Measuring Business and Information Technology Value in BPR: An Empirical Study in the Japanese Enterprises

Michiko Miyamoto, Shuhei Kudo, and Kayo Iizuka

Abstract—This paper presents an analysis result of relationship between business and information technology (IT) in business process reengineering (BPR). 258 Japanese firm-level data collected have been analyzed using structural equation modeling. This analysis was aimed to illuminating success factors of achieve effective BPR. Analysis was focused on management factors (including organizational factors) and implementing management method (*e.g.* balanced score card, internal control, etc.).These results would contribute for achieving effective BPR by showing effective tasks and environment to be focused.

Keywords—BPR, SEM, IS Success Model, user satisfaction

I. INTRODUCTION

BASED on the BPR theory presented by Hammer and Champy[9], a great deal of literature suggests that organization could enhance their overall performance by adopting a process view of business, and firms cannot be competitive or successful if their business and information technology (IT)/information systems (IS) strategies are not aligned[1]. BPR has ranked as one of the most important issues for CIOs since the early 1990s [2, 19]. However, trade press, such as "*CIO Magazine*" still suggests that low adoption and use of IT by employees are major barriers to successful IT implementations in organizations [16, 8].

The studies conducted by Henderson and Venkatraman [10] significantly focus on IT effectiveness from the management viewpoint as well as the technical viewpoint. However, there is a lack of empirical research in this field [6].

This paper contributes to filling this research gap by empirically investigating the relationship of organizational sectors and IT implementation, relationship between leadership and the activities of the CIO and IT effectiveness.

In order to analyze the success/failure factors in business and IT value in BPR, this paper proposes to follow the Delone and McLean IS success model. For estimating how firms' organization types affect the effectiveness of BPR, advanced quantitative techniques of structural equation modeling (SEM) has been employed. SEM has been established as an analytical

M. Miyamoto is with the Department of Management Science and Engineering, Akita Prefectural University, Yurihonjo City, Akita 015-0055 JAPAN (phone: +81-184-27-2163; fax: +81-184 -27-2189; e-mail: miyamoto@akita-pu.ac.jp).

S. Kudo is with the Department of Management Science and Engineering, Akita Prefectural University, Yurihonjo City, Akita 015-0055 JAPAN (phone: +81-184-27-2239; fax: +81-184-27-2189; e-mail: s_kudo@akita-pu. ac.jp).

K. Iizuka is with the School of Network and Information, Senshu University, Kawasaki-shi, Kanagawa 214-8580 JAPAN, phone: +81 -44-911-0517; fax: +81-44- 900-7813; e-mail: iizuka@isc.senshu-u.ac.jp).

tool, leading to hundreds of published applications per year . Overviews of the state of the method can be found in Cudeck et al. [3], Jöreskog [12], Mueller [15], and Yuan and Bentler [20]. In this study, a SEM connecting who plays CIO role in the firms, level of importance of IT within the firms, Intention to use/use of IS, *i.e.* management and IT readiness, User satisfaction on IT projects, Net benefits of IS department in the firms, business process re-engineering and business performance has been estimated, using firm-level data collected through a survey of 258 Japanese firms. According to the earlier empirical study in Japan, many Japanese top management was not fully convinced that IT is a powerful management tool [13]. These works, thus far, do not thoroughly focus on the relationship of organizations or the differences in the satisfaction structure of organizational sections [11].

In real-world, some companies which attempt to implement BPR may have faced problems, since actual business processes are not stable but changing continuously. The success factor of IT implementation should differ according to the circumstances or profile of each company (*e.g.* organization structure types, management type, etc).

II. RESEARCH BACKGROUND

A. D&M IS Success Model

Delone and McLean (D&M) [4] conducted an extensive literature review on 180 empirical studies published in six top IS journals and one of the most important IS conference proceedings. D&M classified dimensions of IS success into six categories, which has been considered a suitable foundation for further empirical and theoretical research, and has met with general acceptance [7]. This taxonomy was based upon Mason's modification of the Shannon and Weaver model [18] of communications which had identified three levels of information: the technical level (accuracy and efficiency of the system that produces it), the semantic level (its ability to transfer the intended message), and the effectiveness level (its impact on the receiver). Mason adapted this theory for IS and expanded the effectiveness level into three categories: receipt of information, influence on the recipient, and influence on the system [14]. D&M identified categories for system success by mapping an aspect of IS success to each of Mason's effectiveness levels. Figure 1 illustrates Delone and McLean's original IS success model:

(1) *System quality*: The desired characteristics of an IS itself.
(2) *Information quality*: The desired characteristics of the product of an IS.
(3) *Information Use*: The receipt consumption of the product of an Information System.
(4) *User satisfaction*: The receipt response to the use of the product of an Information System.
(5) *Individual impact*: The effect of information on the behavior of a receipt.
(6) *Organizational impact*: The effect of information on organizational performance.
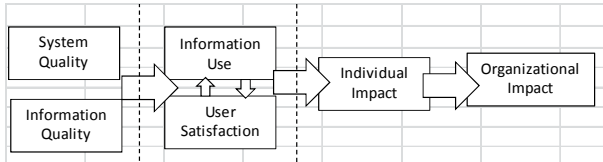

Fig. 1 DeLone and McLean's IS success model in 1992

Since D&M first published their model, over 1000 publications have referenced their work; and at least 150 empirical studies have examined some or all of the relationships in the model. Later, D&M [5] have updated their original success model as shown in Figure 2:

(1) *System Quality:* Performance of the IS in terms of reliability, convenience, ease of use, functionality, and other system metrics
(2) *Information Quality*: Characteristics of the output offered by the IS, such as accuracy, timeliness, and completeness
(3) *Service Quality*: Support of users by the IS department, often measured by the responsiveness, reliability, and empathy of the support organization
(4) *Intention to Use*: Expected future consumption of an IS or its output
(5) *Use*: Consumption of an IS or its output described in terms of actual or self-reported usage
(6) *User Satisfaction*: Approval or likeability of an IS and its output
(7) *Net Benefits*: The effect an IS has on an individual, group, organization, industry, society, etc., which is often measured in terms of organizational performance, perceived usefulness, and effect on work practices.

Petter and McLean [17] examined the strength of the interdependent relationships among the variables that make up IS success by aggregating the results of 52 empirical studies. They examined relationships within the IS success model at the individual level of analysis, they found support for the relationships that encompass the model.

B. Research Model and Hypothesis

In structural equation modeling, we consider the causalities among all variables, especially between the result and the latent variables. Latent variable enables us to find many compiled observed variables at the same time based on the notion of structure. This works for generating and verifying hypothesis to find factors and causalities.

Based on updated D&M IS success model, we introduced latent variables based on the properties of the questionnaire as follows; (1) Intention to use/use, (2)User satisfaction, and (3) Net Benefits on IS department. Net Benefits include benefits come from a level of fusion and closeness between IS department and other departments, *i.e.*, a fusion among organizational structure and a closeness of inter- organizational communication style.
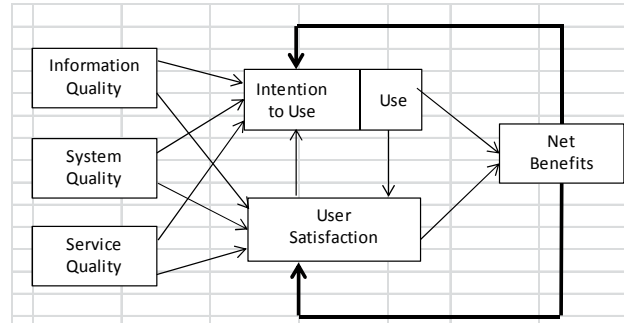

Fig. 2 Updated DeLone and McLean's IS success model in 2003

We had formed 6 hypotheses based on this framework as follows.
H1: There is a significant, positive relationship between who plays CIO role and top management's awareness on IT.
H2: There is a significant, positive relationship between management and Intention to Use/Use.
H4: There is a significant, positive relationship between Intention to Use/Use and Net Benefits.
H3: There is a significant, positive relationship between Net Benefits on IS Department and top management's awareness on IT.
H5: There is a significant, positive relationship between Intention to Use/Use and User Satisfaction.
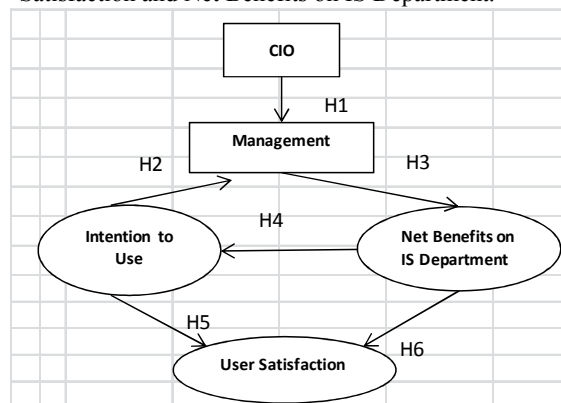H6: There is a significant, positive relationship between User Satisfaction and Net Benefits on IS Department.

Fig. 3 Research Model and Hypotheses

III. SURVEYS

A. Data

Data were collected through a survey of Japanese listed and not-listed companies in August 2007. A sample of the survey was randomly selected from the database of Diamond, the book

publishing company of Japan. The survey was sent to 2,000 companies of all sizes from various industries which divided into the four sectors (manufacturing, distribution, finance, service, and others), and amassed 258 valid responses (response rate: 13%). The questionnaire was sent by mail to the information system division, the corporate planning division, and the internal audit division of the firms. During the period, the recipients who had any questions were answered by phone. Most of the questionnaires are asked by 5 point scale. A list of sample size by different industry classification is shown in Table I.

TABLE I
SAMPLE SIZE BY INDUSTRY CLASSIFICATION

Classification	Frequency	
Manufacturing	123	(48.0%)
Distribution	36	(14.1%)
Finance	19	(7.4%)
Services	34	(13.3%)
Others	44	(17.2%)
Total	256	

B. Variables

The list of variables is shown in Table II.

TABLE II
THE LIST OF VARIABLES FROM THE SURVEY

CIO-Who Plays CIO role?
Measuring importance of CIO role within the firm.
A president of the firm, IS officer, officer other than IS department or General manager of IS Department.
Management-Top management's awareness on IT
Top management regards IT investment as one of important strategies, or not .
Net Benefits: IS Department- Positioning of IT
Q2.1 Relationship between IT department and corporate planning department. Communication closeness between departments.
Q2.2 Organizational structure of IT department and its user department.
Intention to Use/Use-Management and IT readiness
Q4.1 Implementation of the project for management and IT tasks
Q4.2 Corporate policy for business restructuring and improvement.
Q4.3 Relationship between IT and business restructuring and improvement
Q4.4 Corporate policy for business efficiencies and information securities
Q4.5 Corporate policy for internal control
User Satisfaction on IT project
Q6(a) Proficiency for adjustment goals between departments and projects
Q6(b) Less Frequent occurrence of project send backs
Q6(c) Proficiency for setting goals
Q6(d) Timely completion of the projects.
Q6(e) Engagement of top management
Q6(f) Fewer gap between management's instruction and implementation by engineers
Q6(g) Achieving satisfactory results across the organization
Q6(h) Easiness of achievement of project results by setting goals.

C. Result of Analysis

Testing the efficacy of the structural model was conducted by AMOS 19, and the major results of analysis are shown in Figure 4 and 5.

As a result of analyzing various restructuring projects, we found that BPR has provided positive but slightly less satisfaction than the internal control project (including those to support Sarbanes-Oxley Act of 2002), the information security restructuring project, and the Balanced Scorecard (BSC) project, but provided more satisfaction than the Activity-Based Costing (ABC) project, although the results were not statistically significant.

In order to confirm the hypotheses we proposed in section 2.2 to study the underlying relations among components of Intention to Use/Use, User Satisfaction, Net Benefits, and Management, depicted in Figure 5 to the data by fitting the structural model. The path diagram highlights the structural relationships. In this diagram, the measured variables are enclosed in boxes, latent variables are circled, and arrows connecting two variables represent relations, and open arrows represent errors. The followings are results of hypotheses.
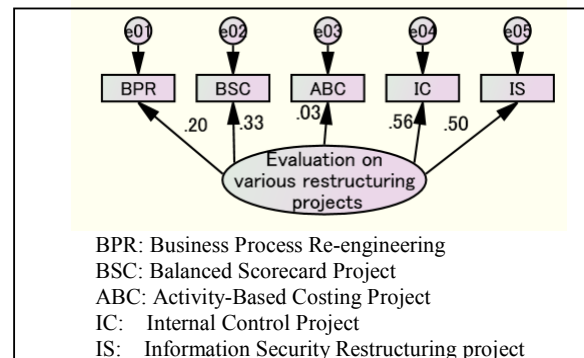

BPR: Business Process Re-engineering
BSC: Balanced Scorecard Project
ABC: Activity-Based Costing Project
IC: Internal Control Project
IS: Information Security Restructuring project

Fig. 4 Evaluation on various restructuring projects

H1: *There is a positive but weak relationship between who plays CIO role and top management's awareness on IT.*

H2: *There is a positive but weak relationship between management and Intention to Use/Use.*

H3: *There is a negative relationship between Net Benefits on IS Department and top management's awareness on IT.*

H4: *There is a positive relationship between Intention to Use/Use and Net Benefits.*

H5: *There is no significant relationship between Intention to Use/Use and User Satisfaction.*

H6: *There is a negative relationship between User Satisfaction (performance) and Net Benefits on IS Department (fusional degree of interorganization communication style) .*
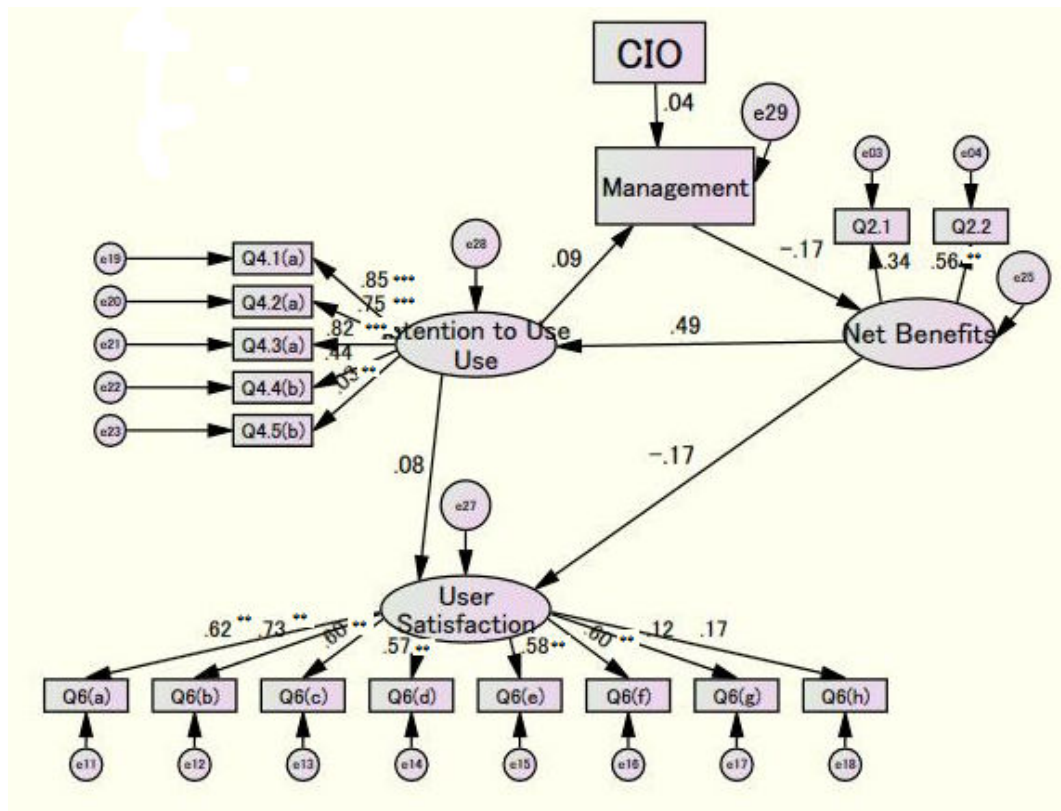
** Significant at 0.05, * significant at 0.10

Fig. 5 The estimated structural model

The results show that Intention to Use/Use (Management and IT readiness), such as Implementation of the project for management and IT tasks, Corporate policy for business restructuring and improvement, Relationship between IT and business restructuring and improvement, Corporate policy for business efficiencies information securities and Corporate policy for internal control are closely related to Net Benefits, which include benefits come from a level of fusion and closeness between IS department and other departments, *i.e.*, a fusion among organizational structure and a closeness of inter-organizational communication style.

As far as a relation with management, IS department under the management has more influence over other departments, compared with those has more independency.

Our hypothesis on a relationship between Net Benefits (fusion degree of interorganizational communication style) and User Satisfaction (performance), Net Benefits on IS Department and top management's awareness on IT, Intention to Use/Use and User Satisfaction were rejected. We would like to further research on these relationships.

IV. CONCLUSIONS AND FUTURE RESEARCH

Based on D&M IS Success Model, we conducted the SEM on the survey data from 258 Japanese firm-level data.

In this study, we found that who plays CIO role as well as Top management awareness on IT are not closely related to Intention to use, and Net Benefits of IS. These results imply that the most significant relation between business and information technology is Intention to Use/Use (the management and IT readiness) and Net Benefits (Positioning of IT department) .

Among various restructuring projects, BPR has provided positive but slightly less satisfaction than the internal control project (including those to support Sarbanes-Oxley Act of 2002), information security restructuring projects, and Balanced Scorecard (BSC) project, but provided more satisfaction than Activity-Based Costing (ABC) project, although the results were not statistically significant. The largest earthquake and Tsunami in the Japanese history occurred off the Pacific coast of northeastern Japan on March 11, 2011. We expect certain influence of this Great Eastern Japan Earthquake on IT investment and business performance of many Japanese firms, so that we have a plan to conduct survey in 2012 to investigate what issues Japanese firms' are facing after March 11.

ACKNOWLEDGMENT

REFERENCES

[1] D. Avison, J. Jones, P. Powell, D.Wilson. "Using and validating the strategic alignment model," *Journal of Strategic Information Systems*, 13, 2004, pp. 223-246.

[2] J.C. Brancheau, B.D. Janz, J.C. Wetherbe, "Key issues in information systems management: 1994–1995 SIM Delphi results," *MIS Quarterly* 20 (2), 1996, pp. 225-242.

[3] R. Cudeck, S. du Toit, D.Sörbom, (Eds.), "Structural Equation Modeling: Present and Future. Scientific Software International, Chicago.W.H. Delone and E.R. McLean, Information systems success: The quest for the dependent variable," *Information Systems Research* **3** (1992), pp. 60–95. 2001.

[4] W.H.,DeLone, and E.R. Mclean, "Information Systems Success: The Quest for the Dependent Variable", *Information Systems Research* (3:1), March 1992, pp 60-95.

[5] W.H DeLone and E.R.Mclean**,** "The DeLone and McLean Model of Information Systems Success: A Ten-Year Update," *Journal of Management Information Systems* (19:4), Spring 2003, pp. 9-30.

[6] A. Eardley**,** H. Shah**,** A. Radman. "A model for improving the role of IT in BPR," *Business Process Management Journal,* Vol. 14 Iss: 5, pp.629 - 653. 2008.

[7] E.J. Garrity and G.L. Sanders, *Information Systems Success Measurement*, Idea Group Publishing, Hershey, 1998.

[8] G. Gross, "Standards a must for adoption for health-care IT," *CIO Magazine*, March 15. 2005.

[9] M. Hammer, and J. Champy, *Reengineering The Corporation*, Harper Collins, 1993.

[10] J.C. Henderson, and N. Venkatraman, "Strategic Alignment: A Framework for Strategic Information Technology Management," *MIT Sloan School of Management, The Management in the 1990's Research Program*, Working Paper 89. 1989.

[11] K. Iizuka, S. Kudo, and M. Miyamoto, "A Framework for Effective IT Investment From the Perspective of Business–IT Alignment and Organization," *Proceedings of 13th International Conference on Enterprise Information Systems* (ICEIS 2011**)**, Beijing, China, Volume 3, pp.344-399. 2011.

[12] K.G. Jöreskog," New developments in LISREL—Analysis of ordinal variables using polychoric correlations and weighted least squares," *Quality and Quantity* 24, 387–404. 1990.

[13] Y. Kadono. "The Empirical Studies on IT Management in Japan: 2000, 2002 and the Futurem," The 4th Asian eBusiness Workshop, Aug., 2004. http://www.mgmt.uestc.edu.cn/Meeting/4ebiz/html/ Schedule. shtml.

[14] R.O. Mason, "Measuring information output: a communication systems approach," *Information & Management* 1 (5), 1978, pp. 219–234.

[15] R.Mueller," Structural equation modeling: back to basics," *Structural Equation Modeling* 4, 353–369. 1997.

[16] S. Overby, "How to win friends and influence users," *CIO Magazine,* September 15. 2002.

[17] S. Petter and E. McLean, "A meta-analytic assessment of the DeLone and McLean IS success model: An examination of IS success at the individual level," *Information & Management* 46, pp.159-166, 2009.

[18] C.E. Shannon and W. Weaver, *The Mathematical Theory of Communication,* University of Illinois Press, Urbana, IL, 1949.

[19] R.T. Watson, G.G. Kelly, R.D. Galliers, J.C. Brancheau, "Key issues in information systems management: an international perspective, "*Journal of Management Information Systems* 13(4), 1996, pp. 91–115.

[20] Yuan, K.-H., Bentler, P.M., "Mean and covariance structure analysis: theoretical and practical improvements," *Journal of the American Statistical Association* 92, 1997, 767–777.