, which includes 7.6 trillion yen in software development and programming. In 2009, orders for software totaled 6.4 trillion yen, accounting for 60.3% of the entire information service industry, while the software products market was 1.2 trillion yen (METI, 2010). Like the rest of the world, many companies in Japan that use enterprise software have not been fully satisfied with the quality, cost, speed and productivity of software that IT vendors deliver. At the same time, IT vendors in Japan are facing drastic changes in their business environment, such as technology innovations and new entrants from emerging
countries all over the world. There are issues that are characteristic of the IT industry in Japan, such as multilayer subcontractors and business models being dependent on custom-made applications for the domestic market (Cusumano, 2004; Kadono, 2007).

In order for the IT industry in Japan to meet these challenges, an important step is to understand how software engineering capability is significant for achieving medium- and long-term success. Therefore, we designed a research survey on software engineering excellence and administered it in 2005, 2006 and 2007 with the Japanese Ministry of Economy, Trade and Industry.

The objectives of the research were to:

• Assess the achievements of the Japanese software engineering discipline, as represented by IT vendors.
• Better understand the mechanisms of how software engineering capabilities relate to IT vendors’ business performance and business environment.

To achieve these objectives, we developed a measurement tool called Software Engineering Excellence (SEE), which can evaluate the overall software engineering capabilities of IT vendors based on several factors: deliverables, project management, quality assurance, process improvement, research and development, human development, and customer contact. We introduced two other indicators as well: business performance and business environment. The business environment complements the relationship between SEE and the business performance of software vendors.

In the 2005 SEE survey, we analyzed the relationships among SEE, business performance and business environment based on data collected from 55 major IT vendors in Japan. We conducted a path analysis, during which we found that SEE characteristics have a direct positive impact on business performance and that the competitive environment directly and indirectly (i.e., via SEE) affects business performance (Kadono, Tsubaki, & Tsuruho, 2006).

In the 2006 SEE survey, we increased the number of surveyed Japanese IT vendors from 55 to 78 in order to more deeply investigate the impact of software engineering on business performance and the business environment. In particular, in this study we focused on the relationships among the SEE factors, the business environment, and business performance as measured by operating profit ratios (Kadono, Tsubaki, & Tsuruho, 2007). By analyzing the data collected from 78 major IT vendors in Japan (Bollen, 1989), we found that superior deliverables and business performance have significant correlations (5% level) with effort expended, particularly on human resource development, quality assurance, research and development and process improvement as shown in Figure 1.

In 2007, we analyzed the data collected from 100 major IT vendors in Japan. At that time, we reproducibly observed that the level of effort expended on human resource development, quality assurance and project management improved the performance of IT vendors in Japan in customer contact, research and development and process improvement, the same tendency we found in 2006. However, the causal relationships differ significantly depending on the vendors’ origin, i.e., whether a business is a maker-turned vendor, a user-turned vendor or an independent vendor (Kadono, Tsubaki, & Tsuruho, 2009).

For this paper, we integrated the data for the three years into a single new database and identified 151 unique companies, consisting of 42 maker-turned vendors, 33 user-turned vendors and 76 independent vendors (Table 1). We focused on investigating the relationships among the SEE factors during the three years.

The paper is organized as follows. In the next section, we discuss our research model, i.e., structural model and measurement model, in connection with related literature. Then we introduce the survey on software engineering excellence. In the subsequent sections, we present the results of our analysis and discuss the implications of our findings. We conclude with contributions and directions for future work.
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