QUALITY OF MANAGEMENT PRACTICES AND APPLICATION OF COMPLEX AUTOMATED SYSTEMS

Kristjuhan, K.; Metsla, E. & Ling, H.

Abstract: This study plugs an important gap in empirical evidence of a relationship between quality of management practices and application of complex automated systems. A pilot study was conducted in Estonian companies which apply robot welding. Evidence of a strong correlation between quality of management practices and effectiveness in utilizing this complex technology was shown. The study also presented a novel survey instrument for studying company’s management and technological capabilities.

Key words: management practices, quality of management, technological capabilities, complex automated systems, methodology.

1. INTRODUCTION

Management innovation theory suggests that companies which do not possess strong management practices are not capable of economically beneficially utilizing complex technological systems [1]. Also, quality authorities, such as Mizuno [2] and Kondo [3], have argued that applying automated systems presupposes excellently planned and coordinated processes, superb information flow, and standardized and disciplined operations. Such processes and operations would premiss high quality of management at the middle and frontline levels of an organization which are supported by clear direction from the top management. However, empirical evidence of a relationship between the quality of management practices and ability to utilize complex automated systems has been lacking.

Recent research in Estonia has indicated that quality of management in companies in Estonia is relatively low both in general at company level as well as at operational production management level [4, 5]. Yet, a number of Estonian manufacturers have invested in complex technology over recent years, resulting in their overall assessment of their technological capability as satisfactory [6]. The same patterns are evident in the 2011 Estonian machine building sectorial study which states that the majority of Estonian machine building companies lack formal management practices both at company level and at operational production management level [7]. Regardless, nearly half of the companies participating in the study attested to having revamped their manufacturing processes by greater automation and implementation of novel technologies, such as laser cutters, welding robots and 3D measuring equipment [8]. This paper argues that, in accordance with theoretical perspectives, there exists a strong positive correlation between a company’s quality of management practices and its capability to utilize complex automated equipment, such as a welding robot.

The paper is structured in the following way: introduction, theoretical framework, method, results, and conclusions and discussion.

2. THEORETICAL FRAMEWORK

2.1 Management Practices

A number of studies have been carried out over the past half a century to identify what
is it that managers do in their daily work. The majority of such studies have been in the form of an observation of managers’ work. Also interviews with managers and document reviews have been used. An exception to the above described line of research was Henri Fayol, who was a top manager himself as well as a scholar. Fayol was one of the first to propose a comprehensive theory of management. He posited that there were five principal functions of management: planning, organizing, coordinating, leading and controlling [7]. Later management scholars have often reduced the five functions to four by removing coordination (e.g. see Daft [8]).

Other oft cited management scholars have been Mintzberg and Kotter. Both of them conducted original studies into what managers do. Minzberg observed activities of five top managers over a five day period and proposed 10 roles of managers based on the observations [9]. Kotter observed work of 15 top managers (for more than 600 hours in total) and additionally collected information from different documented sources in organizations [10]. The limitations of these studies were that, first, the number of managers observed was very small. Second, both scholars only directly observed top managers of organizations. Quality scholars, such as Mizuno [2] and Kondo [3], have argued that, in fact, the most important level of management in terms of delivering quality products and services to customers is the frontline management. Several studies cited in Carroll and Gillen [11] have shown that managers at all levels of an organization participate in planning, coordinating, controlling, and problem solving. Finally, later empirical research has failed to confirm some of their conclusions, e.g. distinct existence of Mintzberg’s ten managerial roles has not been confirmed [11].

Fayol’s model of management functions has stood the test of time [11]. A number of scholarly works have applied these functions directly in empirical research or based research models on them. For example, the „PRINCESS“ factors study by Mahoney, Jerdee, and Carroll cited in Carroll and Gillen [11] extended Fayol’s five functions to eight factors of planning, representing, investigating, negotiating, coordinating, evaluating, supervising, and staffing. The study investigated time allocation of managers on the listed factors. Another indication of a theory’s descriptiveness of a phenomenon is if independent studies of the same phenomenon reach similar results. An independent study by Luthans and Lockwood in 1984, cited in Luthans, Rosenkrantz and Hennessey [12], applied an observation method to measure behavioral frequency of managerial activities. The study identified 12 categories of managerial activities (hereinafter called management practices): planning/coordinating, staffing, training/developing, decision making/problem solving, processing paper work, exchanging routine information, monitoring/controlling performance, motivating/reinforcing, disciplining/punishing, interacting with outsiders, managing conflict, and socializing/politicking [12]. The Luthans and Lockwood management practices can be easily conceptually related to Fayol functions with the exception of socializing/politicking [12]. The latter practice encompasses nonwork-related chit chat and gaming [12] and thus was not the object of Fayol’s studies. The results of the authors’ conceptualization of this relationship have been provided in Table 1.

Luthans and Lockwood management practices have been successfully operationalized by Luthans and his colleagues in later research as well as by other scholars. Some examples include Asllani and Luthans’ study of knowledge managers [13], and O’Driscoll, Humphries and Larsen’s study of links between performance of managerial activities and perceived managerial effectiveness [14].
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<tr>
<th>Fayol functions</th>
<th>Luthans and Lockwood practices</th>
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<td>Planning</td>
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Table 1. Comparison of Fayol functions and Luthans and Lockwood management practices (authors’ conceptualization)

In this study, the Luthans and Lockwood management practices and detailed descriptions of activities have been operationalized to define management practices, quality of which is measured in relation to the company’s technological performance.

### 2.2 Quality of Management Practices

While classical economics and its related organization theories, such as the industrial organization, tend to downplay the role of managers in a company’s performance, management scholars are determined that managerial activities have a significant role in a company’s results [15]. Yet, due to the complexity of defining management and the large variety of factors influencing company performance, investigations into how management relates to company performance are scarce.

Horovitz and Thiart made an early attempt to find relations between classical managerial functions of organizing, planning, and controlling, and firm performance by controlling for company size and industry sector [16]. Good managerial practices were related to good performance in this study.

Bloom and van Reenen used a complex survey instrument to collect data on company practices and compare these to company performance in the form of accounts and the stock market data [17]. Also, this study found that better management practices were associated with better company performance, including higher productivity, profitability, and survival. However, the survey instrument was not theoretically based.

Svirina measured the efficiency of Fayol’s functions and company performance (e.g. profitability, financial stability, and market share) [18]. One of the results of the study suggested that spending time and money on performing motivational functions is more effective than an equal distribution of resources.

In this study, we define quality of management practices as level of application (both in scope and depth) of management practices in a company. The general structure of the study is depicted in Figure 1.

![Fig. 1. Quality of management and performance (authors’ conceptualization)](image)

**Fig. 1. Quality of management and performance (authors’ conceptualization)**

### 2.3 Quality of Management Practices and Application of Complex Technology

While early research has shown that higher quality of management is associated with better performance of a company, management innovation scholars posit that application of complex technological systems outright presupposes strong management practices [1, 19]. Yet, again, empirical evidence is hard to come across.

A study by Wang, Klein and Jiang...
discussed implementation of Enterprise Resource Planning (ERP) in Taiwan \cite{20}. The limitation of this study was that a self-report instrument was administrated to companies’ project managers directly responsible for the technology project. Thus partiality bias could not be ruled out. Another study by Bloom, Sadun, and Van Reenen, conducted on panel data, suggested that US companies were more productive in using IT partially due to their higher management and organizational capital compared to, for example, UK companies \cite{21}.

This study provides empirical evidence of a relationship between quality of management practices and application of complex technology by uniquely focusing on highly complex industrial technology - a welding robot.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{relationship.png}
\caption{Hypothesized relationship between quality of management and technological capability}
\end{figure}

In accordance with theoretical perspectives, the hypothesis: is that there exists a strong positive correlation between a company’s quality of management practices and its capability to utilize a complex automated equipment. (See an illustration of this relationship in Figure 2.)

3. METHOD

A pilot study was carried out among Estonian manufacturers which applied robot welding. A novel online survey instrument was used. An additional aim was to assess the workability of the survey instrument. Quality of management was measured via management practices and activities as defined by Luthans and Lockwood \cite{12}. Eight out of the 12 Luthans and Lockwood management practices were operationalized: planning/coordinating, staffing, training/developing, decision making/problem solving, exchanging routine information, monitoring/controlling performance, motivating/reinforcing and managing conflict. These practices were selected due to their apparent positive effect on operational performance. Four practices (processing paperwork, disciplining/punishing, interacting with others and socializing/politicking) were excluded due to their apparent neutral or negative effect on operational performance. A sample question might have sounded, „Please assess the level of decision-making and problem-solving in your company“, followed by a detailed description of the activities in this management practice. Respondents were asked to mark one out of five levels of quality of the management practice ranging from „There are no such activities present in our company“ to „Such activities are regular and documented. Results are publicly displayed on walls (information boards) for everyone to see“. Planning/coordinating was divided into long-term or strategic (defined by a time period longer than 1 year) planning and short-term (defined by time period shorter than 1 year) planning. Thereby the total number of quality of management practices questions was nine.

In addition, respondents were requested to specify which of three management levels - top management, middle-management and/or frontline management - were actively practicing these management activities to see whether any of the management levels had a specific effect on the company’s technological capability. Company’s technological capability was measured by a single right first time \cite{22} (also referred to as „first-time-right“).
measure of the robot welding. Respondents were also able to mark one or more probable causes in a provided list, if right first time was less than 100% in their company.

The pilot instrument was administered via a freeware Kwik Surveys online application. Links to the survey instrument were sent to one top or middle manager in each company (e.g. General Manager, Quality Manager or Production Manager).

Five manufacturing companies in Estonia which possessed in-house robot welding were selected for the pilot study (2-digit EMTAK 2008 codes 25, 28 and 31).

Analysis of the results of the survey was conducted in a following manner. First, linear correlation coefficient was determined between total quality of management (measured as sum of category responses) and the technological capability measure. Next, an analysis of variance (ANOVA) was utilized in order to determine whether (1) different management levels or (2) general variables, such as company size, capital ownership or tenure of full implementation of robot welding provided statistically significant dependencies to company’s technological capability. Last, frequency analysis was carried out among determinants of right first time parameter. In addition, it was assessed whether the respondents found the survey instrument easy to fill in, or should changes be made to it in future studies.

4. RESULTS

Correlation coefficient of .74 suggests that there is a significant positive dependency between the quality of management practices and technological capability. Thus an assumption can be made that higher level of management quality allows predicting presence of company’s higher technological capabilities.

Results of ANOVA suggest that there is no reason to support the initial hypothesis about the company’s management levels impact to its technological capabilities. In the frame of the nine management practices asked from the respondents there is no evidence about statistically significant dependencies at significance level .05 (F(3,1)=9.55; F(3,1)=2.57; F(3,1)=.81; F(3,1)=8.73; F(3,1)=2.24; F(3,1)=2.72; F(3,1)=.23; F(3,1)=4.20; F(3,1)=4.20).

In addition, there was no reason to support the hypothesis about the existence of statistically significant dependencies between company’s size, capital ownership and tenure of full implementation of robot welding with technological capability at significance level .05 (F(3,1)=3.27).

The most frequent responses for causes of poor right first time were missing jigs (3), poor quality of material (2) and missing a competent operator for the robot (2).

Respondents found the survey instrument easy to use. More nominal range options for or the actual right first time measure could be asked in next studies for a better defined correlation.

5. CONCLUSIONS AND DISCUSSION

The study provided evidence that there is a strong positive correlation between a company’s quality of management practices and capability to apply complex automated systems. To test the hypothesis further, a full-scale study should be conducted among respective companies. This would also allow to further studies of dependencies between technological capability and management levels.

6. REFERENCES

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7. CORRESPONDING ADDRESS

MSc., MBA Kadri Kristjuhan
TSEBA
Tallinn University of Technology
Akadeemia Road 3, 12618 Tallinn, Estonia
Phone: +372 512 0927
E-mail: kadri.kristjuhan@gmail.com