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Recommended Citation
Stijn, Eveline van and Wijnhoven, Fons, "Diagnosing Organizational Memory Mismatches in the ERP Usage Stage" (2000). *AMCIS 2000 Proceedings*. 82.
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Diagnosing Organizational Memory Mismatches in the ERP Usage Stage

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Abstract

Disparities may exist between memory elements (such as knowledge and information) embedded in an organization's ERP package and related memory elements located in other organizational memory media. This paper presents the Systematic Analysis Method of Memory Mismatches (SAMMM). Three types of such disparities, called memory mismatches here, have been observed by applying SAMMM to the usage stage of ERP systems. Because SAMMM includes the analysis of causes of memory mismatches, it can be used as a starting point for improving ERP performance. Additional research may focus on the enhancement and application of SAMMM combined with coping methods.

Keywords: Enterprise Resource Planning systems, ERP Usage Stage, Organizational Memory, Cognitive Dissonance

Introduction

Enterprise Resource Planning (ERP) systems have not only gained increasing ground in businesses all over the world[1]; academic concern for the ERP field is gradually expanding as well. Research on ERP systems in organizations essentially focuses on normative and descriptive models for implementing ERP systems (Kirchmer, 1999; Volkoff, 1999) and on identifying factors which contribute to successful and unsuccessful ERP implementations (Holland et al., 1999; Scott, 1999; Sumner, 1999; Van Slooten and Yap, 1999). Implementing an ERP system is "[…] not as much a technological exercise, but an 'organizational revolution', […] a matter of repositioning the company and transforming the business practices (Bingi et al., 1999, p. 9)."

The scarce research on ERP systems in the usage stage focuses on ERP systems' evaluation, i.e. performance measurement (Rosemann and Wiese, 1999) and has mostly been conducted by practitioners (cf. Deloitte Consulting, 1998). Further analysis based upon performance measurement may lead to the identification of problems as well as opportunities regarding the further development of the ERP system. For instance, data input errors and turnover of personnel (Markus and Tanis, 2000), changing business processes and structures (Davenport, 2000), or the migration to new versions of the ERP system (Kremers and Van Dissel, 2000). Though it is stressed that going live is not the end of the ERP venture, research does rarely discuss theoretical models of and empirical data on ERP systems in the usage stage. Similar to the implementation stage, the technological, organizational and cognitive aspects of the enterprise system need to be considered in the usage stage. Research on information systems in the usage stage, such as software maintenance (cf. Ramage and Bennett, 1998), structuration theory (cf. Orlikowski and Robey, 1991), and utilization of commercial packages (cf. Lassila and Brancheau, 1999) are all build around one or more of these aspects.

A call is made here for another approach that integrates these three aspects, namely the memory mismatch approach, which is primarily based upon organizational memory theory. Much of an organization's memory contents (knowledge, information, paradigms and human capital (Wijnhoven, 1999) is embedded in an ERP system while related memory contents are residing at other memory locations in the organization. Considering that, it could occur that these related memory contents are conflicting. This is a specific type of what is called an ERP memory mismatch in this paper. Suppose for instance that machines at the plant are maintained only when they are out of order (corrective maintenance), and this method is also embedded in the ERP plant maintenance module. When the company wants to change to a combination of corrective maintenance and preventive maintenance, a memory mismatch arises since some related memory contents may not exist in the ERP system yet. For instance knowledge may be lacking on how to compute mathematically what moment is best to check the machines and when to replace which parts. Such a memory mismatch may obviously lead to under-performance of the ERP system.

This paper presents a systematic method to analyze memory mismatches, their causes and their related under-performance, of an ERP system in-use, called Systematic Analysis Method of Memory Mismatches (SAMMM). The next section discusses the memory mismatch construct and provides a typology of memory mismatches. This is the theoretical foundation of SAMMM that is introduced next. Then, the results of the conducted multiple-case study, to demonstrate the theoretical and practical potential and limitations of SAMMM, are described. Three cases of memory mismatches have been observed at one Canadian and two Dutch companies. Next, the potential added value and limitations of SAMMM are discussed. The paper ends with the main conclusions and recommendations for future research.

ERP memory mismatches in theory

Organizational memory

One of the pillars of the memory mismatch construct is the notion that organizations (and its members) 'remember'. Organizational memory "[...] refers to stored information from an organization's history that can be brought to bear on present decisions (Walsh and Ungson, 1991, p.61)." This definition is rather narrow, since it only identifies information as a memory content. In this paper, three other types of memory contents are included too, namely knowledge, paradigms and organizationally accessible human capital. It should be noted that those types of memory contents are interrelated and that they influence each other. But they are not the same.

"[…] Information is the flow of messages, while knowledge is created and organized by the very flow of information, anchored on the commitment and belief of its holder (Nonaka, 1994, p.15)." In other words, information can be seen as messages that can become knowledge when its receivers can interpret these messages. Knowledge may be characterized as ranging from explicit to tacit. Explicit knowledge is transmittable in a formal language. Compared to explicit knowledge, tacit knowledge is more difficult to formalize and communicate and has a personal quality, deeply rooted in action, commitment, and involvement in a specific context (Nonaka, 1994). Paradigms refer to the organizational beliefs and the reigning values and norms (Wijnhoven, 1999). Human capital can be defined as "[…] person-dependent knowledge, information and skills (Wijnhoven, 1999, p.21)" and the individual's personal paradigms. Individual members of the organization typically own these memory contents and only if they are willing to share these contents, the organization is able to access them. Those memory contents may be stored at one or more different retention facilities, as illustrated in Table 1. These retention media each have different opportunities and limitations for storing memory, differing in speed, reliability, physical degeneration and availability (Wijnhoven, 1999). It is important to recognize that the memory contents and memory media cannot be separated from each other. A repository will always imply or embed memory contents and contents cannot exist without a memory medium.

An operationalization of memory mismatches

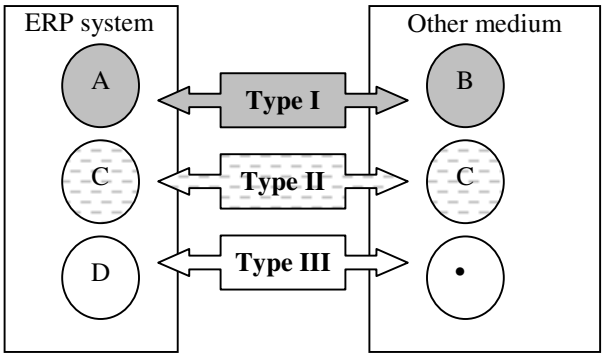
From an organizational memory perspective, the ERP system is a retention medium where memory contents are stored (see Table 1). For example, the reference models of ERP systems are based upon the key premise that they embody best business practices (Kumar and Van Hillegersberg, 2000). Such best practices thus are paradigms by our definition. Furthermore, such reference models imply other memory contents as well, because they "[…] supposedly reflect preferred business models including underlying data and process models, as well as organizational structures (Kumar and Van Hillegersberg, 2000, p. 25)." Then, a memory mismatch may exist between the memory contents in the ERP system and memory contents located in other retention media (Van Stijn, 1999). For instance, the ERP system's best practice paradigms regarding manufacturing may not confirm to the related best practice paradigms of the top managers or the manufacturing personnel (repository: individuals).

Table 1. Retention media and memory contents (Source: Wijnhoven, 1999, p. 160)

Memory medium	**Memory content**
Individual	Professional skills; evaluation criteria and results; explanation of procedures, decision rules; personal ethics and beliefs, performance criteria; individual routines
Culture	Schemes; stories; external communications; cultural routines; norms base
Transformation	Tasks; experiences; rules; procedures and technology; patents
Structure	Task divisions; hierarchy; social structure; formal structure; communication structure
Ecology	Layout of shop floor; building architecture
External	Client and market characteristics; competition profiles; list of "memory-able" people and organizations; technology of competitors
Information Systems	Planning and decision systems; process control systems; GroupWare; computer aided design systems, memory-based systems; administrative systems

The memory mismatch approach significantly differs from other misfit analyses because it explicitly compares memory contents with each other, whereas others indirectly and implicitly include memory contents in their analyses. For instance, one can analyze "[…] gaps between the functionality offered by the package and that required by the adopting organization (Soh et al., 2000, p. 47)", comparing the requirements originating from for instance processes, culture and structure, with the ERP system's best practices. In fact, such requirements are a translation of what memory contents the organization needs or has, based upon memory contents at various repositories, compared to the related memory contents that are standard in the ERP system. The memory mismatch analysis discussed later appears to be a more integrative, systematic, and less ad-hoc method to describe the misfits and gaps that may exist. But first, a typology of memory mismatches is introduced.

Figure 1. Schema of the types of memory mismatches

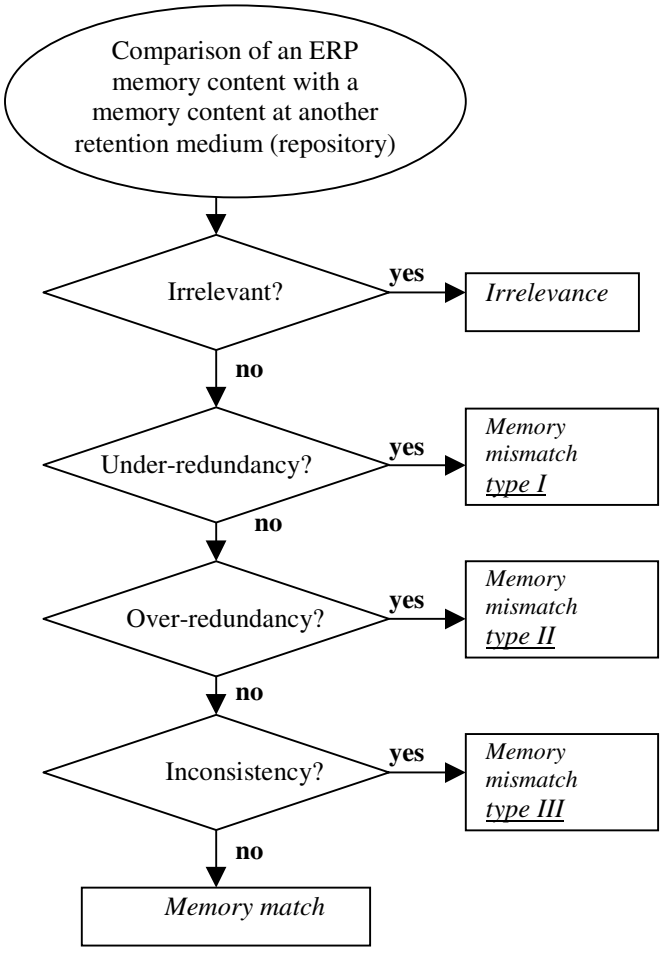


An interesting starting point for the further definition of memory mismatches was not found in organizational memory theory, but in cognitive dissonance theory, where the individual's memory is investigated. In his discussion of cognitive dissonance, the psychologist Festinger (1957) states that there are three possible relations between pairs of cognitive elements within an individual's mind, namely irrelevance, dissonance, and consonance. Irrelevance occurs when two elements have nothing to do with each other. When two elements are related to each other, they may either be consonant or dissonant. Two elements are dissonant if, they do not fit together, because they are inconsistent or contradictory (Festinger, 1957). For our discussion of memory mismatches, two extensions are made to this idea of cognitive dissonance. First, instead of comparing memory contents at one medium (the individual's mind), memory contents at the ERP system are compared with other retention media. Pairs of related content sets on those different media could be dissonant or consonant to each other. The second addition is that dissonance at the two compared media could arise if memory contents are missing where they should be existing, or if memory contents exist on both media where they should not be redundant. Based on this discussion, three types of ERP memory mismatches can be identified, as illustrated in Figure 1.

- **Type I. Under-redundancy**
  The memory content A in Figure 1 is missing in the other retention medium and memory content B is missing in the ERP system, but those memory contents should be existing in both media.
- **Type II. Over-redundancy**
  The memory content C in Figure 1 should not be redundant (being existing and the same in both media), but should exist in either the ERP system or the other retention medium.[2]
- **Type III. Inconsistency**
  If for both media, memory content 'D' in Figure 1 should be the same, the memory content D in the ERP system is inconsistent with the memory content • (not D) in the other retention medium, and vice versa.

Based upon this division, the decision tree shown in Figure 2 provides a logical order to systematically identify the three types of memory mismatches.

Figure 2. The Systematic Memory Mismatch Analysis Tree (Adapted from: Van Stijn, 1999, p. 49)



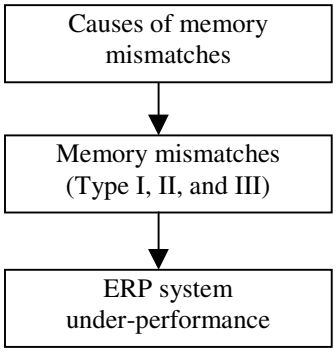
The Systematic Analysis Method of Memory Mismatches in the ERP usage stage

The discussed typology and the tree form the basis for the Systematic Analysis Method of Memory Mismatches (SAMMM). SAMMM includes a diagnosis of memory mismatches with respect to both their causes and the related under-performance of the ERP system. The causal model underlying SAMMM is shown in Figure 3 and provides an analysis scheme. The three steps of SAMMM are (1) to observe memory mismatches by applying the analysis tree and then (2) to further diagnose those memory mismatches by finding the causes and (3) the related under-performance, systematically filling in the causal model. The following key assumptions underpin the model when looking at the ERP usage stage:

1. Memory mismatches may be caused during the implementation stage, or come into existence during the usage stage.

2. During the usage stage, memory mismatches are caused by changes in the repositories and contents of the organizational memory.
3. Memory mismatches cause under-performance of the ERP system.

Figure 3. The causal model underlying SAMMM



The implementation choices made during the implementation stage may lead to memory mismatches that are likely to surface in the usage stage of the ERP system. For instance when the organization does not replace all its legacy systems, but only implements a minimum number of components of the ERP system. Then, for instance, individuals may have the knowledge and skills to integrate human resource and manufacturing information in e.g. capacity planning. But the ERP system may only have the information on human resources and the legacy systems may only have the information on manufacturing, both lacking the knowledge for such integration. Those memory mismatches may have been overlooked or considered to be unimportant during the implementation stage. Over time, the memory mismatch may become apparent.

During the usage stage, changes in the memory contents and repositories may also occur, causing new memory mismatches to arise. Take for example the usage stage problems and opportunities mentioned in the introduction. Data input errors mean that inconsistencies in the information in the ERP system occur compared to for instance the information that individuals have. Turnover of individuals may cause gaps in the skills and knowledge contents. Changing business processes and structure means that memory contents embedded and implied by these repositories change as well, for instance process best practices and procedures, which may lead to inconsistency and under-redundancy of the knowledge, information, and paradigms embedded in the ERP system. New releases of the ERP system, where the new version may have certain new and changed memory contents, as well as left-out memory contents, that may cause memory mismatches compared to the contents at other retention media. A final note to be made here is that the frequency of changes may differ significantly among organizations. This can be related to the concept of organizational uncertainty (Duncan, 1972). Depending on their internal and external environment, some organizations face more changes than others, i.e. having higher respectively lower levels of uncertainty.

The memory mismatches negatively affect the performance of the ERP system. Under-performance is defined here as realizing the ERP benefits to a lower extent than would be realized without the memory mismatch. In our opinion, the ERP system should have added value to the organization as a whole: the package should enhance the effectiveness and efficiency of the company's resource management. Efficiency and effectiveness dimensions, such as cost and integration (Quinn and Rohrbaugh, 1983), are embedded in many alternative IS success measures. Discussing such measures in detail is beyond the scope of this paper, we only mention the following two, because they are explicitly focusing on ERP systems. First, the ERP Balanced Scorecard specifies quantitative performance measures (Rosemann and Wiese, 1999). However, some of the benefits of the ERP system will not be easy to quantify (Rosemann and Wiese, 1999), if quantifiable at all. The second one is a measure proposed for client-server systems (Chengalur-Smith and Duchessi, 2000), i.e. the hardware technology currently used for ERP systems. Looking at some of the examples provided earlier, it becomes clear that the memory mismatches cause the organization to realize ERP benefits to a lesser extent than without the memory mismatch. For instance, the decision making may be seriously hampered by memory mismatches caused by data input errors, also increasing decision-making time because the memory mismatches have to be solved. The arising memory mismatches because of personnel turnover may lead to under-performance, such as lower quality decision making, and decreased organizational productivity. High costs may be involved to have other individuals (new or old employees) acquire those specific skills, knowledge, and information. Memory mismatches regarding structure and processes may lead to reduced empowerment of employees, lower control/ management of the business, outdated ERP business processes, and lower customer service.

It can be concluded from this discussion that the extent to which memory mismatches cause under-performance, thus, differs per case. Furthermore, it is important to notice that a memory mismatch is not a mediator of other underlying factors that cause ERP under-performance. Looking again to the turnover of personnel, it is not the fact that the person is leaving the organization that is causing the under-performance, it is the fact that he or she may leave with specific memory contents that causes the ERP system to under-perform. Though we believe that a large variety of memory mismatches may occur that cause ERP systems to under-perform there are also other factors influencing ERP performance as well. Just think about the effect of a major

power failure. Additionally, it is highly likely that some memory mismatches will always exist, although the under-performance is not considered to be significant to the organization. Finally, it should be noted that under-performance leads to the need for coping behavior, that is, the need to solve the memory mismatches, for instance by adapting the ERP system or training and learning of employees. This paper does not discuss such coping behavior in detail, but it is the premise here that applying SAMMM provides the basis for identifying directions of coping behavior to enhance ERP performance in the usage stage.

Applying SAMMM in the ERP usage stage

The research methodology

The theoretical and empirical research has been guided by the following research question: *What is the potential added value and what are the limitations of SAMMM?*

The goal has been to analyze one instance of each identified type of ERP memory mismatch using SAMMM in order to evaluate the potential added value and limitations of SAMMM, for both science and practice. A multiple-case study strategy has been chosen as being the most appropriate for this research (Yin, 1989). Because the research is exploratory, based upon a new theoretical approach, hypotheses have not been generated in advance, nor tested during the research (Eisenhardt, 1989). Three companies have been selected based on the availability of a standard ERP system that had been in-use for at least one year at the start of the research.

Interviews have been held with the current IT/ ERP manager. Those interviews were structured at a low detail level, using the previously discussed memory mismatch approach, SAMMM and its underpinning model and assumptions, as the interviewer's guide to help signaling and diagnosing the memory mismatches. The discussed subjects are threefold. One: the company in general, focusing on general aspects of the business, such as goals, products, and the unit of the interviewee. Second: the development of the ERP system, why the firm uses the ERP system and which modules or components are implemented over time, by whom they are used, what kind of benefits the organization expects to realize, and what problems occurred. And three: the memory mismatch in the ERP system during the usage stage. In each interview, one of the mentioned problems has been related to one of the identified types of memory mismatches and further diagnosed according to SAMMM. The analysis of the causes is partly retrospective, since memory mismatches may origin earlier than the ERP system usage stage. The next subsections present and discuss the empirical results.

SAMMM at Clean's

Background: Clean's is part of a worldwide multinational holding, and sells professional cleaning systems. In the Netherlands, Clean's has two sites, a Dutch head office where the sales organization is located, and a plant, where fluid cleaning products (like fluid soap) are manufactured.

The memory mismatch: The ERP system at Clean's did not include knowledge and information contents regarding the planning of the manufacturing process at the Dutch plant, since such a component was not implemented. Related knowledge and information is primarily located at individuals, at planning documents, and in a separate manufacturing planning system. Since the memory contents should be existing in the ERP system, this is a case of under-redundancy, a type I memory mismatch.

Causes: Earlier, in the implementation phase, only the sales and financial processes were included, since it was not considered important to include the manufacturing planning then. This can be explained by the fact that the two sites were co-operating rather informally, though not independently, and that the operations were not integrated during the implementation phase.

Under-performance: In the usage stage, it became apparent that the ERP system produced output that the planners at the plant now had to copy into their own systems and documents. Furthermore, the ERP system also used the planning results as input for the financial and sales processes, and again, copying needed to be done. Thus, the memory mismatch caused under-performance regarding the process cost and time (of copying) and the lack of integration between the processes.

SAMMM at Financia

Background: The Canadian Financia exists of a group of companies in the financial area. The offered services include activities such as personal and commercial banking, wealth management, corporate and investment banking, and insurance. The focus lies on North American operations.

The memory mismatch: At Financia, Human Resource Management components of two standard ERP packages were implemented in the organization at the same time, thus creating partly overlapping knowledge and information. This is a case of over-redundancy or a type II memory mismatch.

Causes: One of the causes of this over-redundancy is the fact that Financia consists of a group of companies. The Wealth Management group is operating highly independently, whereas the rest of the companies form a separate, more integrated group. Another cause, related to this independence, is that the implementation of the HRM module was not part of an organization-wide ERP transition. It was a method to solve some problems, like

Y2K incompatibility, with the old information system, both within the Wealth Management group and the other group of companies.

Under-performance: It was not until a broader ERP view was adopted during the usage stage, that this over-redundancy and its apparent consequential under-performance were discovered. The cost of maintaining two systems is significantly higher than of maintaining one system. Furthermore, the HR process is sub-optimized, being not integrated across the entire organization.

SAMMM at Marketee

Background: The Dutch Marketee is part of both a national and an international holding firm, and is characterized as a "marketing organization", dealing with the marketing and distribution of a very large quantity of products, varying for instance from clothing, house decorations, to CDs and office chairs.

The memory mismatch: At Marketee, the implemented cost accounting component of the ERP system originally embedded knowledge and information based upon the fact that the organization consisted of cost centers, but during the usage stage the organization was changed to profit centers. This lead to a type III memory mismatch, because memory contents embedded in the ERP system were inconsistent with memory contents in the structure of the organization, such as information of which department was responsible for which costs and revenues.

Causes: During the implementation stage, the company was actually structured according to cost centers, so there was no memory mismatch at that point in time. However, top management's knowledge about organizing changed, and they wanted to structure the company in profit centers instead of cost centers.

Under-performance: Marketee's management realized that they had to cope with this memory mismatch before the organizational changes actually occurred. Not solving that inconsistency would cause the ERP system to under-perform since it would not be able to generate the necessary information for the profit centers. Then, the ERP system would not be able to support the financial resource management effectively. Actual ERP under-performance did not occur.

Review of the empirical evidence

The empirical results of applying SAMMM in the ERP usage stage are summarized in Table 3. Looking back at the three underpinning assumptions of SAMMM that guided our research, the following notes can be made. The results show that a memory mismatch arising in the usage stage may be caused during the implementation stage. However, the investigated organizations were not aware of the possible memory mismatch then. Memory mismatches may also arise during the usage stage, caused by changes in memory contents (and their media). This was specifically the case at Marketee. The environment (external) changes rapidly for Marketee, so the organization has to be very responsive. The top management learned that the organization would be more responsive if the units were managed from a profit-based perspective instead of a cost-based perspective. That would leave the units more room to create new opportunities. When the management started to re-organize the company based on this new paradigm, it became clear that the ERP system did not support this change in the internal environment yet. A memory mismatch would arise. Adaptation of the ERP system was necessary to solve that mismatch. Here, the memory mismatch was predicted in advance, leading to a more pro-active solution where the ERP system was not under-performing as a result of that memory mismatch.

Table 3. Summary of the results of SAMMM (MM = memory mismatch)

	Clean's	**Financia**	**Marketee**
MM content	Manufacturing planning	Human Resource Management	Accounting structure of the organization
MM type	I. Under-redundancy	II. Over-redundancy	III. Inconsistency
MM causes	• Informal co-operation • No integration	• Independent operations • No integration • No organization-wide ERP transition	• Environmental change • Organizational learning • Organizational change
Moment of origin MM	Implementation stage	Implementation stage	Usage stage
Moment of signaling MMs	Afterwards	Afterwards	Beforehand
under-performance ERP system	• Process costs • Process time • Lack of integration	• Maintenance costs • Process sub-optimization • Lack of integration	• Did not occur

Assessment of SAMMM

Next, what is the potential added value of SAMMM, and it's underlying memory mismatch approach? Looking at the theoretical aspects, the memory mismatch approach is a new approach. It is eclectic, building upon existing research areas such as information systems, cognitive psychology, and organizational memory theory. The

memory mismatch approach integrates and adds to those fields, because the approach encompasses technical, organizational, as well as cognitive elements of ERP systems and the other repositories, organizations consist of. SAMMM provides a research framework and method to collect empirical data, as is done for three cases of memory mismatches in the ERP usage stage. Practically, SAMMM is relevant as a basis for decision-making aiming at improving ERP performance. The application areas go beyond the ERP usage stage, because memory mismatches may also come into existence in the implementation phase. SAMMM may be used to signal, or even predict memory mismatches in an early stage, preferably before they actually cause under-performance.

One can also identify a number of theoretical and practical limitations. SAMMM and its underlying assumptions and theory have not been validated on a large scale (statistically) yet by means of hypotheses testing. More empirical data are needed for that. However, observing memory mismatches is not an easy task, given the many aspects of the organization involved. Furthermore, many organizations are not eager to give outsiders data on their ERP (under-) performance. A final remark is that the practical value of SAMMM would be enhanced if the method is coupled to specific coping behavior to solve the memory mismatches in order to improve the ERP performance.

Conclusions and recommendations

Recapitulating, the theoretical ERP memory construct is based on organizational memory and cognitive dissonance theory. When comparing memory contents of the ERP system with related memory contents at other locations, one may identify three possible mismatches, namely over-redundancy, under-redundancy, and inconsistency. Such ERP memory mismatches are considered to be an underlying explanation for ERP under-performance in the usage stage. The presented diagnosis method SAMMM has been applied to ERP systems in the usage stage and it's theoretical and practical value and limitations have been identified.

Future research should in our opinion focus on the validation and broad application of SAMMM. To overcome the limitations, the existing literature offers many suggestions. Organizational memory theory provides methods and tools (Laukkanen, 1994; Walsh, 1995) that may be used to observe the memory contents. Regarding performance measurement, there is literature available on organizational (Van Breukelen et al., 1998) and IS performance (Delone and McLean, 1992), again including methods and tools. With respect to coping behavior in the ERP usage stage, the areas of organizational learning (Argyris and Schön, 1978), organizational change (Scheer, 1994), and software maintenance (Bennett, 1996) can be further investigated.

A further improved SAMMM can offer a new, systematic and integrative way to theoretically explain ERP under-performance, analyze its causes, *and* at the same time can give organizations specific directions for solving them to enhance the ERP performance.

[1] The combined sales of Baan (2000), SAP (2000), J.D.Edwards (2000) and PeopleSoft (2000) expanded from US $1,460 million in 1994 to $7,502 million in 1999 (figures based on their annual reports).

[2] It should be noted that redundant memory contents may be perfectly matching, but they may also cause specific ERP under-performance and in that situation we speak of a memory mismatch here. The type II memory mismatch is illustrated in the Financia case.

Acknowledgements

The authors wish to express their appreciation to Joseph Paradi and Anthony Wensley at the University of Toronto, and Piet Bolwijn and Peter Schuur at the University of Twente for their efforts during this research project. Furthermore, thanks to Robert Stegwee and the anonymous reviewers for their comments on previous versions of this paper.

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