THE ROLE OF INFORMATION SYSTEMS AND KNOWLEDGE MANAGEMENT IN IMPLEMENTING DIGITAL TRANSFORMATION: EVIDENCE FROM JAPAN

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ABSTRACT: *Digital transformation has recently become a new paradigm of business strategy. However, it is still unclear that what factors affect effective implementation of digital transformation. This paper investigates the factors that affect the implementation of digital transformation empirically. We address especially the role of information systems management and knowledge management as promoting factors of digital transformation. A regression model of the relationship between these factors and digital transformation is proposed. The model is analyzed using the data from a survey of sample of firms in Japan. The results suggest that each of the degree of information systems management and knowledge management has a significant influence on digital transformation implementation, and former has the most positive impact on it. Furthermore, this relationship is not affected statistically by either firm size or the type of industry. And finally implications of this study are discussed. This paper therefore provides an empirical perspective on the implementation of digital transformation of firms in Japan.*

Keywords: digital transformation, information systems management, knowledge management, empirical study

1. INTRODUCTION

In recent years, digital technologies have spread rapidly in much of the world. According to the World Bank, implementation of digital transformation (DT) has led to digital dividends– broader development benefits of society from using new digital technologies [1]. DT has recently become a new paradigm of business strategy [2-5]. An enterprise-wide digital transformation strategy by leveraging technology to improve business processes is necessary for organizations to attain and stay their competitive advantage. Thus, DT has become a high priority on leadership agendas, with nearly 90% of business leaders in the U.S. and U.K. expect IT and digital technologies to make an increasing strategic contribution to their overall business in the coming decade [6]. IDC, a famous consulting firm, reported that "Digital Leaders" have experienced double the benefits of "Followers", and these improvements will be more pronounced by 2020 [7]. However, it is still unclear that what factors affect digital transformation efforts in management research fields as well as for practitioners.

The aim of this paper is to analyze and identify the factors that influence the implementation of digital transformation. Using a sample of 114 firms in Japan based on our original survey and multiple regression analysis, we show statistically the role of the information systems management and knowledge management on DT [8, 9].

This paper is organized as follows. In Section 2, we briefly review some previous literature of DT and mention about our research questions. After reviewing relevant literature of DT, we propose research hypotheses of the factors that have impact on the implementation of the DT, and describes the data based on our original survey in Section 3. Section 4 presents the results of the multiple regression analysis. Finally, in Section 5 we conclude by a summary of this paper.

2. LITERATURE REVIEW

The following section outlines the state-of-the-art in the field of digital transformation. We currently lack a comprehensive understanding of this phenomenon [3, 4, 10].

Digital transformation can be defined in many ways and from various viewpoints. And there is no common definition yet [11]. Here, we will illustrate typical definitions. In general, digital transformation is a concept that Stolterman & Fors first came up with in 2004 [12]. They define DT as the changes that digital technology causes or influences in all aspects of human life. In other examples, Fitzgerald *et al.* described DT as the use of new digital technologies to enable major business improvements such as enhancing customer experience, streamlining operations, or creating new business models [13]. According to Hess *et al*., DT is concerned with the changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or in the automation of processes [5]. Then, based on an inductive approach to reviewing 282 works of the literature on DT, Vial develops a conceptual definition of DT as a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies [10].

Thus, in spite of differences, similarities exist across above mentioned definitions, that is "digital technologies." In the context of DT, digital technologies such as social, mobile, analytics, cloud and the Internet of Things (SMACIT) is each important element of implementing DT [4, 10, 14]. Also, according to Moreira & Rocha, digital technologies consist of 4 elements (DT pillars), that is, cloud computing, mobile connectivity, social, and big data and associated analytics [15].

However, in previous research by Goran et al., it is said that successful digital transformation requires not just technology, but also the alignment of strategy and other factors, such as people, culture, mindset, talent development, and leadership [16]. Other researchers also point out that adequate models, methods and tools are needed for managers and scholars to take advantage of digital opportunities [3, 11].

Therefore, in this study, we address the managerial aspect of digital transformation. And we will analyze the factors affecting DT from a management perspective rather than technology perspective. Currently, the main research approaches (methods) in digital transformation are conceptual, illustrative case study, and literature review [3, 5, 17]. Hence, in this research field, empirical and/or

quantitative studies are required to accumulate empirical evidence and to understand DT phenomena.

A few of previous empirical research concerning digital transformation are the studies of Ferreira et al. and Galindo-Martin *et al.* as examples [18, 19]. Using a sample of 938 companies in Portugal and multivariate statistical analysis, Ferreira *et al.* show that entrepreneurs' and managers' profiles and these leaders' adoption of new digital processes contribute to these companies' greater competitiveness [18]. Galindo-Martin *et al*. analyze the theoretical and quantitative effects of digital transformation and digital dividends on entrepreneurial activity [19]. In their study, partial least square estimation is used to develop an empirical estimation in the case of 29 European countries.

In light of the above mentioned previous studies, we engage in further discussion concerning the factors affecting the implementation of digital transformation of firms in Japan. Especially, we address the role of information systems management and knowledge management on DT. In order to answer this question, we use multiple regression analysis based on our original questionnaire survey.

3. DATA AND MODEL

Data Collection

The sample data used in this study is obtained from questionnaire survey carried out by our laboratory in 2018. This survey targeted Japanese firms with 500 or more employees from different sectors of industry. And we extracted 735 firms at stratified random sampling. TABLE I shows the overview of our survey. The number of valid responses was 114 and the response rate was 15.51%. Although more details of characteristics of sample are omitted here, every data (construct variables mentioned later) follows the normal distribution.

Table I. Overview Of The Survey

Item	Description
Scope	Japan
Target	Japanese firms with more than 500 employees
Sampling	Extracted 735 firms at stratified random sampling
Procedure	Sending/return by snail mail
Respondent	Representative of information systems division
Sample size	114 firms (effective response rate: 15.51%)
Survey date	September – October 2018

Construct Variables and Operationalization

We assume 4 constructs in this study, and they are as follows.

- Information systems management: *IS*
- Knowledge management: *KM*
- Formulating digital transformation strategy: *DS*
- Implementing digital transformation: *DT*

These constructs variables work with theoretical concepts, however it is difficult to observe and measure directly. Therefore, this study measures these constructs using various question items. Here, *IS*, *KM* and *DT* consist of 6, 6, and 8 question items, respectively, and each question item was measured by 6-point Likert scale (from 1 = Not apply at all to 6 = Apply fully). Normally, the Likert scale consists of 5 or 7 options. But in this study, we use 6 options to avoid a neutral answer.

The sum of each measurement data of the prepared question items wes used as a scale to measure each above construct.

For instance, to measure the construct *IS*, 6 question items are used and 3 of them are as below.

- We develop and implement IT strategy based on corporate strategy.
- We collect and grasp IT-related technical information and trends of other companies.
- We clarify the role of the information system department and the make-or-buy decision making of information systems operations.

Similarly, to measure the construct *KM*, 6 question items are used and 3 of them are as below for examples.

- We encourage the sharing of information and knowledge through direct dialogue and discussions among employees.
- We encourage that employees make use of knowledge and/or technology created or developed in other departments.
- We systematically convert practical and empirical findings into documents and/or manuals as much as possible.

Then, to measure the construct *DT*, 8 question items are used and 3 of them are as follows.

- Company-wide sharing of understanding and cognition of digitization
- Development of systems and organizations promoting digitization
- Collection of digitization related information and investigation of leading cases

While, the construct *DS* is measured by score from 1 to 5 based on the question item in a single-selection. The followings are typical polar examples of prepared 5 options of the question.

- We have already implemented digital transformation strategy.
- We do not have any plans to develop and/or implement digital transformation strategy.

When a respondent selects the above former option, the firm gets 5 points. In the same manner, if a respondent selects the latter option, he can get 1 point score.

In these construct variables, for simplification, the process of factor analysis was skipped, and instead of it, we examined the reliability of the test scale (Cronbach's α). As a result, shown in TABLE II, every α coefficient is greater than 0.8 in all construct variables, and sufficient reliability was confirmed.

The table also depicts that there is each significant positive correlation among 4 constructs at 1% level.

Tsable Ii. Descriptive Statistics And Correlation Between Construct Variables

Construct	# of Items	Mean	S.D.	α	*IS*	*KM*	*DS*	*DT*
IS	6	4.15	0.82	0.82	–			
KM	6	3.43	0.78	0.82	0.56**	–		
DS	–	3.50	1.31	–	0.34**	0.42**	–	
DT	8	3.78	0.89	0.92	0.64**	0.57**	0.54**	–

** $P < 0.01$ (two-sided test).

Research Hypotheses and the Model

In this empirical analysis, a regression model is developed to verify the following hypotheses. The objective variable is *DT* and the explanatory variables are *IS*, *KM* and *DS*.

H1. There is a positive relationship between *IS* and *DT*.

H2. There is a positive relationship between *KM* and *DT*.

H3. There is a positive relationship between *DS* and *DT*.

In order to control the firm size, we add an additional variable, which is the logged number of employees, abbreviated *emp*. This is Model 1 and written as follows.

$$DT = ß_0 + ß_1 IS + ß_2 KM + ß_3 DS + ß_4 emp + \varepsilon \quad (1)$$

Furthermore, we also estimate another model in order to control the type of industry. In this "0–1" dummy variables abbreviated type, "1" means manufacturing industry and "0" is otherwise. This is Model 2 and written as follows.

$$DT = ß_0 + ß_1 IS + ß_2 KM + ß_3 DS + ß_4 emp + ß_5 type + \varepsilon \quad (2)$$

Fig. 1 shows our research model and related hypotheses. We assume a positive path in all relationships among variables on the basis of above mentioned hypotheses.

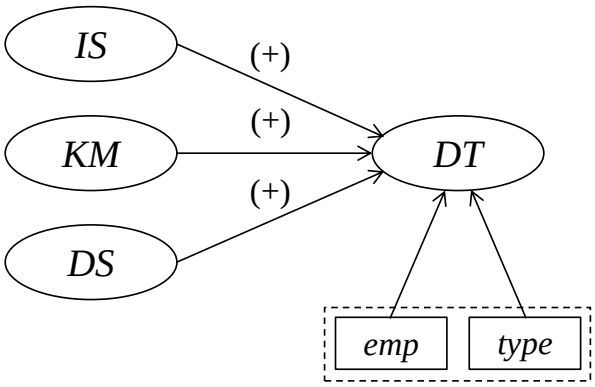

Fig. 1. A Proposed Hypothetical Model

4. RESULTS AND ANALYSIS

A multiple regression analysis was conducted by the forced entry method including all independent variables mentioned above with 112 effective sample data. *DT* is treated as the dependent variable in this study. Homoskedasticity test of the variance of each error term was performed on both models. As a result, homoskedasticity was not recognized in Model 2, and therefore robust standard error was adopted. Then, for each regression, the existence of variance with potential multicollinearity effect was analyzed through variance inflation factors (VIF). And the result confirmed the non-existence of multicollinearity.

TABLE III shows the estimated results. Both regression models are significant at 1% level statistically based on the results of the F test. Our regression analysis indicated that each independent variable, *IS*, *KM*, and *DS* has a significant positive effect on digital transformation, and *IS* has the most influence on *DT* in both models. Hence, all of the hypotheses (H1., H2. and H3.) mentioned above are accepted statistically. Furthermore, each of the relationship between *emp* (*type*) and *DT* is positive (negative), but there are not either significant statistically. Therefore, both the firm size and the type of industry did not have a significant impact on the implementing *DT*. The positive relationships between 3 factors and the implementation of *DT* are still confirmed significantly even when controlling the number of employees or the type of industry.

Table Iii. Estimated Results Of Regression Analysis

Construct	Model 1	Model 2
Intercept	0.11 (-0.63)	0.17 (-0.62)
IS	0.45 (0.09)**	0.41 (0.11)**
KM	0.24 (0.09)**	0.29 (0.12)**
DS	0.19 (0.05)**	0.20 (0.05)**
emp	0.04 (-0.08)	0.05 (-0.08)
type	–	-0.22 (-0.15)
R-squared	0.54	0.56
Adj. R-squared	0.53	0.54
F-value	31.86**	26.68**
Sample size	112	112

** $P < 0.01$ (two-sided test),
Standard errors in parentheses in Model 1,
Robust standard errors in parentheses in Model 2.

5. CONCLUSION

This paper analyzed the factors that affect the implementation of digital transformation. In particular, we address the role of information systems management (IS) and knowledge management (KM) as promoting factors of DT. The regression model of the relationship between factors and DT is proposed. The model is analyzed using the data from a survey of a sample of firms in Japan. The results suggest that each of the degrees of IS and KM has a significant influence on DT implementation, and IS has the most positive impact on it. In addition, this relationship is not affected statistically by either firm size or the type of industry. These empirical findings contribute to a better understanding of DT and support the need for many firms to be aware of the importance of DT.

We acknowledge, this study has certain limitations. The main limitation is related to our proposed research model. In this regression model, we analyzed several important factors affecting the implementation of DT. However, since digital transformation is a highly complex and company-wide endeavor, any other factors need to be taken into account. Then, it is necessary to analyze not only the relationship between these factors and DT, but also the relationship with its performance. Furthermore, due to the limitation of a normal OLS regression model, the interrelationship among the explanatory variables cannot be analyzed in this study.

Hence, future investigation, additional empirical analysis, is necessary. However, the results are potentially important because of providing useful information for practitioners. Many of founded significant factors depend on manager's choices, and, therefore, our results can help managers to select optimal and/or successful strategies that increase their opportunities of the implementing DT.

Based on the results, in the future, we will analyze the more detail factors that affect digital transformation and its effectiveness/performance by using structural equation modelling (SEM).

ACKNOWLEDGMENT

This research was partly supported by JSPS KAKENHI Grant Number 20K01903 and authors would like to thank the organization. The authors are grateful to the anonymous reviewers for their valuable comments and insightful suggestions.

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