

How do organizations remember? The influence of organizational structure on organizational memory

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Abstract

How do organizational factors influence knowledge retention and storage within companies? In this study, we examine the influence of organizational structure on organizational memory. We are specifically interested in the effects of specialization and standardization—dimensions of the organizational structure—on organizational memory as conceptualized by Walsh and Ungson (1991) and Argote (2005). This study is based on recent survey data from 122 respondents of multi-unit organizations that are mainly from the consulting, financial, automotive, and electrical industries. The results suggest that structural organizational factors, i.e. specialization and standardization as well as organizational processes such as codification and personalization of information and electronic communication influence organizational memory. Furthermore, the results show that codification of information fully mediates the relationship between standardization and organizational memory and that electronic communication partially mediates the relationship between specialization and organizational memory. Overall, the results suggest that the processes of codification of knowledge as well as electronic communication are conducive to the formation of organizational memory and that respective organizational memory bins have unique associations with the organizational structure factors. Our study is one of the first to empirically test propositions with regard to the concept of organizational memory.

Keywords: knowledge process variables, knowledge retention, organizational memory, organizational process, organizational structure, specialization, standardization

Introduction

Understanding how organizations remember and store knowledge is an important research issue that has received increased attention in general organization studies (e.g. Huber 1991; Paoli and Prencipe 2003; Vince et al. 2002; Walsh and Ungson 1991; Weick 1979), as well as in knowledge management (e.g. Davis 1997; Vikas et al. 1998). Organizational memory has been linked to improved decision-making (e.g. Markus 2001; Park and Bunn 2003; Ozorhon et al. 2005), facilitated turn-over (Yates 1989), organizational learning (Cross and Baird 2000; Fitzpatrick 2006; Hanvanich et al. 2006), and the development of innovative products (Moorman and Miner 1997).

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Prior research has indicated that the theoretical construct ‘organizational memory’ (OM), which conceptualizes an organization as a collective that stores information, is not new. Levitt and March (1996: 524), for example, argue that: ‘Rules, procedures, technologies, beliefs and cultures are conserved through systems of socialization and control.’ Thus, OM can also be understood as a structure of repositories in which different forms of knowledge are stored, and from which knowledge can be retrieved (Weinberger et al. 2008). The term OM has been explicitly¹ used since 1991 when Walsh and Ungson (1991) and Huber (1991) used it in their seminal papers. According to Huber (1991) OM must be stored in memory and then brought forth from memory in order to enable organizational learning. Prior studies have concentrated on an information technology perspective of OM (e.g. Hassell 2007; Martz and Shepherd 2001; Randal et al. 2001). Furthermore, while several researchers have investigated the OM concept theoretically, few have as yet investigated it empirically.²

In their article, Walsh and Ungson (1991) do not cite a single quantitative empirical study on OM and this situation has not changed much over the past 15 years (e.g. Lien et al. 2007; Olivera 2000; Stein and Zwass 1995). A number of authors have studied OM qualitatively, but only very few studies have attempted to empirically test propositions formulated by OM scholars (e.g. Ackermann and Halverson 2000; Olivera 2000). This lack of empirical examination is unfortunate, as it hinders the identification of stable relationships of OM with important organizational outcome variables and hinders the practical application and theoretical advancement of OM theories. Some scholars have even asked whether OM should be abandoned as a concept (e.g. Ackermann and Halverson 2000) if it remains empirically unexamined. Consequently, we know very little about the relation between organizational structure, processes, and OM, i.e. what its organizational antecedents are and how exactly organizations remember. Being one of the first studies to empirically examine OM, this study combines an exploratory and confirmatory approach analyzing OM and its respective dimensions. In doing so, we test confirmatory hypotheses with regard to total OM and also provide descriptive analyses for the relationship between organizational structure variables and the respective OM bins.

This article partly builds on the work of previous studies that have described the OM concept (Anand et al. 1998; Huber 1991; Rusaw 2005; Walsh and Ungson 1991), but have not empirically examined how OM is related to organizational structure and processes, which this study proposes to do. Previous research on OM suggests that it is not a one-dimensional and undifferentiated concept. A distinction between different dimensions of OM that is generally accepted is that between the different OM retention facilities, namely individual, cultural, transformational, structural, and ecological retention bins. Walsh and Ungson (1991), for example, distinguish between different retention bins: the ‘individual retention bin’ (individual recollections of what has transpired in organizations), ‘cultural retention’ (how members of the organization think, feel, and perceive problems), ‘transformational retention’ (the logic that guides the transformation of input in organizations), ‘structural retention’ (how organizations reflect and store information about the organizational environment), and ‘ecological recollections’ (the actual physical or workplace ecology of an organization).

Following the Aston Studies (e.g. Pugh and Hickson 1976), we propose to look at the influence of organizational structure on OM. Walsh and Ungson (1991) and Karsten (1999) identify structure as a key variable of knowledge storage, but this article goes beyond their work by conceptually and operationally differentiating different structural dimensions—specialization and standardization—and their effect on OM, which previous studies have failed to do. In addition, this study investigates the mediating processes that influence the relationship between structural variables and organizational memory. The effects of *specialization* (the extent to which indirect activities are accomplished by specialists or experts) are of particular interest, as previous studies have shown that specialization can have ambiguous effects on OM. Potentially, it can both increase (e.g. Wilkins and Ouchi 1983) and decrease (e.g. Huber 1991) information processing within a work unit. Similarly, previous studies have proposed differing views on the likely effects of *standardization* (the extent to which procedures are standardized) on OM. West (1994), for example, argues that operating procedures manage to obstruct the learning process, whereas Lin and Germain (2003) report that formal control has a significant positive influence on the utilization of customer product knowledge.

A number of scholars have recently started to identify processes as important mediating variables in the relationship between organizational substance and organizational knowledge management (e.g. Chia 2002; Pajunen 2008; Schatzki 2006). We follow these scholars and assume that organizational memory is ultimately the result of processes rather than substances. The term organization memory is derived from an information-*process* perspective and implies that members of an organization help each other to evoke remembrances and share interpretations (e.g. Walsh and Ungson 1991). The organizational memory of a process-oriented organization is influenced—among other things—by the documentation of projects undertaken, the decisions that were made during the execution of the projects, and the expertise obtained while working on them (Favela 1997). We therefore look at the process variables of codification and personalization of information and electronic communication in order to understand the complex links between organizational structure and organizational memory.

Against this background, this article explores the relation between organizational structure and OM. In order to understand the nature of OM better, this study separates different OM aspects as identified by Walsh and Ungson (1991), and examines these by means of primary survey data from 122 respondents of multi-unit firms in German-speaking Europe following the approach of Olivera (2000). OM is an important issue for multi-unit companies as knowledge acquired in one unit can be beneficial to other sites as well (Goodman and Darr 1996, 1998). *The central questions of this study are how specialization and standardization influence organizational memory of companies and how codification of information, personalization of information, and electronic communication mediate the relationship between variables of organizational structure and organizational memory.*

Our research into understanding the determinants of OM extends the organization management as well as knowledge management literature. By conducting an empirical study, we also hope to contribute to the OM literature as OM and

its respective dimensions have rarely been empirically examined. In addition, this study also contributes to the literature on organizational development by providing insights into the retention and processing of knowledge from both an individual and organizational perspective using a process perspective and testing a process model. Further, by studying the different dimensions of organizational structure and their effects on OM, this study also seeks to address the gap in the literature regarding research on the influence of structure on knowledge management, as highlighted by Walsh and Ungson (1991).

The remainder of this article is organized as follows: Section 2 develops hypotheses on the influence of organizational structure on OM dimensions; Section 3 presents the research methodology, while Section 4 presents the empirical results. We conclude in the final section with an analysis of the results and suggestions for possible avenues for future research.

Hypotheses: Influence of Organizational Structure on Organizational Memory

The OM literature knows many varying and sometimes even competing definitions of OM (Ackermann and Halverson 2000). Generally speaking, individual memory is ‘the faculty of retaining and recalling things past’ (Walsh and Ungson 1991: 58). Previous research questions whether organizations can actually have a memory (e.g. Wegner 1986). Opinions on this questions range from Argyris and Schön (1978: 11), who argued that OM is only a metaphor, to Sandelands and Stablein (1987: 136), who raised the possibility that ‘organizations are mental entities capable of thought’. In their article, Walsh and Ungson (1991: 61) recognize and integrate these scholarly differences and develop the following definition:

The construct of [OM] is composed of the structure of its retention facility, the information contained in it, the processes of information acquisition and retrieval, and its consequential effects. In its most basic sense, [OM] refers to stored information from an organization’s history that can be brought to bear on present decisions.

A well-performing organizational memory thus stores information from an organization’s history that can be brought to bear on present decisions (Walsh and Ungson 1991). Since organizational structure is usually represented as a product of historical forces and managerial choices, OM is reflected in the organizational structure (Walsh and Ungson 1991). However, Walsh and Ungson (1991: 79) add: ‘Even though [OM] is reflected a bit in organizational structure, we argue that it is not an isomorphic representation. OM includes other artifacts (i.e. ecology, transformations, etc.) that build on the historical interactions among members of the organization.’ Nevertheless, organizational structure guides the coding and channeling of information in a firm and supports the use of OM (Sandoe and Olfman 1992; Walsh and Ungson 1991). In her case study analysis, Karsten (1999) found that organizational form changes coincide with changes in the company’s OM profile. Senge (1990: 40) likewise states that: ‘Structure influences behavior: Different people in the same structure tend to produce qualitatively similar results ... more often than we realize, systems cause their own crisis, not external forces or individuals’ mistakes.’ Argote et al. (2003) suggest that organizations

can influence organizational learning if they increase the proximity between office members. Even though organizational structure seems to be of some importance in the OM context, organizational theory has had little to say about the influence of the former on the latter. Hence, we are interested in how organizational structure (i.e. specialization and standardization) influences OM.

Influence of Standardization on Organizational Memory

The dimension 'standardization' deals with the degree of standardization, formalization, and automation of regularly occurring events that the organization legitimizes (Pugh et al. 1968). According to Fredrickson (1986) this dimension can be defined as the extent to which an organization uses rules and procedures to prescribe behavior such as the details on how, where, and by whom tasks are to be performed. The notion that standardization influences OM can be dated back to Cyert and March (1963), who find that standard operating procedures are related to the memory of an organization. Similarly Nelson and Winter (1982) conclude that standardized routines represent states of settlement among individual members of the organization that influence the memory of the organization. In their article on different types of bureaucracies, Adler and Borys (1996) identify enabling as well as coercive standardization and formalization processes. This conceptualization helps with the understanding of the contrasting theoretical and empirical results and assessments of standardization and formalization processes. Whereas coercive standardization and formalization procedures are associated with autocratic or mechanistic mechanisms that inhibit creativity, innovativeness, and information exchange (Dickson 1992; Leonard-Barton 1992; Levitt and March 1996), enabling standardization and formalization processes are associated with the contrary. The influence of enabling standardization and formalization on OM is illustrated with the following citation from an interview conducted by Orlikowski (1995) on the use of NOTES technology:

I'm finding I have to be more careful about how I formulate things. Sometimes I think it takes forever for me to put some comment in because I want to make sure that it's technically accurate, that what I'm saying is correct, non-ambiguous—mostly because I hate it when people send me queries that have the negative of those qualities. When we used personal notes before I wouldn't have to worry about that, because I knew nobody else had to look at that. And usually I was going to verbalize my queries or comments, rather than have them written and seen.

Many scholars have developed theories and concepts that enabling standardization facilitates information and communication exchange and can thus foster OM. Exemplary reasons are the higher degree of personal and organizational work routines achieved, the development of a shared language and mental models, and unambiguous work layouts and easy retrieval of OM.

Sandoe and Olfman (1992) suggest that formalization of unstructured, abstract information and knowledge helps organizations to retain personal information from employees and thus to be more independent from them. Adler and Borys (1996) state that enabling formalization and standardization can be designed to enable employees to deal more effectively with inevitable contingencies. Standardization procedures can thus capture lessons learned from experience and

codify best-practice routines so as to stabilize and diffuse new organizational capabilities (Adler and Borys, 1996). They also state that the idea of an enabling type of standardization and formalization is consistent with Blau's (1955) finding that 'good' procedures are those seen as valuable resources that help professionals meet clients' needs. Ackermann (1998) describes an information system named Answer Garden that helps to grow OM by a series of standardized menus where users can narrow down the topic they wish to ask about. If the user doesn't find the answer to their question they can email an expert with a specific question. The responses of experts are used to enlarge the database. Ackermann (1998) found that standardization facilitates information seeking and therefore decreases the potentially negative status implications of information requests and the need for reciprocity. Baldwin and Clark (2000) formulate a theory of the relationship between structure and value. According to their theory modular architectures add value to system designs by creating options to improve the system by substituting or experimenting on individual modules. Hence their theory sees a value in standardizing previously informal procedures, while also keeping them flexible by improving or exchanging modules. Käkölä and Koota (1999) develop a standardized information systems architecture that aims at enabling and reinforcing both effective, institutionalized working and the questioning and (re)construction of computer-supported work routines and thus the improvement of OM. Droege et al. (2000) state that organizations with standardized routines show good performance by efficiently using prior knowledge. Lin and Germain (2003) find that standardization has a significant positive influence on the utilization of customer product knowledge, and Goebel et al. (2004) find that standardization is positively linked to communication formality. Chang and Cho (2008) conclude from their empirical study that the use of formal procedures has a positive effect on new product success. Wijnhoven (1998) argues based on a literature review that some OM bins are more standardized than others. If the OM itself is standardized, then the degree of standardization will have a positive impact on the OM—at least on the more standardized knowledge stores, such as the structure and the transformation bin. From the above we can assume that enabling standardized processes help organizational members to integrate new information within their mental models with less effort, and should thus have a positive influence on the individual memory bin. Furthermore, standardization forces organizations to explicate their processes, to define unambiguous interfaces, and to communicate them in a meaningful way to others, all of which should benefit the culture, transformation, structure, and ecology bins.

However besides a direct influence of standardization on OM the relation between the degree of standardization and organizational memory is most probably mediated by processes. Chang and Cho (2008) conclude that the process of memory sharing is a crucial success factor and the mere stocking of memory is not enough if it is not shared, because memory has to be dispersed throughout the organization in the form of individual knowledge, behavioral routines, and organizational structures. Hence, information has to be collected, evaluated, transferred, stored, and retrieved. The design of these processes will thus have most probably a mediating influence between the degree of standardization and organizational memory. Walsh and Ungson (1991) themselves conceived organizational memory as an information processing system which they

imagined was similar to the memory of an individual, an interpretative system, and a network of intersubjectively shared meanings (Feldman and Feldman 2006). The two processes that are analyzed most often in the context of information sharing are the codification and personalization strategies (Hansen et al. 1999). According to Hansen et al. (1999) codification strategy means that knowledge is carefully codified and stored in databases where it can be accessed and used readily by anyone in the company. Conversely, personalization strategy is where knowledge is used closely by the person who developed it and is shared mainly through direct person-to-person contacts. A process that is related to those two processes is the degree of electronic communication an organization uses, since it allows for codification of information but also for personalized information exchange. From the theoretical, conceptual, and empirical results we can assume the following:

Hypothesis 1: The degree of standardization has a positive influence on the organizational memory.

Hypothesis 1a: The relation between the degree of standardization and organizational memory is mediated by the degree of codification.

Hypothesis 1b: The relation between the degree of standardization and organizational memory is mediated by the degree of personalization.

Hypothesis 1c: The relation between the degree of standardization and organizational memory is mediated by the degree of electronic communication.

Influence of Specialization on Organizational Memory

Specialization, i.e. the division of the value chain into many parts and the concentrating on single task components (Favela 1997), offers a number of advantages. It allows the development of specific and deep knowledge, abilities, and processes with which these tasks can be completed in an efficient manner. The division of a task into its respective components requires that the task is understood well enough to divide it into its respective components. However, the partitioning of a value chain in several steps also creates more interfaces, which require definition and codification. In addition, in order to combine partial tasks into specific production methods or consumer goods, employees must exchange services and communicate effectively. In other words, partially specialized tasks must be reunited in a coordinated way so that the entire task can be completed. Specialization entails focusing on a narrow area of knowledge or skill or activity and involves a person's or an organization's adapting for the unusually effective or efficient performance of some particular function, often at the expense of the individual's or organization's ability to perform most other functions for themselves, which are then necessarily left to others with more appropriate skills or talents or abilities (Favela 1997).

Specialization, as well as exchange and coordination, requires information when decomposing the aggregate of tasks, when assigning partial tasks to individual employees, when controlling task completion activities, and when consolidating individual task components or exchanging services. Consequently, a

high degree of specialization should have a positive effect on the individual, transformation, and organizational memory, since specialization should help the individual to develop a deeper understanding of the task (Argot et al. 2003; Postrel 2002; Schilling et al. 2003) and prevent an information overload (Adler and Borys 1996; Käkölä and Koota 1999). Moreover, specialization requires the processes responsible for transforming all kinds of inputs to be well defined. Furthermore, the structure bin in a highly specialized organization should provide an extended and improved set of work rules and roles that allows the organization to divide and coordinate the tasks efficiently.

Specialization should also have a positive effect on organizational memory since a high degree of work specialization will be indicated in the workplace design, as well as in an increased dependence on reciprocal information flows. Consequently, specialists show a higher degree of collaboration (Argote et al. 2003; Hage and Aiken 1967; John and Martin 1984; Menon and Varadarajan 1992). However, organizational memory seems to be critically dependent on the design of processes. For example, one can argue that the specialization of the different activities in processes leading to memorizing might be hampering because of the interfaces. Each interface possibly acts as a filter.³ The two main processes related to memory processes seem to be codification and personalization (see above).

Following this line of reasoning we believe that the relation between specialization and organizational memory is mediated by the codification and personalization of information and electronic communication that (enabled by the specialization-induced documentation and codification of the tasks and value chain parts) enables the formation of organizational memory. Hence

Hypothesis 2: The degree of specialization has a positive influence on the organizational memory.

Hypothesis 2a: The relation between the degree of specialization and organizational memory is mediated by the degree of codification.

Hypothesis 2b: The relation between the degree of specialization and organizational memory is mediated by the degree of personalization.

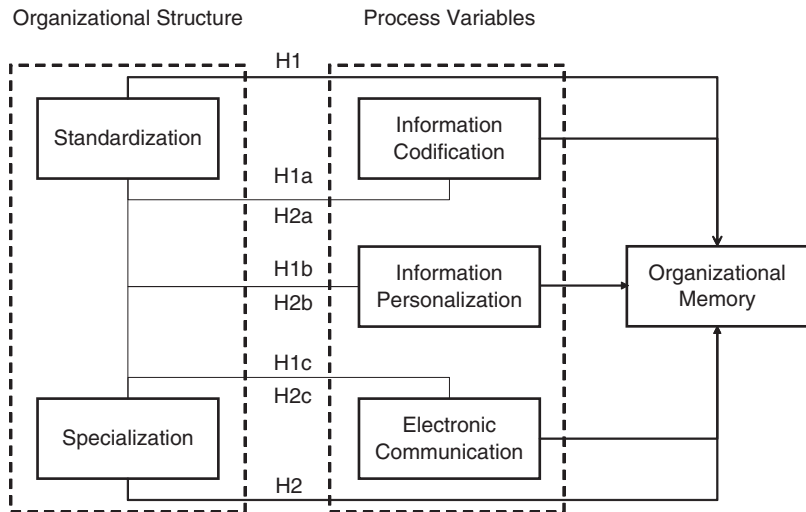
Hypothesis 2c: The relation between the degree of specialization and organizational memory is mediated by the degree of electronic communication.

Method

Sample, Survey Design, and Data Collection

The data presented in this study are obtained through a pre-tested survey of 122 employees between April 2007 and May 2007. The empirical investigation was based on a new database developed by the authors. The authors estimate that the database is sufficiently representative since it does not contain any systematic omission errors (Bortz and Döring 1995: 452). The use of a quantitative survey seemed primarily appropriate because publicly available information does not provide the level of detail that was required for this study, including fine-grained information on the knowledge management and storage processes

Figure 1.
Hypothesized Model



within firms. The data are consequently self-reported, but previous research supports the reliability and validity of self-reported measures (Rogelberg et al. 2001), especially when other sources are unavailable. In addition, subjective measures are appropriate when there are no objective measures (Dess and Robinson 1984).

Furthermore, individual judgment provides an opportunity to gather information on multiple dimensions of organizational structure and their effect on the respective OM storage bins. To ensure that a high proportion of the answers were valid, the questionnaires were directly administered to the CEOs and department managers of the corporations, using the key informant approach (Huber and Power 1985). The authors are naturally aware of the necessary trade-off between objective data collected from secondary sources at various different times and data richness derived from primary sources. However, given the unavailability of sufficient secondary data, this study had no choice but to opt for a survey of self-reported data (Venkatraman and Grant 1986). To ensure additional validity, the sample was restricted in the following way. Firms had to be active in the consulting, financial, automotive, and electrical industries and had to be registered in Germany. Questionnaires were sent to 320 employees. A total design method as suggested by Dillman (1978) was used for the mailing process. The final number of completed surveys was 122—a response rate of 38.13%. Non-response tests found no differences between respondents and non-respondents regarding company size, age, and country.

The firms in the sample came from the following industries: 8.7% from the automotive industry, 8.7% banks and insurances, 4.9% chemical and pharmaceutical firms, 16.5% service firms, 45% consulting firms, and 16.2% from other areas. The majority of companies (47.2%) were between 50 and 100 years old, 26.4% were more than 100 years old, and 26.4% were less than 50 years old. 17.5% of firms in the sample had over 100,000 employees, 15.2% had between 5000 and 100000 employees, and 23.8% had between 1800 and 5000 employees.

71% of the respondents were male and 29% were female, their average age was 37.56 (SD = 10.91), and at the time of the survey they had been with their respective firms for an average of 7.3 years (SD = 8.56).

Survey Measures

Dependent Variables

Walsh and Ungson (1991) identify five internal retention facilities, namely individuals, culture, transformations, structure, and ecology. In operationalizing OM we follow Walsh and Ungson (1991) who distinguish between several OM dimensions.

Individual Bin. Individuals gain experience and make their own observations relevant for the organization by keeping them in mind or using memory aids such as notes and files. They also 'store their organization's memory ... in the cognitive orientations they employ to facilitate information processing' (Walsh and Ungson 1991: 61). We asked the respondents to rate how the experiences that they had had during the previous three months extended their personal ways of thinking and perceiving, and their problem-solving methods, and how the experiences had improved their personal work routines. We calculated the mean of these two items and built a composite measure of Individual OM (Cronbach's α 0.83).

Culture Bin. Schein (1995) conceives organizational culture as the result of the complex learning process of groups within the organization. Consequently, culture represents the group members' experience (Walsh and Ungson 1991). While Schein (1995) defines all visible structures and processes as artifacts of the organizational culture, Walsh and Ungson (1991) have a narrower understanding of culture, which fits Shrivastava's (1985, 1995) understanding of 'cultural products' better. In keeping with Walsh and Ungson (1991), we consequently asked the respondents to rate how the experiences they had had during the previous three months extended the terminology and wording used in their division, their common vision of their division, tedium habits (e.g. more informal meetings, coffee breaks with colleagues), the common language in their division, and their company manners (e.g. promotion ceremonies, salutation rituals). We calculated the mean of these five items and built a composite measure of 'culture' (Cronbach's α = 0.81).

Transformation Bin. The transformation bin refers to all processes transforming different inputs, such as raw materials, supplies, capital, or human factors, to outputs including past experience and information. This retention facility also includes standard policies and procedures (Rusaw 2005), work processes and support systems (Cross and Baird 2000), production processes and personnel life-cycle processes (Stein and Zwass 1995), products and services (Cross and Baird 2000), and patents, tasks, and rules. We asked the respondents to rate how they experienced within the last three months an extension and improvement ... in the processes for storing information in databases and documents (e.g. field reports) and ... in the project management processes (e.g. budgeting, resource planning). We calculated the mean of these two items and built a composite measure of 'Transformations' (Cronbach's α = 0.77).

Structure Bin. Organizational structures display which roles the different members of the organization hold (Stein and Zwass 1995) and their link to the environment must be regarded (Walsh and Ungson 1991). We asked the respondents to rate how their experiences during the last three months ... extended and improved work roles; ... led to more efficient collaboration, coordination, and division of work structures in their department. We calculated the mean of these two items and built a composite measure of 'Structure OM' (Cronbach's $\alpha = 0.80$).

Ecology Bin. Ecology includes the actual physical structure of an organization and the workplace design, and holds much information on past experience (Walsh and Ungson 1991). Office equipment, for example, usually mirrors an employee's hierarchical status. Managers often have expensive art works on the wall and big leather seats. It is not just a single workplace, but also the entire architecture of a building and/or the layout of a shop floor that embody a vast amount of experience (Wijnhoven 1998). The workplace ecology also indicates how important the status of the hierarchy is in the company, how employees feel about the company, and how stakeholders consider the company (Hackbarth and Grover 1999). We asked the respondents to rate how the experiences they had had during the previous three months led to more efficient employee allocation (e.g. collaborating employees working in the same area), improved workplace ecology, and improved access to hard and software, as well as communications channels. We calculated the mean of three items and built a composite measure of 'ecology' (Cronbach's $\alpha = 0.81$).

Organizational Memory bin (total). Finally we calculated the mean of the five OM retention bins into an OM bin (total).

Independent Variables

All organizations have a formal structure. This organizational structure reflects all formal regulations concerning the division of labor and coordination of the single units of an organization (Kieser and Walgenbach 2003). In the 1960s, the researchers of the Aston Studies group developed scales to measure the dimensions of an organization structure. We built on the scales developed by the Aston Studies group by including standardization and specialization as independent variables. In the following paragraphs, we describe how we operationalized these two organizational structure dimensions.

Standardization. We measured the degree of organizational standardization and formalization as suggested by Pugh et al. (1968). We asked the respondents to rate, on a seven-point scale, the extent to which there are well-defined central recruiting and interviewing procedures, standard selection procedures for foremen and managers and standard discipline procedures with listed offenses and penalties. They also rated the extent to which the top management has provided a fairly defined set of rules and policies to govern collaboration between divisions within their company, to deal with conflicts between R&D units engaged in joint R&D, and to regularly monitor compliance with these regulations. We calculated the mean of these six items and built a composite measure of 'standardization and formalization'. (Cronbach's $\alpha = 0.81$).

Specialization. Specialization can be divided into functional specialization and role specialization. Functions, such as public relations, service, and maintenance can be carried out by specialists. These are employees who only perform this function and no others. Within each of the 16 functional specializations identified by the Aston researchers, employees who exclusively deal with each of these roles can also carry them out (Pugh et al. 1968). In the context of our study, it is important to mention that the Aston researchers focus on the specialization of indirect activities and not on the production process's direct activities. For instance, they interpret the ratio of line personnel to staff personnel as an indicator of the relative importance of specialization. But in all larger companies, the production process is also divided into different activities and the roles within these are also specialized. This becomes obvious in the following example: huge car manufacturers use assembly lines to produce cars. Mounting the tires on a car is an activity within the manufacturing process that two employees carry out. One mounts the tires on the right side of the car and the other does the same on the left side. Consequently, the roles within the function 'mounting tires' are also specialized. We measured the degree of specialization according to Pugh et al. (1968). We thus asked the respondents to rate the degree to which the following tasks are assigned to specialists or specialized divisions on a seven-point scale: PR and Advertising; Distribution; Transport and Shipping; Human Resources; Welfare and Social Services; Procurement; Maintenance of Equipment; Financial Resources; Workflow Control; Quality Control and Management; Production Management; Design and Development of New Outputs, Equipment and Processes; Administration; Legal and Insurance; Market Research; and the Training of Personnel. We calculated the mean of these 16 items and built a composite measure of 'Specialization' (Cronbach's $\alpha = 0.91$).

Process Variables

Codification of Information. We asked participants the following questions in order to assess the degree of codification of information in their respective companies: How well is knowledge documented (e.g. know-how, technical capabilities)? To what extent is it required to document the results from meetings and projects? To what extent is knowledge accessible through formal documents and handbooks, and to what extent is knowledge in codified form (e.g. handbooks, documentation) accessible? We calculated the mean of four items and built a composite measure of 'codification of information' (Cronbach's $\alpha = 0.87$).

Personalization of Information. We asked participants the following questions in order to assess the degree of personalization of information in their respective companies: How easy is it for experts and colleagues to access your knowledge and experience? How easy is it for you to get in touch with experts and ask for their help? How often is knowledge passed in informal talks and meetings? To what extent are mentors present for you and your colleagues that share their knowledge? We calculated the mean of four items and built a composite measure of 'personalization of information' (Cronbach's $\alpha = 0.76$).

Electronic Communication. We asked participants the following questions in order to assess the use of electronic communication in their respective companies: To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between department heads? To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between project/team managers? To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between employees? To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between department head and top management? To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between your department and the top management? To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between project/team managers and top management? To what extent has there been an exchange of knowledge between your department and other departments of the same hierarchical level through electronic means between employees and top management? We calculated the mean of six items and built a composite measure of 'electronic communication' (Cronbach's $\alpha = 0.86$).

Control Variables

Company Age. Previous research has shown that OM is also a function of an organization's age (Sinkula 1994) and that the knowledge management routines of larger and older corporations differ from those of smaller and younger ones (Lukas et al. 1996). Therefore, to ensure additional validity of the results, we include company age as a control variable in our regression analyses.

Number of Employees per Unit. Prior research also suggests that organizational memory is influenced by an organization's size (Berthon et al. 2001). Therefore, 'number of employees' per organizational unit was also included as a control in respect of the hypotheses regarding organizational memory bins.

Age of Employees. From a purely cognitive perspective, it is presumed that employees who have worked for the same corporation for a number of years become more socialized and familiar with the written and unwritten rules (Finkelstein and Hambrick 1996), because they have had more time to learn them. This greater knowledge is likely to facilitate OM creation and we therefore control for it in our study. We consequently asked the respondents to indicate their age.

Gender. The respondents were asked to indicate their gender.

Tenure. Tenure is a variable that has been thoroughly studied in organizational demography research. It has been shown to influence employee behavior inside the corporation. For example, the longer employees have worked for an organization,

the more they tend to internalize the organization's norms, values, and routines. Thus, we feel it is important to include this variable as a control in our study. We asked the respondents to indicate the number of years that they had worked for their present employer.

Job Communication Intensity. An important dimension in respect of work tasks and responsibilities is how much communication is needed with others in order to complete the work. The degree to which employees are required to communicate with others in order to finish their job is likely to influence at least the individual OM memory bin. Consequently, we control for this influence and asked the respondents to indicate the degree to which fulfilling their work responsibilities required them to collaborate and communicate with others on a 7-point Likert scale.

Decentralization. We measured the degree of decision centralization according to Pugh et al. (1968), asking the respondents to indicate the hierarchical level on which the following decisions are reached on a seven-point Likert scale: Factory/Warehouse Location Planning, Modification or Upgrading of Existing Buildings, Design of New (Operating) Processes, Research Budgeting, Technical Infrastructure within the Company, and Inventory Planning. We calculated the mean of these five items and built a composite measure of 'centralization', which has a reliability of 0.70 (Cronbach's $\alpha = 0.70$).

Results

The hypotheses were tested by means of hierarchical regression analyses. Column 1 of Table 2 indicates the results in respect of hypotheses regarding the influence of organizational standardization and specialization on organizational memory. 24% of the variance has been explained. Consistent with hypotheses H1 and H2, the regression results show that both standardization and specialization have a positive influence on organizational memory. The effect of standardization on the individual memory bin is positive and significant ($p < .05$), supporting H1. The effect of specialization on the individual memory bin is positive and significant ($p < .1$), supporting H2 on the 10 percent level. However, when testing H1 and H2 on the individual OM bin level we find that whereas standardization is significantly related to four OM bins, specialization seems to be only significantly related to the structure bin (Table 2d, Column 1).

Column 2 of Table 2 indicates that an additional 9% of the variance of organizational memory can be explained by including codification of information in the regression equation. In total this regression model explains 33% of the variance in the dependent variable. The regression result confirms H1a, which suggested a mediation of the relationship between standardization and organizational memory through codification of information. We can see that codification of information fully mediates this relationship and H1a is thus confirmed (Sobel z test was significant [$z = 3.5$; $p < .001$]). This mediating effect of codification can be traced to the culture and the structure OM bin (Tables 2b and 2d, Column 2).

Contrary to Hypothesis 2a, the regression results show that codification of information does not mediate the relationship between specialization and organizational memory. Consequently, H2a is not supported. Similarly, H1b and H2b have to be rejected.

Column 4 of Table 2 indicates that 29% of the variance in respect of the hypotheses regarding organizational memory has been explained. Contrary to the prediction made in H1c, the regression results show that electronic communication does not mediate the relationship between standardization and organizational memory. Thus H1c is rejected. However, electronic communication does partially mediate the relationship between specialization and organizational memory supporting H2c (Sobel z test was significant [$z = 2.0$; $p < .05$]). This mediating effect of electronic communication can be traced to the OM structure bin (Table 2d, Column 4).

Discussion

We set out to study the effects of organizational structure and processes on OM by examining the effect of organizational standardization and specialization with regard to organizational memory. We argued that organizational structure is positively associated with OM and that process variables mediate the relationship between organizational structure and OM. We examined these relationships by looking at the total OM as well as by looking at the effects of the structural antecedents on the respective bins in order to obtain insight into both the concept of OM and its respective subdimensions. Our study was conducted in the context of the knowledge management system of large, publicly-held companies, focusing specifically on the respective OM bins. The focus and context of the study allowed us to bring new insights into issues of the formation of total OM as well as OM bins. Drawing on theories of knowledge management and organizational structure (Karsten 1999; Pugh and Hickson 1976) and organizational memory (e.g. Huber 1991; Walsh and Ungson 1991), we identified two key structural factors: organizational specialization and organizational standardization. We argued that both specialization and standardization would be positively associated with OM. Furthermore, we predicted that the effects of specialization and standardization on OM would be mediated by process variables, namely, codification of knowledge, personalization of information, and electronic communication. In general, these predictions were supported, but the association between the organizational structure variables and OM as well as the mediating influence of the process variables varied slightly from our prediction and with regard to the respective OM bins.

The empirical analyses overall confirm the expected relationships between standardization and specialization and OM. Further, although ours was not a longitudinal study, the significantly different patterns of standardization and specialization for the respective organizational memory bins strongly suggest that the impact of the organizational structure may vary in systematic ways over the different dimensions of the relationship, especially with regard to the mediating effect of the process variables.

Table 1. Correlations of Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 Organizational Memory (total)																	
2 OM Individual	0.67***																
3 OM Culture	0.87***	0.52***															
4 OM Transformation	0.73***	0.38***	0.59***														
5 OM Structure	0.83***	0.38***	0.65***	0.51***													
6 OM Ecology	0.73***	0.30**	0.58***	0.31**	0.61***												
7 Standardization	0.33***	0.22*	0.29**	0.28**	0.28**	0.18†											
8 Specialization	0.27**	0.09	0.27**	0.23*	0.28**	0.18†	0.45***										
9 Codification of Information	0.48***	0.23*	0.45***	0.25*	0.48***	0.43***	0.40***	0.18†									
10 Personalization of Information	0.46***	0.36***	0.40***	0.40***	0.36***	0.23*	0.23*	0.05	0.58***								
11 Electronic Communication	0.30**	0.26**	0.20*	0.27**	0.32**	0.10	0.20*	0.24*	0.25**	0.23*							
12 Company Age	-0.02	-0.03	0.02	0.09	-0.07	-0.10	0.08	0.24*	-0.03	0.10	0.13						
13 Number of Employees	0.01	0.05	0.06	0.05	-0.02	-0.13	0.21*	0.29**	0.12	0.14	-0.06	-0.06					
14 Employee Age	-0.19†	-0.18†	-0.17†	-0.13	-0.11	-0.10	0.10	0.12	0.14	0.02	0.05	0.17†	0.04				
15 Gender	0.12	0.13	0.09	0.09	0.08	0.08	0.02	0.02	-0.07	0.03	0.11	0.02	-0.06	-0.28***			
16 Tenure	-0.06	-0.14	-0.10	-0.04	0.01	0.08	0.19†	0.15	0.16	-0.03	-0.08	-0.04	0.13	0.60***	-0.28		
17 Job Com Intensity	0.34***	0.34***	0.26**	0.27**	0.27**	0.13	0.04	0.01	0.23*	0.45***	0.11	0.06	0.18†	-0.04	0.00	0.01	
18 Decentralization	-0.03	-0.04	-0.04	-0.04	0.08	-0.10	-0.07	-0.10	-0.02	0.07	-0.06	-0.16	0.13	0.05	0.16	0.13	0.03

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

Table 2.
Hypotheses Test Based
on OLS Regression for
Dependent Variable:
Organizational
Memory (Total)

	Organizational Memory (total)	Organizational Memory (total)	Organizational Memory (total)	Organizational Memory (total)
H1 Standardization	0.299**	0.159	0.218*	0.268**
H2 Specialization	0.175†	0.197*	0.201*	0.108
H1a/2a Codification of Information		0.350**		
H1b/2b Personalization of Information			0.347**	
H1c/2c Electronic Communication				0.250*
Company Age	-0.198†	-0.126	-0.167†	-0.239*
Number of Employees	0.038	-0.019†	-0.007	0.122
Employee Age	-0.162	-0.221†	-0.241†	-0.252†
Gender	0.054	0.046	0.034	0.019
Tenure	-0.037	-0.029	0.037	0.050
Job Com Intensity	0.295**	0.215*	0.142	0.251**
Decentralization	0.034	0.045	0.014	0.026
F-Value	4.459***	5.800***	5.738***	4.964***
R ²	0.313	0.400	0.397	0.363
Adj. R ²	0.243	0.331	0.328	0.290

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

Table 2a.
Hypotheses Test Based
on OLS Regression for
Dependent Variable:
Organizational Memory
(Individual Bin)

	OM Individual	OM Individual	OM Individual	OM Individual
Standardization	0.279**	0.234*	0.227*	0.248*
Specialization	0.062	0.069	0.078	-0.006
Codification of Information		0.113		
Personalization of Information			0.224*	
Electronic Communication				0.252*
Company Age	-0.128	-0.105	-0.108	-0.170
Number of Employees	0.000	-0.019	-0.029	0.084
Employee Age	-0.079	-0.098	-0.130	-0.170
Gender	0.065	0.063	0.053	0.029
Tenure	-0.150	-0.147	-0.102	-0.062
Job Com Intensity	0.292**	0.266*	0.193†	0.247*
Decentralization	-0.006	-0.003	-0.019	-0.015
F-Value	2.909**	2.722**	3.125**	3.388***
R ²	0.229	0.238	0.264	0.280
Adj. R ²	0.150	0.151	0.180	0.198

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

Specifically, we found that the relationship between the organizational structure variables and organizational memory is mediated to a different extent by the process variables codification of information, personalization of information, and electronic communication.

We found that codification of information completely mediates the relationship between standardization and OM. Thus, codification of information is identified as a mechanism that underlies the relationship between standardization and OM. Rather than assuming a direct causal relationship between standardization and OM, our results suggest that standardization causes codification of information, which in turn affects OM. Thus, codification of information clarifies the nature of the relationship between the standardization and OM.

Table 2b.
Hypotheses Test Based
on OLS Regression for
Dependent Variable:
Organizational
Memory (Culture Bin)

	OM Culture	OM Culture	OM Culture	OM Culture
Standardization	0.255*	0.113	0.185†	0.238*
Specialization	0.159	0.181†	0.181†	0.122
Codification of Information		0.352**		
Personalization of Information			0.298**	
Electronic Communication				0.137
Company Age	-0.168	-0.095	-0.141	-0.190†
Number of Employees	0.116	0.058	0.077	0.162
Employee Age	-0.115	-0.175	-0.183	-0.165
Gender	0.029	0.021	0.012	0.009
Tenure	-0.118	-0.109	-0.054	-0.070
Job Com Intensity	0.205*	0.124	0.074	0.181†
Decentralization	0.020	0.031	0.003	0.015
F-Value	3.000***	4.145***	3.674***	2.899***
R ²	0.235	0.323	0.297	0.250
Adj. R ²	0.156	0.245	0.216	0.164

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

Table 2c.
Hypotheses Test
Based on OLS
Regression for
Dependent Variable:
Organizational Memory
(Transformation Bin)

	OM Transformation	OM Transformation	OM Transformation	OM Transformation
Standardization	0.218†	0.176	0.142	0.191†
Specialization	0.128	0.136	0.159	0.072
Codification of Information		0.109		
Personalization of Information			0.352**	
Electronic Communication				0.203†
Company Age	-0.044	-0.024	-0.021	-0.074
Number of Employees	0.034	0.015	-0.014	0.102
Employee Age	-0.088	-0.106	-0.166	-0.163
Gender	0.053	0.052	0.038	0.023
Tenure	-0.049	-0.048	0.020	0.023
Job Com Intensity	0.221*	0.195†	0.063	0.186†
Decentralization	0.033	0.038	0.019	0.024
F-Value	1.857†	1.757†	2.826**	2.071*
R ²	0.161	0.170	0.247	0.194
Adj. R ²	0.074	0.073	0.160	0.100

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

In addition we found that electronic communication partially mediates the relationship between specialization and OM. We found that personalization of information has a strong direct effect on OM and all OM bins, but does not mediate between the structural variables and OM.

This finding is important in its support of the proposition that organizational memory is a complex and differentiated concept and that possibly these effects are consistent across different antecedent variables. This proposition has received limited empirical attention in management and has not been assessed empirically in the context of large companies, which depend more than small and young firms on the development of OM. Further, we observed a trend that codification and electronic communication—variables which pertain predominantly to the writing down of work processes and rules of collaboration—seem to be

Table 2d.
Hypotheses Test Based
on OLS Regression for
Dependent Variable:
Organizational Memory
(Structure Bin)

	OM Structure	OM Structure	OM Structure	OM Structure
Standardization	0.223*	0.075	0.168	0.182†
Specialization	0.232*	0.254*	0.247*	0.166
Codification of Information		0.370**		
Personalization of Information			0.247*	
Electronic Communication				0.270**
Company Age	-0.182	-0.105	-0.157	-0.235*
Number of Employees	-0.041	-0.103	-0.076	0.057
Employee Age	-0.083	-0.146	-0.141	-0.178
Gender	0.029	0.022	0.019	-0.019
Tenure	-0.016	-0.008	0.037	0.078
Job Com Intensity	0.271**	0.186†	0.163	0.216*
Decentralization	0.128	0.139	0.114	0.116
F-Value	3.119***	4.447***	3.458**	3.697***
R ²	0.244	0.341	0.287	0.301
Adj. R ²	0.166	0.264	0.204	0.219

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

Table 2e.
Hypotheses Test Based
on OLS Regression for
Dependent Variable:
Organizational Memory
(Ecology Bin)

	OM Ecology	OM Ecology	OM Ecology	OM Ecology
Standardization	0.138	-0.019	0.088	0.123
Specialization	0.105	0.135	0.123	0.076
Codification of Information		0.386**		
Personalization of Information			0.203†	
Electronic Communication				0.115
Company Age	-0.258*	-0.177	-0.240*	-0.278*
Number of Employees	0.032	-0.032	0.005	0.070
Employee Age	-0.197	-0.264†	-0.240	-0.237
Gender	0.077	0.062	0.066	0.061
Tenure	0.204	0.208	0.246	0.243
Job Com Intensity	0.115	0.028	0.026	0.094
Decentralization	-0.082	-0.070	-0.095	-0.086
F-Value	1.794†	3.025**	1.950*	1.724†
R ²	0.160	0.265	0.188	0.170
Adj. R ²	0.071	0.177	0.092	0.072

†p < 0.1, *p < .05, **p < .01, ***p < .001. Two-tailed significance tests.

stronger mediators between organizational structure and OM than personalization. Further research clarifying this relationship is warranted.

The hypothesized direct relationship between the degree of standardization and organizational memory (Hypothesis 1) was supported; similarly, the hypothesized mediation of degree of codification and OM (Hypothesis 1a) was also supported. However, the hypothesized mediations of degree of personalization (Hypothesis 1b) and degree of electronic communication (Hypothesis 1c) were not supported. With regard to specialization, the results show that as hypothesized, the degree of specialization has a positive influence on the organizational memory (Hypothesis 2), although this hypothesis only received marginal support at the 10% level. However, the hypothesized mediation of degree of codification (Hypothesis 2a) and degree of personalization (Hypothesis 2b) were not supported, but Hypothesis 2c—the hypothesized mediation of degree of electronic communication and OM—was supported. The pattern of results is somewhat surprising. Specifically, the results show that standardization has a more

stable and stronger relationship with OM than specialization. Thus, whereas we anticipated that both standardization and specialization would be mediated (either partially or fully) through all three process variables, we actually observed a differentiated pattern with regard to the respective OM bin. One possible implication for this trend is that future studies should also be sure to measure OM in all its components and assess OM increase or decrease in all OM bins. That is, it is possible that OM increases only because of an increase in one separate OM bin. Scholars who focus on a single OM bin may thus obtain wrong results with regard to total OM increase. If or when scholars have found inconsistent results with regard to OM, they may have measured only a small part of total OM. Finally, contrary to our prediction, we found that personalization of information did not mediate the relationship between organizational structure and OM but had only direct effects on OM and its respective bins.

Implications

Overall, our results are consistent with several aspects of past work and make a number of contributions to the literature. First, our findings inform research and theory on the formation and development of OM. The results empirically confirm, in the unique context of large and mature firms, earlier work on the role of organizational structure in knowledge formation. By examining the mediating role of process variables, we provide some insight into how mediating factors exert differential influence on OM bins. Second, our results contribute to the discussion of the antecedents of knowledge retention within organizations from an organizational perspective. Our regression and mediation analyses reveal that it is really the codification of information as well as electronic communication which is linked to the development of the structural and cultural dimensions of organizational memory, not the structural variables per se.

Third, it is one of the first studies to empirically examine Walsh and Ungson's (1991) theoretical model of OM's storage bins. Our results confirm their model in that OM can be classified in different information storage bins that are distributed across different storage facilities, where it is retained. Choosing to measure several OM bins as part of our study contributes to 'key epistemological questions' regarding assessing the structure of OM as formulated by Walsh and Ungson (1991). Our results show that the OM concept does indeed have construct validity and is composed of separate bins. Our approach was to measure several OM bins, as 'any attempt to directly measure or assess OM is doomed to be partial and incomplete, unless one rigorously examines all the bins' (Walsh and Ungson 1991). Interestingly, we confirm Walsh and Ungson's (1991) suggestion that it is pertinent to measure all OM bins, as we find differential effects with regard to the antecedents of the separate OM bins.

However, despite the fact that our results empirically confirm the existence of separate storage bins, they also confirm scholars' notions (e.g. Karsten 1999) that the retention bins suggested by Walsh and Ungson (1991) also overlap. Our results therefore support Corbett (1997: 225) who argued: 'Whilst such a model reflects the hybrid and fragmented nature of memory, it does not do justice to the interconnectedness of such memory sites, nor to the fact that each storage bin

contains memories of others.' Third, the study extends earlier research on different types of OM by testing the influence of organizational structure on distinct OM storage bins, revealing that different organizational forms present different kinds of OM arenas. The results support the findings of Karsten (1999) who demonstrated that form changes coincided with changes in case study companies' OM profile. Finally, several researches (e.g. Paoli and Prencipe 2003; Walsh and Ungson 1991) have highlighted the importance of context for the empirical study of OM. Our study examines OM in the context of multi-unit businesses that are particularly dependent on the storage and sharing of knowledge across different organizational units.

Limitations and Future Directions

This study has some limitations that have to be taken into account in order to adequately interpret the results and judge their generalizability. First, inferences in this study are based on cross-sectional data, making causal claims difficult. Consequently, we did not actually observe changes in OM within a given dyad over time, and we cannot conclude with certainty that the mediating effects of the process variables reflect developmental effects. The well-known problem of inferring causation from cross-sectional data (e.g. Biddle and Marlin 1987; Cliff 1983) suggests that special care should be exercised in causally interpreting results derived from (cross-sectional) data (Baumgartner and Homburg 1996). The authors believe that a longitudinal database in which the relevant variables have been strictly measured should be developed to assess these questions. Second, although the results explained up to 33% of the variance in the dependent variables, 67% remains unexplained. In future models, additional context as well as psychological factors should be included in the analysis. Future models could also examine the dynamics of knowledge creation and disintegration, which we have not done.

Third, as is common and often necessary in studies of knowledge management and memory, we relied on self-reported measures in many instances to capture our key constructs. However, some of the issues related to questionnaire designs (such as consistency bias and social desirability bias) are mitigated somewhat in this study by what we measured and how we measured it. For example, many variables were easily recalled factual information and unlikely to be subject to systematic distortion. Therefore, although our criterion variable of OM was necessarily perceptual, we have little reason to believe that relationships with the predictors would be inflated by consistency bias.

As with all studies, the findings are bound by the context and sample. We examined OM in a specific context of large and mature firms characterized by certain degree of standardization and formalization. Consequently, our results are most relevant to knowledge management aspects in large and mature firm contexts. It should be noted that the sample was limited to German-speaking countries; Germany has a relatively high level of stability in situations underlying business relationships that may lead to more rapid development of OM and cooperation than is observed in other countries (Zaheer and Zaheer 2006). Thus, the impact of organizational structure on OM may differ elsewhere.

Future research may build on the results of this study in a number of ways. First, from the point of view of organizations, future research may consider the *consequences* of OM for the organization as called for by Tsang and Zahra (2008). It may be that OM has an influence on performance or performance-related variables. Second, future investigations might also examine the evolution of OM in organizations with that in other types of organization, such as family firms, low growth businesses, or government agencies. Third, this study found that standardization was associated with greater OM storage. However, consistent with the arguments presented by Ozorhon et al. (2005), it may be important to consider whether and how well the OM retained is actually being transferred and used within the organization.

More theoretical work is therefore required to address the question of how stored knowledge can be retrieved and recalled from the various organizational repository bins. Such information should enrich the understanding of OM. Some researchers have argued that when examining OM, it is important to fully understand how dispersed stored knowledge is collated. Fourth, a number of researchers have pointed out that the dynamics of OM storage changes over time (e.g. Akgün et al. 2007). Thus, future research should take a longitudinal perspective. Research could further consider the consequences of OM from organizations' point of view. It could be, as pointed out by several authors, that organizations that 'remember too well' actually hinder innovation and new knowledge. Further, in the light of the absence of quantitative empirical studies on OM, we would like to encourage and caution scholars with regard to this undertaking. We agree with Walsh and Ungson (1991: 81) who stated that 'sound empirically studies of OM are a daunting task'. Finally, the finding that decentralization is not related to OM storage bins merits further examination in light of the effect of other structural variables (i.e. standardization) on OM. More broadly, future research should also investigate the contingencies under which centralization plays a role in explaining knowledge retention in organizational settings. A number of other variables, especially with regard to the retrieval of OM, were not considered in this study and could provide an avenue for future research. Finally, as this study has focused on work specialization, we encourage future studies to investigate whether any differential effect of group specialization on OM exists.

Conclusion

Overall, this study represents an early attempt to empirically study the dynamics of organizational structure, processes, and OM. The authors hope that future research will build on these results. In conclusion, we examined how organizational structure might exert an influence on OM and its respective bins, looking specifically at the mediating effect of process variables. As had been noted in prior studies regarding OM and structures, we observed what appeared to be differential effects of OM antecedents. Interestingly, however, we found that the pattern was not always simply a direct or indirect relationship of one of the organizational structure variables with the organizational memory bin variables but rather, in some cases, surprising turns of direction. Our findings show that organizational structure influences organizational

memory through processes of codification of knowledge and electronic communication. We also show that respective organizational memory bins have unique associations with the organizational structure factors. Our study is one of the first to empirically test propositions with regard to the concept of organizational memory. We believe the entire area of examining longer-term effects of organizational structure and organizational memory offers promise for new insights into the evolution of organizations.

Notes

Both authors contributed equally and are listed in alphabetical order on the opening page of this article. We would like to thank Arnold Picot, Robert Wastian, Susan Grämer, Silvia Heer, an anonymous reviewer, and Ilse Ivertse.

1. The origin of the concept of organizational memory is attributed to Durkheim (1985) and Vygotsky (in press), who worked on collective memory and social construction theory.
2. Exceptions are for example Ackermann and Halverson (2000) and Moorman and Miner (1997) who made first attempts to operationalize and study organizational memory empirically and

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- Souren et al. (2004) who study collective memory experimentally.
3. We would like to thank an anonymous reviewer for pointing this out.
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