Inventing a business-ERP alignment assessment model through three Japanese companies

Tingting Huang
Graduate School of Economics and Management, Tohoku University, Sendai City, Japan, and
Akinori Yokota
Department of Business Administration, College of Business Administration, Ritsumeikan University, Kyoto, Japan

Received 20 March 2017
Revised 18 August 2017
13 January 2018
17 February 2018
Accepted 17 June 2018

Abstract

Purpose – The purpose of this paper is to present a new approach for assessing the status of alignment between organizations and enterprise resource planning (ERP) systems—more friendly and quantitatively.
Design/methodology/approach – An issue-based ERP assessment model is invented based on thorough literature review and empirical data from three Japanese companies. A modified Cartesian coordinate system is adopted to link the alignment criteria and the system maintenance activities.
Findings – The findings prove the feasibility of the model and reveal the variation of ERP alignment in a visualized way. It is also indicated that the utilization of the issue-based ERP assessment model is a more convenient method to help the organizations to pinpoint the status of the ERP alignment.
Originality/value – This is the first approach to measuring the business–information technology alignment visually. One major implication of this research is to provide an easy assessment method which may encourage organizations to do evaluations regularly. The information accumulated by regular assessment can further pinpoint the perfect time to make decisions and provide essential evidence for decision makings, such as when to expand or retire the current system. From the academic perspective, this model provides a new approach to evaluating the assimilation of organizations and ERP systems.

Keywords Enterprise resource planning, Alignment, ERP life cycle, Post-implementation, Japan
Paper type Research paper

Introduction

The enterprise resource planning (ERP) system generally refers to a software architecture that integrates the complete range of a business's processes and functions in order to present a holistic view of the business from single information and information technology (IT) architecture (Klaus *et al.*, 2000). It is considered to be a comprehensive solution seek to integrate business processes and functions in order to present a holistic view of the business from a single IT architecture (Klaus *et al.*, 2000). With the development of IT and the demands of organizations, the ERP system originated from manufacturing cores has been able to cover nearly all essential processes and functions of organizations and became one of the most widespread information systems (ISs) during the past two decades.

Recently, traditional ERP in organizations, such as on-Premise ERP, has already been increasingly impacted by emerging IT, such as cloud services and social media technologies. A recent survey conducted by Gartner group in 2013 reveals that 47 percent of the organizations planned to move to cloud-based systems within the next five years (Rayner, 2014). The dilemma of ERP switching appears more serious to large enterprises (LEs) may be because the legacy system which had cost a lot. There are already considerable cases in which organizations have successfully replaced a traditional ERP system with a new type of ERP system. As a matter of fact, in a recent study, Huang (2016) found out that within 40 organizations in Japan that have conducted ERP switching/reversion, 29 are LEs. For the majority, whether or not making this critical decision still lacks reliable methods and

Business Process Management Journal
© Emerald Publishing Limited
1463-7154
DOI 10.1108/BPMJ-03-2017-0068

experience to back up. One critical issue is how those organizations can aware of the right timing to decide to switch or revise the current ERP. In other words, is there any way to reveal the status of the alignment between business and system whenever necessary?

In order to deal with the above issue, the primary step is to assess the ERP system whether it still fits the organization. Indeed, considerable evaluation methods can be found in the previous literature. The majority of these evaluation methods are conceptual ERP success models usually based on the IS success model of DeLone and McLean (2003). The success models may be suitable for telling the success of an implementation project or the reach of the perfect alignment between business and ERP system. However, it provides little help to solve the addressed issue. On the other hand, alignment models and process models can tell the level of the alignment status or the stage in the ERP life cycle; however, there are some common concerns in these methods in general. For instance, the evaluation criteria are qualitative; those models tend to be too complex and abstract, and the results are also difficult to be read, which make those methods hard to be used in practice; it is more difficult for organizations to use these models regularly. Hence, the purpose of this research is to present an approach for assessing the status of alignment between organizations and ERP systems—more friendly and quantitatively.

The results of this research indicate that the utilization of the business–ERP alignment assessment model is a more convenient method to help the organizations to pinpoint the status of the alignment between organizations and ERP systems. By using the maintenance documents, the quantitative approach is more doable than qualitative methods. One major implication of this research is to provide an easy assessment method which may encourage organizations to do evaluations regularly. This model can be adopted in the whole system or in one department. The information accumulated by regular assessment can further pinpoint the perfect time to make decisions and provide essential evidence for decision makings, such as when to expand or retire the current system.

Theoretical background

For nearly half a century, organizations strive to link their business with IT/IS. Researchers are also fascinated by exploring the relationship status between organizations and adopted IT/IS. The expected relationship status is described as alignment (Luftman, 2000), integration, assimilation (Jones *et al.*, 2008), linkage, diffusion (Lorenzo *et al.*, 2005), institutionalization (Pishdad *et al.*, 2014), maturity (Holland and Light, 2001), harmony or success (Moalagh and Ravasan, 2013). All above terms are used to address a desirable condition in which the IT/IS is fully installed, routinized and widely accepted in the strategic, managerial and individual level.

Assessing and evaluating certain criteria or antecedents highly associated with the IS alignment is one way to study this topic. In general, the studies related to IS assessment and evaluation in the post-implementation phase can be divided into two categories. One is assessing the IS whether or not reaches a certain point, such as IS success evaluation and IS performance evaluation. The difference between ERP success evaluation and the ERP performance evaluation is that the former usually refers to the success of the ERP implementation project and the later most focuses on the status in the post-implementation phase. The other one is pinpointing the alignment level or stage in a certain measure metric. As we discussed earlier, the second approach is more suitable for our research. Strategic alignment model (SAM) (Henderson and Venkatraman, 1990) is the classic strategic alignment model which covers the interactions between strategic aspect and functional aspect in both IS/IT and business. Strategic alignment models based on SAM are well applied. Other than the Gestalt model of strategic alignment (Bergeron *et al.*, 2004) referred in the above literature review, Luftman (2000) presented the first approach for assessing the maturity of the business–IT alignment in the organizational context; five levels of strategic alignment maturity are proposed and validated by an empirical survey. Another business–IT alignment model originated from SAM is the unified framework proposed by Maes *et al.* (2000). After reviewing all above strategic models, Avison *et al.* (2004) conducted a four-step process for practical usage of SAM in the real world. Aversano *et al.* (2012) categorized other alignment models, such as business rules models, integrated alignment model used in IT unit, IS capability model, etc. One of the latest models, Peng and Nunes (2017) proposed the 9D ERP evaluation framework, which includes 9 dimensions and 85 evaluation criteria, focusing on critical failure factors to address in the post-implementation phase. Additionally, there are two other ERP-related alignment models which focus on phases other than the post-implementation phase. One is the Path model (Velcu, 2010) used to organize different variables, which focuses on the ERP implementation project. The other is the UML model (Wu *et al.*, 2007) which is for ERP selection.

A traditional IS application is usually developed or customized based on the business process and the needs of the organizations. On the contrary, organizations which adopted off-the-shell ERP packages have to modify the system or themselves to achieve the alignment of business and IT/IS. Process models, such as ERP institutionalization model (Maheshwari *et al.*, 2010), ERP life cycle model (Huang and Yasuda, 2016) and other process models in the ERP implementation course (Huang and Yasuda, 2014) tend to divide the time of the use of ERP systems into several stages, at which distinctive features both in the ERP system and the organization are contained. They are considered to be useful in understanding the complex phenomena and knowledge in the assimilation process. In order to use the process model in practice, Holland and Light (2001) constructed a three-stage ERP maturity model with five criteria: strategic use of IT, organizational sophistication, penetration of the ERP system, vision, and drivers and lessons. Although it is considered to provide a better understanding of the ERP implementation issue and strategy, the process model, like above SAMs, is a little bit of tricky to be used in practice to assess the relationship between IT/IS and the business of organizations.

One common feature of alignment models is that multiple variables are defined in the model, usually from both business perspective and system perspective. Although most of the mentioned models are claimed to be got from or to be adopted by firms in a practical evaluation, all the evaluation criteria are qualitative rather than quantitative. The status of alignment is usually measured on several levels, which also use qualitative criteria. This makes the boundary between levels to be very vague. Another issue is that the levels are set from the worst to the best, and the top level and the bottom level are conceptual rather than practical. As the survey results of Luftman (2000) show, most organizations' alignment maturity is at the level 2 (five levels), which reflects that the discrimination of these models is not very good. The process model, on the other hand, is easier to be understood. It consists of multiple stages which are divided by different time periods, and each stage usually contains certain distinctive features. For instance, the product life cycle model is a classic process model. However, the boundary between two stages of the process models is vaguer than the alignment models. Hence, we try to invent a business–ERP alignment assessment model that has the advantages of both alignment models and process models and eases the disadvantages.

Methodology

The adopted methodology combines relevant literature review and empirical data from three Japanese companies. The process of the research design is illustrated in Figure 1. After a thorough literature review on IS alignment models and process models, four prior models are selected to generate the assessment criteria and assessment levels for our model. We reference the Cartesian coordinate system to form the conceptual model for better visual appearance. Then, we use the data from three Japanese companies to connect the conceptual model to practical use and to validate the four propositions proposed to distinguish the four assessment levels.

The foundations of this model are the SAM (Henderson and Venkatraman, 1990), business–IT alignment maturity assessment model (Luftman, 2000), the software maintenance life cycle (Nah *et al.*, 2001) and the ERP life cycle model (Huang, 2016). First, we intend to keep the advantages of the alignment model and the process model. In the SAM and the business–IT alignment maturity assessment model, the organization and IT criteria covered the whole organization and IS, which are suitable for the assessment criteria. In the ERP life cycle model, the four stages represent the whole lifespan of adopted ERP in an organization, which are perfect for the assessment level. In order to connect the assessment criteria to the assessment level, we introduced the software maintenance life cycle model which contains the maintenance activities to tie the issues and stages together. More importantly, the maintenance activities caused by organizational and technological issues (TIs) are quantitative criteria, and the data are kept in organizations. Hence, the proposed business–ERP alignment assessment model contains four major assessment criteria (ERP-related organizational issue (OI), ERP-related TI, routine maintenance activity and exploration maintenance activity (EMA)) and four assessment levels. The process of generating those criteria is described in the following section.

Conceptual business–ERP alignment assessment model

Assessment criteria

Nah *et al.* (2001) proposed a software maintenance life cycle model which consists of four stages—the Introduction stage, the Growth stage, the Maturity stage and the Decline stage. These patterns related to the variation of maintenance activity can be revealed from quantitative data such as maintenance log that documented regularly by organizations or vendors. Maintenance activity is one important criterion which exists through the whole life of IS in organizations, even if the IS is not to be an on-premise system. Nah *et al.* (2001) classified six maintenance categories—corrective maintenance, adaptive maintenance, perfective maintenance, preventive maintenance, user support and external parties—based on the most frequently cited classification of Lientz and Swanson which consists of the corrective maintenance, the adaptive maintenance and the perfective maintenance. Each maintenance category has two to five maintenance tasks which describe the issues generated by the business and system. Based on the criteria of SAM (Henderson and Venkatraman, 1990) and business–IT alignment maturity assessment model (Luftman, 2000), we reform and redefine the maintenance tasks into 2 major categories and 16 sub-categories. The maintenance activities also are re-organized into two major categories.

Organizational and TIs. Two dimensions of the ERP-related issue are the ERP-related OI and the ERP-related TI. “ERP-related” before each term emphasizes all the issues that qualified in these categories should have relation with ERP. A total of 16 sub-categories within six categories are defined in Table I.

Routine maintenance and EMA. In this research, only two categories of maintenance activity are proposed. The routine maintenance activity (RMA) refers to maintenance activities that are caused or required by the regular operation of a system, which is equivalent to the contents of the last three maintenance categories of Nah *et al.* (2001). On the other hand, maintenance activity related to major changes both organizational and technological is

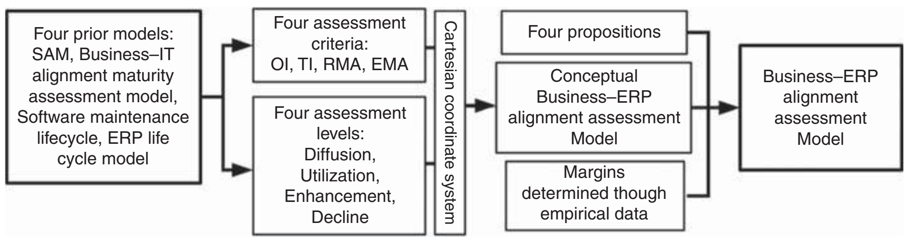

Figure 1.
Research design

RMA	EMA
OI	
End-user support	Business enhancement
Users ask questions related to system usage	Business process needs to be added, modified or deleted
Users are trained to adapt new system and new added functions	Adding or developing new functions, modules, systems to fit new needs
End-user management	Reconstruction
New administration tasks related to the system, such as access, authority, etc. occur when adding or reducing uses	Major changes in organizational structures, human resources, rules, strategic objectives or budgets
Man-made failure	Industry variation
Major failure or damage caused by using system inappropriately	Economy situation and macro-environment vary uncontrollably
Third-party coordination	Supply chain variation
New system notice, request, report, suggestion or question that related to the individuals from the vendor, the consultant, the partner organizations or other third-parties	Organizations linked in supply chain vary unpredictably
Management variation	Mergers & acquisitions
Routine variation in management and administration tasks	Planned or unexpected mergers and acquisitions
TI	
Routine enhancement	Major modification
Hardware maintenance and regular system errors and upgrades need to be fixed	Enhancing, deleting, modifying or expanding the existing functions for better performance
Critical enhancement	Technology trends
Sudden, dramatic or fatal system errors need to be dealt with	Following the emerging of new information systems, services and information technology
	System collaboration
	Linkage or interface adjustments caused by systems' variation of partner organizations
	Outsourcing variation
	Major changes of outsourcing organizations (e.g. Bankruptcy, out of production, etc.)

Notes: OI, ERP-related organizational issue; TI, ERP-related technological issue; RMA, routine maintenance activity; EMA, exploration maintenance activity

Table I. Classification of maintenance activities and corresponding issues

defined as the EMA, which is equivalent to the contents of the first three maintenance categories. Since one issue corresponds to one maintenance activity, Table I shows the specific relationships between maintenance activities and the corresponding issues.

Assessment levels

Huang (2016) proposed the four-stage life cycle model (Figure 2) for the ERP system which describes the entire lifespan of adopted ERP system in an organization from go-live to withdrawal. It contains four stages—the Diffusion stage, the Utilization stage, the Enhancement stage and the Decline stage, which also matche the above software maintenance life cycle model (Nah *et al.*, 2001). Every stage represents a certain period in the ERP life cycle which is distinctive to the others. In this research, issues and corresponding maintenance activities are used to tell the differences among those four stages. In general, the Diffusion stage, in which users are usually struggling to adopt the new ERP system, happens when the adopted ERP first operates in organizations. Issues occur due to the process of alignment between ERP and business process, and the maintenance activities—both RMA and

EMA—rise correspondingly; only a few of them are caused by extending or modifying the ERP due to rare exploring activity since the ERP is unfamiliar to the users. On the contrary, in the Enhancement stage, in which new enhancement projects are added in, exploring activities both in business management and system management, such as business process reengineering, system extending and so on, become the main reasons for an unstable situation, and proportion of the EMA increasing dramatically. The Utilization stage is the most stable period, in which routines are conducted by end-users through the ERP system. Contrary to the Utilization stage, the Decline stage is the most unstable stage, in which various issues emerge and will be out of control sooner or later if they are not handled appropriately.

Adopt the Cartesian coordinate system

In order to connect all the assessment criteria and levels mentioned above, a modified Cartesian coordinate system is adopted for better visual appearance. The proposed model is depicted in Figure 3. It consists of four assessment criteria and four assessment levels divided by three margin lines.

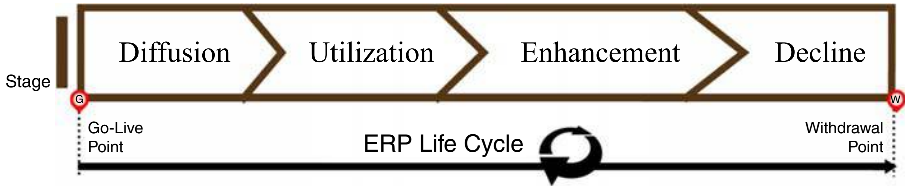

Figure 2. ERP life cycle model

Source: Huang (2016)

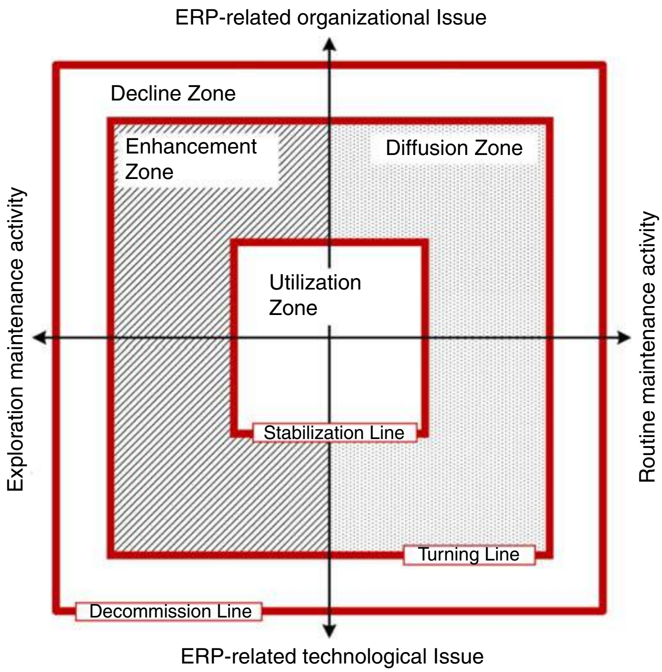

Figure 3. Conceptual business–ERP alignment assessment model

Three margin lines. Three margin lines are proposed to distinguish the four assessment levels from each other. All the margin lines—Stabilization line, Turning line and Decommission line—are shaped into a rectangle which caused one and only one certain crosspoint in each of four directions.

The Stabilization line distinguishes the Utilization zone from the Diffusion zone and the Enhancement zone. More issues and more maintenance activities correspond to a more unstable of the ERP system. The Stabilization line means that the status of ERP alignment inside the Stabilization line is more stable than the outside.

The Turning line distinguishes the Decline zone from the Diffusion zone and the Enhancement zone. Similarly, as in the case of the Stabilization line, the status inside the area of the Turning line is better than the outside. However, when the status of a system is running out of the Turning line, it usually means serious risks that need to be paid attention to.

The Decommission line is the final margin line which represents the current ERP has or will be decommissioned if it has been reached from any direction. It should be set up in advance as the bottom line of the business–ERP alignment.

In order to adopt the model into practice, the determination of the Stabilization line and Turning line is critical. In the next section, we will present the process by using the case data.

Four propositions

In this research, a rectangular shape, which presents the amount of different OI, TI and maintenance activities, is called the Dynamic Issue Zone (DIZ). The DIZ is a floating rectangular to show the status of alignment at certain time slice. Each side of DIZ is determined by the number of issues or activities in each category. Four propositions can be established based on the ERP life cycle theory (Figure 4):

P1. When every side of the DIZ is inside the Stabilization line, the status of ERP alignment is in the Utilization stage.

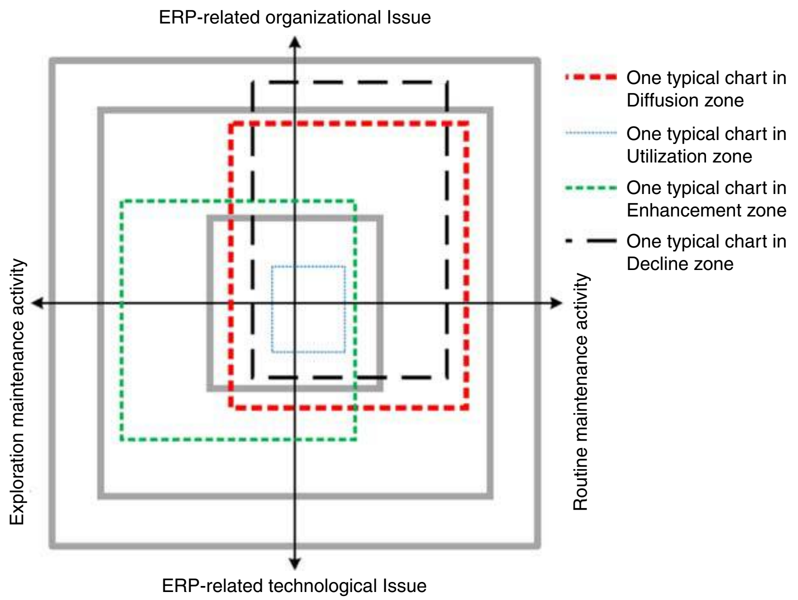

Figure 4.
Four typical charts corresponding to four assessment levels

P2. When any side of the DIZ is between the Stabilization line and the Turning line, every side of DIZ stays inside the Turning line, and it occurs in an early period, the status is in the Diffusion stage.

P3. When any side of the DIZ is between the Stabilization line and the Turning line, ever side of DIZ stays inside the Turning line, the proportion of EMA increases, and it occurs in a relatively late period, the status is in the Enhancement stage.

P4. When any side of the DIZ is outside the Turning line, the status is in the Decline stage.

Using the proposed model in three Japanese companies

Research data were collected from three large Japanese manufacturing companies which have successfully implemented ERP system (SAP R/3) around the 2000s. All three companies are listed in the First Section of the Tokyo Stock Exchange with a capital more than $300m. As the requests of research subjects, all three companies will be referred anonymously and the specific information about the companies will not be included.

Case A

The implementation of the ERP system was successfully finished in 1999. The company aimed to not only optimize the internal business process management but also build an automatic link for information exchange with other ISs of the business partners. The company adopted a Big-Bang method to implement most modules of the ERP system at the same time both in the head office and eight branch offices of production. The ERP system is used in production management, quality control, sales management, human resource management, accounting and inventory control of external business partners. The number of end-users is approximately 100,000.

Case B

The ERP system of the Case B started to operate around 2001. Top management of the company aimed to rebuild the business process and IT infrastructures simultaneously. The new IS was planned to be able to link and support all business units, employees and the business process (e.g. accounting, human resource management, production management, sales management and quality control). A total of six business divisions with more than 12,000 employees are routinely using the ERP system.

Case C

The ERP system of the Case C went live in 2002. One of the goals of the company was to replace the legacy enterprise system. There is one difference from the above two cases, that only financial-related modules were installed due to the company focusing more on the financial and accounting management. Among more than 9,000 employees, the ERP system is used in three business units and involves approximately 5,000 employees.

Data collection

Two main sources of data are applied in this research—observations and documents. The observations were supervised by the CEO and CIO of each company and conducted in each IS department. The maintenance documents are stored on the companies' computers. We were given the permission of reviewing the maintenance documents. Documents consist of maintenance requests and reports, system logs, defect reports and trouble reports. Data from the same period, five years, were collected in all three cases. The five years are calculated from the go-live point of the ERP system. Based on the classification of issues and activities, the number of each category was counted manually and recorded in the following tables. The causes of the maintenance requests were first located. Then, the causes were identified into the above 16 sub-categories (Table I). Based on the identification table earlier, the two main maintenance activities were located. Finally, the number of issues in each category was accumulated (Tables II–IV). For instance, when one maintenance log for dealing with modifying one business process in the system of Case A was located in the 44th month, the corresponding issue, based on the framework of issue identification, belongs to the "Business enhancement" which belongs to the "Internal management-driven issue" which belongs to the OI; the maintenance activity belongs to the EMA. Then, one was added to the cell of OI and EMA each under the 44th month in Table II.

Data analysis

The variation of the four categories in three cases along with 60 months is illustrated in Figure 5. The vertical axis represents the number of issues. The horizontal axis refers to the time period. There are some similarities in three cases during the first five years. First, most issues and maintenance activities happened in the first year. Second, all four categories reach the peak rapidly in the first three months and decrease to a stable level slowly.

Month	1	2	3	4	5	6	7	8	9	10	11	12
First year												
OI	293	306	259	246	212	178	105	70	46	39	17	19
TI	215	219	222	186	169	102	104	56	70	68	57	53
EMA	100	115	112	96	53	15	16	15	21	27	16	17
RMA	408	410	369	336	328	265	193	111	95	80	58	55
Second year												
Month	13	14	15	16	17	18	19	20	21	22	23	24
OI	15	17	17	19	21	14	20	25	15	17	10	10
TI	53	36	38	38	42	51	46	55	49	60	46	40
EMA	13	16	12	12	8	7	12	18	13	19	7	5
RMA	55	37	43	45	55	58	54	62	51	58	49	45
Third year												
Month	25	26	27	28	29	30	31	32	33	34	35	36
OI	16	12	11	12	10	22	28	20	19	29	35	34
TI	42	44	45	44	58	58	55	58	56	53	51	60
EMA	11	11	8	7	8	11	16	16	14	14	13	12
RMA	47	45	48	49	60	69	67	62	61	68	73	82
Forth year												
Month	37	38	39	40	41	42	43	44	45	46	47	48
OI	31	30	36	49	45	46	49	45	33	38	29	31
TI	66	68	81	80	73	86	64	69	61	64	57	59
EMA	11	13	29	40	37	46	29	43	33	29	22	28
RMA	86	85	88	89	81	86	84	71	61	73	64	62
Fifth year												
Month	49	50	51	52	53	54	55	56	57	58	59	60
OI	44	53	42	42	49	45	50	83	86	97	115	96
TI	57	63	77	84	86	93	92	131	136	137	141	121
EMA	27	32	39	33	34	42	50	108	102	100	107	76
RMA	74	84	80	93	101	96	92	106	120	134	149	141

Notes: OI, organizational issue; TI, technology issue; EMA, exploration maintenance activity; RMA, routine maintenance activity

Table II. Data collection of Case A

Table III.
Data collection of Case B

Month	1	2	3	4	5	6	7	8	9	10	11	12
First year												
OI	160	241	223	172	148	115	100	88	76	78	54	51
TI	169	169	163	147	112	88	61	49	45	42	40	41
EMA	115	115	108	86	68	46	30	19	17	15	11	17
RMA	214	295	278	233	192	157	131	118	104	105	83	75
Second year												
Month	13	14	15	16	17	18	19	20	21	22	23	24
OI	52	52	47	56	57	52	44	37	38	30	29	25
TI	41	47	51	52	43	49	48	49	42	37	37	40
EMA	13	20	24	22	15	22	19	19	14	10	13	14
RMA	80	79	74	86	85	79	73	67	66	57	53	51
Third year												
Month	25	26	27	28	29	30	31	32	33	34	35	36
OI	21	20	24	22	26	28	27	36	31	27	31	26
TI	38	32	36	36	38	35	42	46	45	39	36	42
EMA	11	9	8	9	12	9	12	17	18	12	10	11
RMA	48	43	52	49	52	54	57	65	58	54	57	57
Forth year												
Month	37	38	39	40	41	42	43	44	45	46	47	48
OI	26	47	51	68	61	48	48	45	54	53	58	51
TI	45	39	45	45	41	54	61	62	60	55	56	54
EMA	15	8	14	14	10	26	37	34	28	27	27	24
RMA	56	78	82	99	92	76	72	73	86	81	87	81
Fifth year												
Month	49	50	51	52	53	54	55	56	57	58	59	60
OI	68	91	100	102	104	99	90	82	68	74	58	59
TI	53	85	112	146	173	151	109	95	73	60	37	42
EMA	24	58	85	120	121	97	50	38	28	15	4	6
RMA	97	118	127	128	156	153	149	139	113	119	91	95

Notes: OI, organizational issue; TI, technology issue; EMA, exploration maintenance activity; RMA, routine maintenance activity

Third, a second wave can be spotted after three years. An integrate wave is recorded in the Cases B and C. In the Case A, the second wave occurred relatively late in the end of the fifth year.

Determine the margin lines of the assessment model

Determine the turning line

In order to convert the data into a visualized graph, first, the three margins in the business–ERP alignment assessment model need to be determined. The most dangerous period after the implementation of ERP system is the period right behind the go-live point. As we can see in Figure 5, the sign of highest risks shows in the first to the third month. Hence, the value of the Turning line is approximately equal to the mean of the values in the first three months. The Turning line has a different value in the four categories, which determines the location of it in the four directions. As Figure 6 illustrates, the value of Tuning line in the category of the RMA in the Case A—396—is calculated by average the number of RMA in the first to the third month (408, 410 and 369). Similarly, the value in the category of the ERP-related OI is 286 (the average of 293, 306 and 259). The other two categories are calculated in the same way.

Month	1	2	3	4	5	6	7	8	9	10	11	12
First year												
OI	80	104	115	107	84	56	52	23	22	24	20	14
TI	80	68	52	50	46	38	39	37	31	27	20	14
EMA	60	45	27	22	18	7	9	3	3	5	4	1
RMA	100	127	140	135	112	87	82	57	50	46	36	27
Second year												
Month	13	14	15	16	17	18	19	20	21	22	23	24
OI	13	7	2	0	4	4	2	4	5	7	4	4
TI	13	13	14	11	12	10	10	11	11	12	11	10
EMA	0	0	1	0	1	1	1	0	1	1	3	1
RMA	26	20	15	11	15	13	11	15	15	18	12	13
Third year												
Month	25	26	27	28	29	30	31	32	33	34	35	36
OI	2	1	1	3	10	10	5	4	4	8	4	5
TI	11	12	11	10	12	11	12	10	14	15	17	14
EMA	1	1	2	1	1	0	2	2	4	5	6	5
RMA	12	12	10	12	21	21	15	12	13	18	15	14
Forth year												
Month	37	38	39	40	41	42	43	44	45	46	47	48
OI	13	14	15	31	40	36	36	45	34	28	21	15
TI	20	25	27	50	64	78	75	59	53	44	34	23
EMA	12	18	17	48	57	66	60	39	31	19	7	3
RMA	21	21	25	33	47	48	51	65	56	53	48	35
Fifth year												
Month	49	50	51	52	53	54	55	56	57	58	59	60
OI	14	9	2	4	2	2	0	2	2	3	3	3
TI	17	12	10	10	9	10	10	13	13	10	10	11
EMA	0	1	0	0	0	1	0	1	0	0	0	1
RMA	31	20	12	14	11	11	10	14	15	13	13	13

Notes: OI, organizational issue; TI, technology issue; EMA, exploration maintenance activity; RMA, routine maintenance activity

Table IV. Data collection of Case C

Determine the stabilization line

The Stabilization line is inside the Turning line. The inside of the Stabilization line is the Utilization zone which refers to the routine operation of ERP system. This line can be determined by averaging the values of the four categories during the 6th to the 12th month. Using the same method as the Turning line, the value in the category of the ERP-related TI in the Case A is 73 (the average of 102, 104, 56, 70, 68, 57 and 53). Similarly, the other three values can be calculated in the same way, which determine the location of the Stabilization line. The location of the Decommission line in Figures 6–8 is not determined by precise data calculation since all of these companies have decommissioned the ERP system under study.

Technically, 60 graphs in total five years can be drawn based on the issue-based ERP assessment model. For simplicity, only three representative graphs in each case were chosen. In Case A, the graphs from the 4th, 24th and 56th month are illustrated in Figure 6. Figure 7 shows the 4th, 24th and 51st month in Case B. The three representative months of Case C are the 4th, 24th and 40th month (Figure 8). The fourth month is chosen because it is the first month after the highly risky three-month period.

Based on the four propositions, the graphs in the fourth month of Cases A and B are typical charts showing the status of the ERP system is in the Diffusion stage.

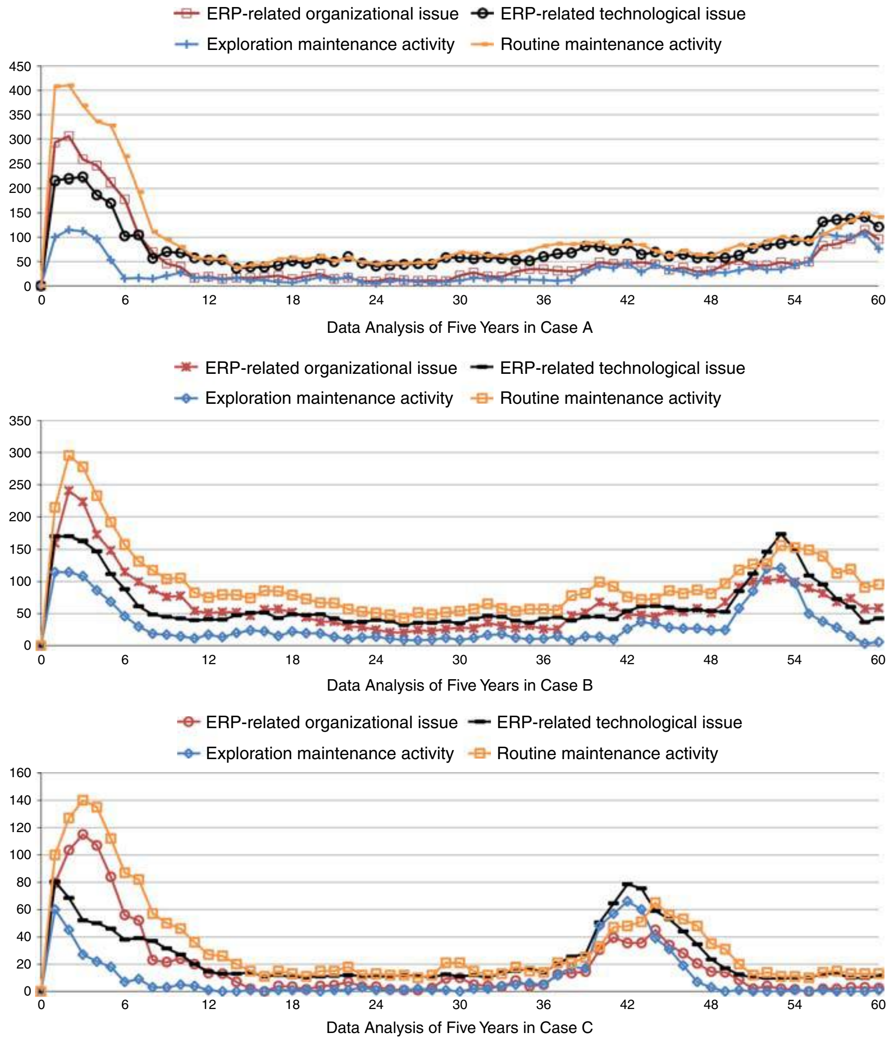

Figure 5.
Data analysis of five years in three Cases

The turbulence in Case C was so dramatic which causes the status staying in the Decline zone until the fifth month. The second representative month—the 24th month—is chosen to show the routine usage. The last representative month that varies in three cases refers to the enhancement event. The graph in the 24th month of each case is in a state of resembling, which shows the status is in the Utilization stage as *P1* described. The exploratory activity is rare and the organization issues are low; the system-driven issues and the corresponding routine maintenance activities are the majority. The third representative month in three cases shows the status of the system in the Enhancement zone, as *P3* described, which is featured by the increasing of the EMA. In Case A, the enhancement event, forming the supply chain management system with the partner companies, happened from the 38th month. Almost in the same period as Case A, the company of Case B started to extend the system functions. The extending project was operated in one department first to control the

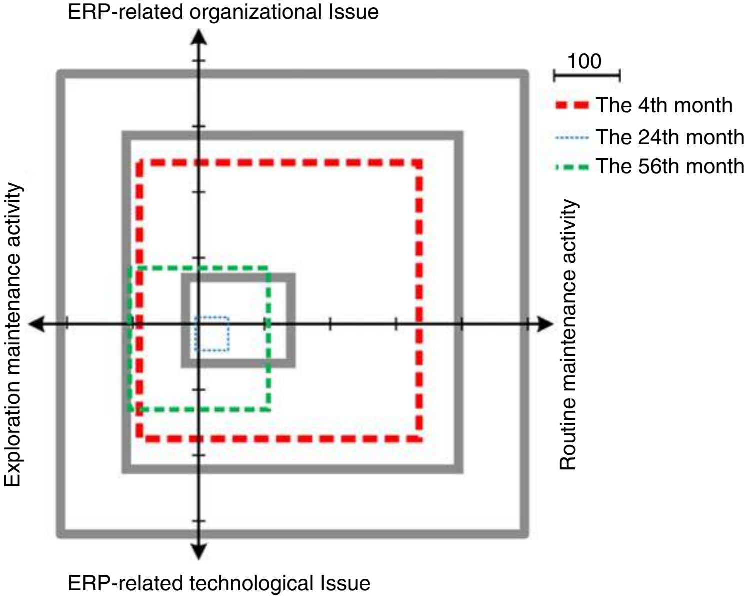

Figure 6.
Assessment results of Case A in three representative months

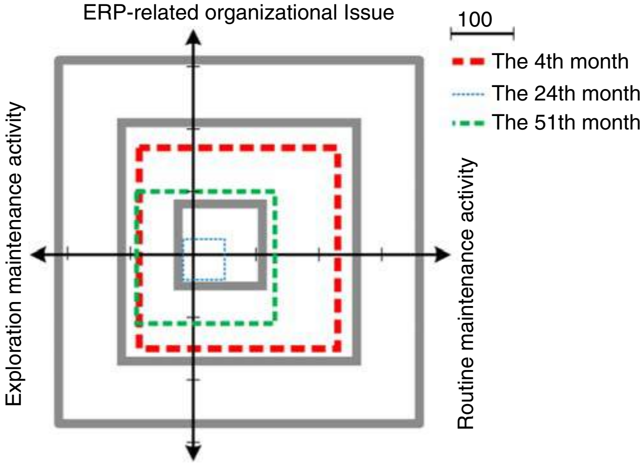

Figure 7.
Assessment results of Case B in three representative months

risks, and then it was carried out in the whole company which caused the turbulence from the 48th month. In Case C, a major upgrade of a system offered by the vendor was decided in the 36th month. The consultant was also involved in the decision making. Additionally, the DIZ in Figure 8 in the 40th month reaches the Decline zone suddenly and remains for another three months.

Due to the limitation of the amount of data, the permanent Decline stage cannot be tested in this research. However, *P4* has been partially proved by looking at the graphs in the early months. Because of the highest amount of issues and corresponding maintenance activities, the status of ERP alignment was in the Decline stage for the first two months. If this situation cannot be fixed, there might be a high risk of failure in ERP implementation project.

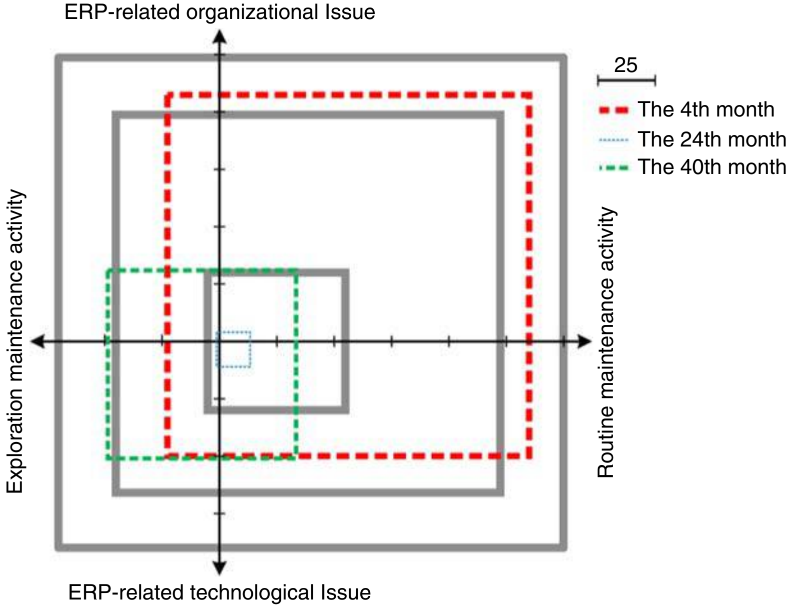

Figure 8.
Assessment results of Case C in three representative months

Discussions

Implications

From the academic perspective, this research contributes to the body of knowledge. First, the proposed model provides a new approach to evaluating the alignment of organizations and ERP systems. According to the results of literature review, most alignment assessment models are made up of key criteria and measurement levels. For instance, the SAM (Henderson and Venkatraman, 1990) points out the critical factors which are essential for business–IT alignment; the business–IT alignment maturity assessment model (Luftman, 2000) is able to set five qualitative levels to each critical factor for measurements. The proposed model not only contains considerable assessment criteria and assessment levels, which makes sure to provide a grounded foundation to evaluation but is also able to connect the criteria and levels to add a quantitatively feature to the assessment model. Second, choosing the Cartesian coordinate system to construct the model makes sure to be able to assess the alignment status of ERP and business quantitatively, and the result of the assessment is easier to be recognized through intuitive graphs. Third, the process models usually present distinguish stage 1 after another in a certain sequence during the ERP lifespan. However, by drawing the assessment results every month with the proposed model, we get the empirical evidence of the variation of the business–ERP alignment along with time. For instance, the Utilization stage and the Enhancement stage might occur repeatedly one after another. For other researchers, the process of model construction in this research might enlighten them to invent conceptual model using a similar approach. The enhancements and variations of the proposed model are expected as well as the usage of them in other ISs.

One major practical implication is that this research provides an easy assessment method which might encourage organizations to do evaluations regularly. Second, maintenance data of IS are usually not used for the second time in organizations. This study provides a better method to make the data valuable and usable to the organization again. Further, the information accumulated by regular assessment can pinpoint an appropriate timing to make decisions and provide essential evidence for decision making, such as when to expand or retire the current system. Usually, more time and costs will be spent before organizations realize that they should retire the current system. It is like the disease of cancer, people tend to bear the minor symptom until it is too late. Our method is like the physical examination to organizations. By doing evaluations regularly, organizations can realize that the status of the business–ERP alignment remains in the Decline zone and is difficult to get out of it, which is different from the chaos just after the system go-live or new add-on. Then it is the appropriate timing to consider other options, such as revise or switch the current system.

Additionally, the proposed method not only can be adopted in the whole system but also in one department or business unit. For other practitioners, such as consultants and vendors, the quantitative model can be easily turned into assessment application or module to make evaluation more convenient and to refine the assessment services.

Potential issues

During the investigation, we find that some potential issues exist, however, without recordation and enough attention. Every maintenance task has one corresponding issue, but the issue usually exists long before it causes the maintenance activity. We call this kind of issues as the potential issues. The potential issues are the antecedents of most modifications of ERP system and organization. For instance, at the individual level, a representative potential issue is the User satisfaction. Many studies have concluded the effect of the User satisfaction on ERP post-implementation success (Hsu *et al.*, 2008; Longinidis and Gotzamani, 2009; Ng, 2013; Saatçıoğlu, 2009; Zviran *et al.*, 2005). User satisfaction refers to "the extent to which users perceive that the IS available to them meets their information requirements" (Somers *et al.*, 2003). The expression of the low user satisfaction may be a low frequency of system usage, complaints, new workarounds (Ignatiadis and Nandhakumar, 2009), etc. The potential issues also exist in management and system levels. For instance, other companies in the same industry start to replace current ERP system with new ERP services, partner companies have plans to upgrade or implement new modules, new technology spreads fast, critical problems occurring in third-parties and so on. All potential issues may affect the ERP systems and organizations in the future. By recording these potential issues in advance and adding them into the assessment model will get more realistic results which may bring organizations time to prepare themselves in advance, instead of reacting passively to a burst of crisis.

Assessment files

Not just the potential issues, but other categories of issues are also hard to be located as well. As we described in the section of data collection, the maintenance documents do not have a unified format in one organization. For most of the time, all the maintenance reports, system logs, defect reports and trouble reports may not be reopened again. The results of this research reveal the potential value of regular documents in organizations. By building a system of assessment file management, system evaluation can be operated efficiently with fewer costs and more accurate results, which also may shorten the period between two regular assessments and enables the organizations keeping a close eye on their ERP systems. The organizational and TIs which have already caused the maintenance activities can be organized by analyzing the maintenance documents. The cause of every maintenance document can be identified and classified into the assessment files. On the other hand, the potential issues need to be recorded exclusively by managers at every level.

Decline zone

In process model such as ERP life cycle model, the Decline stage usually appears in the last. However, the results of this research reveal the Decline stage can occur after every other stage as an inevitable process but maybe not fatal all the time. As Figure 5 illustrates, the first three months contain violent turbulence, in which the value of the RMA is out of the Turning line, which indicates the Decline zone. For instance, Case C in the fourth month has not gotten out of the Decline zone. Luckily, the period in the Decline zone is not more than four months in all three cases, which could explain the failure of ERP project if its status is stuck in the Decline zone for too long. Similarly, major business process reengineering or system integrations may also cause severe fluctuations. For instance, the Case B reaches the Decline zone in the 52nd and 53rd month, and the Case C stays in the Decline zone from the 40th month to the 43rd month. Nevertheless, they all return to the Utilization zone soon. On the other hand, a considerable situation in the Decline zone is the one caused by the potential issues. For instance, despite the assessment result of the ERP system shows the status to be in the Utilization zone for a long time, the competitive advantage and the organizational performance keep dropping. If the organization has taken notes of the potential issues, they would find out that new cheap and efficient ERP systems are being adopted by competitive enterprises, more complaints or neglects from the end-users, habits changing of customers, etc. By counting these potential issues in the first place, the assessment results may show a completely different picture—being in the Decline zone with high organizational and TIs.

Limitations

There may be some deviations in identifying and counting the issues and maintenance activities. The quality and integrity of the maintenance documents vary in different organizations because the maintenance data are rarely reused systematically. Additionally, there may be some overlooked documents as well. Due to all the three cases use the ERP system from the same vendor, it needs more empirical data of other ERP systems to confirm the universality of the calculation method which locates the margin lines of the model. Based on the data of three companies, the method of calculating the zone boundaries was proved to be appropriate in the main. Nevertheless, it needs more empirical data of other ERP systems to confirm the universality of the calculation method which locates the margin lines of the model and to refine the accuracy. The three companies are all LEs which may leave the question about whether there are differences in SMEs. Only five years' data are analyzed in this research. The entire maintenance data of a whole ERP life cycle—from the go-live of the ERP system to the replacement—will be more valuable to test the model.

Conclusions and future work

In this research, a business–ERP alignment assessment model is proposed and validated through three Japanese companies. As we can see in the results of assessing the five year's maintenance data in three companies, the chart stays in the Diffusion zone for the first year and rapidly shrinks into the Utilization zone for a relatively long period. When the chart enlarges again, it shows as the chart in the Enhancement zone. According to the real events of three companies, there was an upgrade or new implementation in the same period when the chart shows the Enhancement zone. The above results prove the feasibility of the model and reveal the variation of the ERP alignment in a visualized way. It is also indicated the utilization of the business–ERP alignment assessment model is a more convenient method to help the organizations to pinpoint the status of the ERP alignment. In regular qualitative assessment methods, for instance, the same criterion within different assessment levels is distinguished by "Good […]," "Limited […]," "Some […]" or "Lack of […]," which might cause a very subjective outcome—different people can conclude different results. By using the maintenance documents, the quantitative approach is more objective and reliable than qualitative methods and eases the above problems. The analysis also points out the neglected areas of document management in organizations, such as the importance of recording the potential issues and building the assessment files. In order to be able to improve the accuracy and the efficiency of the method, we have the following recommendations:

- build assessment files to record the ERP-related organizational and TIs and the corresponding maintenance activities from the beginning;
- build the category of the potential issues into the assessment files;
- execute the assessment regularly and continually in every three to six months; and
- pay attention to the status in the Decline zone and find out its reasons and make the plan in advance.

A general guideline for applying this model for practitioners and other researchers are summarized in the following. First, file all the system maintenance data into 16 categories of issues and 2 categories of activity and accumulate the value of the OI, TI, EMA and RMA. Second, record the data continuously for at least one year (best from the beginning) to set up the margin lines. The margin lines represent the extreme status of every zone. Hence, each margin line should be set up by using the most representative data. Third, Stabilization line can be determined by averaging the values of the four categories during a relatively stable six-month-long period (the sixth to the 12th month in Case A). Turning line is better to be set by averaging the data from the first unstable period (first three months in Case A). Decommission line is affected by the capacity of organization on both business and system management, which can be determined dynamically by the strategic plan, such as budget, cost-benefit efficiency, etc. Fourth, pick the four values of any month to draw the DIZ in the business–ERP alignment assessment model to assess the ERP alignment status. Additionally, the calculation of the margin lines is not fixed as the examples in the research. Organizations can modify the calculation formula to reach the most suitable results for regular assessment.

As the first step of an exploratory research, more empirical data are needed for the perfection of this model, such as the method to determine the Decommission line in practice, especially, the Decline stage which we did not have the relevant data this time needs to be focused on in the future study. Meanwhile, empirical data from different type of ERP system, different industry, different culture and different time period are also expected.

References

Aversano, L., Grasso, C. and Tortorella, M. (2012), "A literature review of business/IT alignment strategies", *Procedia Technology*, Vol. 5 No. 2012, pp. 462-474.

Avison, D., Jones, J., Powell, P. and Wilson, D. (2004), "Using and validating the strategic alignment model", *Journal of Strategic Information Systems*, Vol. 13 No. 3, pp. 223-246.

Bergeron, F., Raymond, L. and Rivard, S. (2004), "Ideal patterns of strategic alignment and business performance", *Information & Management*, Vol. 41 No. 8, pp. 1003-1020.

DeLone, W.D. and McLean, E.R. (2003), "The DeLone and McLean model of information systems success: a ten-year update", *Journal of Management Information Systems*, Vol. 19 No. 4, pp. 9-30.

Henderson, J.C. and Venkatraman, N. (1990), *Strategic Alignment: A Model for Organizational Transformation through Information Technology*, Oxford University Press, New York, NY.

Holland, C.P. and Light, B. (2001), "A stage maturity model for enterprise resource planning systems use", *ACM SIGMIS Database*, Vol. 32 No. 2, pp. 34-45.

Hsu, L.-L., Lai, R.S. and Weng, Y.-T. (2008), "Understanding the critical factors effect user satisfaction and impact of ERP through innovation of diffusion theory", *International Journal of Technology Management*, Vol. 43 Nos 1-3, pp. 30-47.

Huang, T. (2016), "Peeking at the ERP decline stage: Japanese empirical evidence", *Computers in Industry*, Vol. 82 No. 2016, pp. 224-232.

Huang, T. and Yasuda, K. (2014), "ERP life cycle models: an annotated bibliographic review", *Proceedings of the 15th Asia Pacific Industrial Engineering and Management Systems Conference, Jeju, October 12-15*, pp. 70-77.

Huang, T. and Yasuda, K. (2016), "Reinventing the ERP life cycle model: from go-live to withdrawal", *Journal of Enterprise Resource Planning Studies*, Vol. 2016, pp. 1-21.

Ignatiadis, I. and Nandhakumar, J. (2009), "The effect of ERP system workarounds on organizational control: an interpretivist case study", *Scandinavian Journal of Information Systems*, Vol. 21 No. 2, pp. 59-90.

Jones, M.C., Zmud, R.W. and Clark, T.D. Jr (2008), "ERP in practice: a snapshot of post-installation perception and behaviors", *Communications of the Association for Information Systems*, Vol. 23, pp. 437-462.

Klaus, H., Rosemann, M. and Gable, G.G. (2000), "What is ERP?", *Information Systems Frontiers*, Vol. 2 No. 2, pp. 141-162.

Longinidis, P. and Gotzamani, K. (2009), "ERP user satisfaction issues: insights from a Greek industrial Giant", *Industrial Management & Data Systems*, Vol. 109 No. 5, pp. 628-645.

Lorenzo, O., Kawalek, P. and Wood-Harper, T. (2005), "Embedding the enterprise system into the enterprise: a model of corporate diffusion", *Communications of the Association for Information Systems*, Vol. 15, pp. 609-641.

Luftman, J. (2000), "Assessing business-IT alignment maturity", *Communications of the Association Information Systems*, Vol. 4 No. 14, pp. 1-50.

Maes, R., Rijsenbrij, D., Truijens, O. and Goedvolk, H. (2000), *Redefining Business: IT Alignment through a Unified Framework*, Universiteit van Amsterdam, Department of Accountancy & Information Management, Prima Vera Working Paper No. 2000-19.

Maheshwari, B., Kumar, V. and Kumar, U. (2010), "Delineating the ERP institutionalization process: go-live to effectiveness", *Business Process Management Journal*, Vol. 16 No. 4, pp. 744-771.

Moalagh, M. and Ravasan, A.Z. (2013), "Developing a practical framework for assessing ERP post-implementation success using fuzzy analytic network Process", *International Journal of Production Research*, Vol. 51 No. 4, pp. 1236-1257.

Nah, F.F.-H., Faja, S. and Cata, T. (2001), "Characteristics of ERP Software maintenance: a multiple case study", *Journal of Software Maintenance and Evolution: Research and Practice*, Vol. 13 No. 6, pp. 399-414.

Ng, C.S.-P. (2013), "A case study on the impact of customization, fitness, and operational characteristics on enterprise-wide system success, user satisfaction, and system use", *Journal of Global Information Management*, Vol. 21 No. 1, pp. 19-41.

Peng, G.C. and Nunes, M. (2017), "Establishing an evidence-based 9D evaluation approach for ERP post-implementation", *Industrial Management & Data Systems*, Vol. 117 No. 2, pp. 398-424.

Pishdad, A., Koronios, A., Reich, B.H. and Geursen, G. (2014), "ERP institutionalisation – a quantitative data analysis using the integrative framework of IS theories", *Australasian Journal of Information Systems*, Vol. 18 No. 3, pp. 347-369.

Rayner, N. (2014), "Survey analysis: adoption of cloud ERP, 2013 through 2023", Gartner Group Inc., Connecticut.

Saatçıoğlu, Ö.Y. (2009), "What determines user satisfaction in ERP projects: benefits, barriers or risks?", *Journal of Enterprise Information Management*, Vol. 22 No. 6, pp. 690-708.

Somers, T.M., Nelson, K.G. and Karimi, J. (2003), "Confirmatory factor analysis of the end-user computing satisfaction instrument: replication within an ERP Domain", *Decision Sciences*, Vol. 34 No. 3, pp. 595-621.

Velcu, O. (2010), "Strategic alignment of ERP implementation stages: an empirical investigation", *Information & Management*, Vol. 47 No. 3, pp. 158-166.

Wu, J.-H., Shin, S.-S. and Heng, M.S.H. (2007), "A methodology for ERP misfit analysis", *Information & Management*, Vol. 44 No. 8, pp. 666-680.

Zviran, M., Pliskin, N. and Levin, R. (2005), "Measuring user satisfaction and perceived usefulness in the ERP context", *Journal of Computer Information Systems*, Vol. 45 No. 3, pp. 43-52.

Corresponding author
Tingting Huang can be contacted at: yoruhuang@gmail.com