European Journal of Information Systems (2012) 21, 268–286

www.palgrave-journals.com/ejis/

RESEARCH ARTICLE

Reviewing Enterprise Content Management: a functional framework

Knut R. Grahlmann[1], Remko W. Helms[2], Cokky Hilhorst[3], Sjaak Brinkkemper[2] and Sander van Amerongen[4]

[1]*Ernst & Young Advisory, The Netherlands;* [2]*Department of Information and Computing Sciences, Utrecht University, The Netherlands;* [3]*Tilburg University, Tilburg, The Netherlands;* [4]*PricewaterhouseCoopers Advisory N.V., The Netherlands*

Correspondence: Knut R. Grahlmann, Ernst & Young Advisory, P.O. Box 7883, 1008 AB Amsterdam, The Netherlands.
Tel: +31 6 2908 3401;
E-mail: knut.grahlmann@nl.ey.com

Abstract
Enterprise Content Management (ECM) focuses on managing all types of content being used in organizations. It is a convergence of previous approaches that focus on managing only particular types of content, as for example documents or web pages. In this paper, we present an overview of previous research by categorizing the existing literature. We show that scientific literature on ECM is limited and there is no consensus on the definition of ECM. Therefore, the literature review surfaced several ECM definitions that we merge into a more consistent and comprehensive definition of ECM. The Functional ECM Framework (FEF) provides an overview of the potential functionalities of ECM systems (ECMSs). We apply the FEF in three case studies. The FEF can serve to communicate about ECMSs, to understand them and to direct future research. It can also be the basis for a more formal reference architecture and it can be used as an assessment tool by practitioners for comparing the functionalities provided by existing ECMSs.
European Journal of Information Systems (2012) **21,** 268–286. doi:10.1057/ejis.2011.41; published online 25 October 2011

Keywords: enterprise systems; Enterprise Content Management (ECM); Functional ECM Framework; literature study

Introduction

Organizations constantly produce various forms of content, for example text documents, spread sheets, web pages or e-mails. Even though organizations are highly dependent on the accessibility and integrity of their content (Dourish *et al*, 2000), the increase in the amount of content to be managed and its scatteredness throughout organizations have resulted in a situation where the professional management of content has become close to impossible (Grudin, 2006). Files are often just stored locally, making the localization, accessibility, consistency and publication control (e.g. through authorization) of content difficult (Vidgen *et al*, 2001; Scott *et al*, 2004). At the same time, external pressures, such as the Sarbanes–Oxley Act, force companies to manage (e.g. archive) their content in an organized manner (Engel *et al*, 2007). Furthermore, the trend towards working in virtual teams and telework requires easy digital access to content to enable work and collaboration from a distance (Strader *et al*, 1998; Bentley & Yoong, 2000), a prerequisite for working in 'the next generation workplace' (Van Heck, 2009).

The domain that studies the above-mentioned problems is referred to as Enterprise Content Management (ECM). It involves an 'integrated approach to managing all of an organization's information including paper documents, data, reports, web pages and digital assets [… and all …] the strategies, tools, processes, and skills an organization needs to manage all its information assets (regardless of type) over their lifecycle'

Received: 22 October 2009
Revised: 5 September 2011
Accepted: 16 September 2011

(Smith & McKeen, 2003, pp. 647–648). ECM Systems (ECMSs) are positioned as (technical) solutions for the organization-wide management of all types of content (Tyrväinen *et al*, 2006). Researchers consider ECMSs as a new class of Information Systems (ISs) and have therefore positioned ECM as a new field of IS research, including research on diverse subjects ranging from how to present information to users, over algorithms for information retrieval to processes for implementing ECMSs (Tyrväinen *et al*, 2006).

Although ECMSs offer large potential benefits for organizations to manage their content, research on ECM is scarce and in its infancy (Nordheim & Päivärinta, 2006). According to Smith & McKeen (2003), there is a lack of consensus about the term ECM. In addition, Andersen (2008) has observed that the discourse about ECM mainly occurs in practitioners' literature. As Päivärinta & Munkvold (2005) indicate: 'Whereas practitioners are already facing […] challenges, researchers still have provided few aids to manage them from the viewpoint of the enterprise' (ibid, p. 9).

The intention of this paper is to review and summarize the insights into ECM that academics have provided so far. In particular, we have two research aims. First, by conducting an extensive literature review we want to provide a clear definition of ECM. Second, we aim at providing a Functional ECM Framework (FEF) that describes the functionalities that, according to literature, can potentially be offered by an ECMS. Both the definition and the FEF can serve as a basis for further research and discussion in the field. In addition, the FEF can guide organizations in formulating their ECMS requirements and can be used to compare the functionalities offered by different ECMS vendors (Grefen & De Vries, 1998).

The remainder of this paper is organized as follows. In the next section, our research method and an overview of ECM research is provided, followed by our definition of ECM. The FEF is presented in the subsequent section. In the following section, we shortly present two case studies that provide indications about the completeness, accuracy and usefulness of the FEF. The paper concludes with a discussion of the results, highlighting the contributions and providing recommendations for further research.

A literature review of ECM

Since ECM is a relatively new concept within the field of IS, the existing body of literature is small and a common definition of ECM has not yet been developed. In this section, we shortly present the position of ECM as an IS research field, specifically in relation to knowledge management. Then, we analyse the current ECM literature. Finally, we review the definitions of ECM in the currently available literature and propose a more consistent and comprehensive definition.

The position of ECM as an IS research field

Tyrväinen *et al* (2006) position ECM as a field of IS research, aggregating research results of diverging subjects such as retrieval algorithms, usability issues or implementation methods. Nordheim & Päivärinta (2006) and Päivärinta & Munkvold (2005) regard ECM as a subfield of knowledge management, since ECMSs can be used to capture and utilize content that contains explicit knowledge in repositories or to manage organizational knowledge resources. However, even Munkvold *et al* (2006) and Päivärinta & Munkvold (2005) themselves argue that ECM incorporates fields that are distinctly different from knowledge management, such as the long-term storage of content or managing scanned invoices. By definition, this kind of content is not organizational knowledge that only exists in the heads of humans. Although ECMSs can be used for supporting knowledge management, it seems likely that ECM and knowledge management are in fact different fields of research that partly overlap (Herschel & Jones, 2005; Dilnutt, 2006; Kuechler & Vaishnavi, 2006), but which should not be subordinated to each other.

Literature filter criteria

We conducted a systematic literature review using the methods described by Webster & Watson (2002), who focus on the structure of a literature review paper, and Okoli & Schabram (2010), who focus on the process of conducting a systematic literature review. For identifying academic papers on ECM, we searched for papers in the following databases: ACM Digital Library, EBSCO, Google Scholar, IEEE Xplore, ProQuest and Worldcat. Additionally, we searched the databases of a number of well-respected conferences in the Information Systems field, including AMCIS, ECIS and ICIS.

We conducted full-text searches up until 2009 using 'Enterprise Content Management' and the combination of these terms, that is 'Enterprise' AND 'Content' AND 'Management', as our search keys. Furthermore, we followed the practice described by Webster & Watson (2002) to look for citations in the found papers to check for earlier appropriate papers ('going backward'). Where possible, the databases were also used to look for papers that cite the found papers ('going forward'). This search process resulted in a collection of several hundred academic papers.

During the collection of the academic papers, we applied a practical screen to determine which papers should be kept for further study (Okoli & Schabram, 2010). Applying the screen has been alternated with the literature search in order to limit the amount of work for 'going backward and forward'. A rather tolerant screen was used since obtaining a broad overview of papers published in this domain was the goal. For example, limiting the selection to top outlets only would potentially exclude ECMS functionalities. This is particularly applicable for emerging research fields like ECM, where the discussion is likely to occur in many different outlets.

Table 1 Categorized overview of reviewed articles

Paper		*Content*			*Technology*	*Enterprise*	*Process*	*Research field*
		Information	*User*	*System*				
1	Kittl & Zeidler (2007)	X						
2	Aleksy & Schwind (2006)	X			X			
3	Reimer (2002)			X	X			
4	Cheung & Chiu (2003)			X	X			
5	Kwok & Chiu (2004)			X	X			
6	Chiu & Hung (2005)			X	X			
7	Dilnutt (2006)			X	X			
8	Becker *et al* (2007)			X	X			
9	Böhm (2007)			X	X	X		X
10	De Carvalho (2008)	X		X	X	X		
11	Scott *et al* (2004)	X		X	X	X	X	
12	Päivärinta & Munkvold (2005)	X		X	X	X	X	X
13	Smith & McKeen (2003)	X			X	X	X	X
14	Munkvold *et al* (2003)	X	X		X	X	X	X
15	Andersen (2008)		X		X	X	X	
16	Nordheim & Päivärinta (2004)		X	X		X	X	X
17	Iverson & Burkart (2007)		X	X		X	X	
18	Scheepers (2006)			X		X	X	
19	O'Callaghan & Smits (2005)	X				X	X	
20	Erickson & Brickey (2008)					X	X	X
21	Nordheim & Päivärinta (2006)			X			X	X
22	Munkvold *et al* (2006)	X	X	X			X	X
23	vom Brocke & Simons (2008)	X					X	
24	vom Brocke *et al* (2008a)	X					X	
25	Rückel *et al* (2007)			X			X	
26	vom Brocke *et al* (2008b, 2009)			X			X	X
27	Reich & Behrendt (2007)			X		X		X
28	Usman *et al* (2009)			X		X		
29	Smolnik (2007)		X			X		X
30	Sprehe (2005)					X		
31	Osl & Otto (2007)					X		
32	Tyrväinen *et al* (2006)							X
	Total (32)	11	6	19	14	17	16	12

Screening the papers consisted of checking whether they just accidentally contained the words 'enterprise', 'content' and 'management' and whether they really addressed the topic of ECM. During screening, we developed a more elaborate understanding, resulting in continuous iterations while going through the literature. After screening our database of identified literature, 32 academic papers remained (see Table 1). The papers range from theoretical explorations of the ECM concept to empirical studies and summaries of practitioner case studies. We also decided to exclude Tyrväinen *et al* (2003) as well as Salminen *et al* (2005) because they are only one-page-long introductions to the ECM-minitracks at the Hawaii International Conference on System Sciences (HICSS) 2003 and 2005.

We used two different methods for data extraction. To address the first research aim, all papers were scanned for definitions or descriptions of ECM. To address the second research aim, a more comprehensive method for data extraction was followed based on coding techniques from grounded theory research. The technique that was used is very similar to open coding. This is an analytical technique in which phenomena are named and categorized through close examination of data (Strauss & Corbin, 1990). This is also known as 'labelling': taking a sentence, conceptualizing the general idea of this part of text and giving it a name. Labels that pertain to similar types of phenomena can then be grouped into categories, which can then be re-grouped by comparing them semantically. As described in more detail below, this coding finally resulted in the FEF.

When we analysed these academic papers during the creation of the FEF, we felt that the studied papers did not cover the full range of ECMS functionalities. Therefore, we also added practitioner papers to our database and included them in the data extraction. Including non-scientific literature represents the 'clinical perspective' described by Schein (1987), who states that there often is

a difference between what is being described in scientific literature and what practitioners believe to 'really be going on' (Schein, 1987, p. 13). We included practitioners' papers from a broad range of sources to limit bias, for example by including only a single vendor. Even though we could find a large number of sources, we chose those papers that we considered to have a certain quality. This resulted in the inclusion of nine practitioner papers for creating the FEF. They are from an often-referenced industry association (the Association for Information and Image Management, AIIM) and two major ECMS vendors who had provided more detailed descriptions of their ECMSs. We also included the observations of an ECM-consultant and descriptions from market researchers. As can be seen from Table A1 in the Appendix, the inclusion of the clinical perspective proved to be useful since several functionalities were either exclusively mentioned in practitioners' literature or are mainly derived from it.

Structuring the literature

To structure our literature research, we used a framework for research on ECM defined by Tyrväinen *et al* (2006), which has also been adopted by other researchers (cf. vom Brocke & Simons, 2008). Using this framework, we categorized the identified papers according to the four perspectives used in the framework:

1. The *content perspective* is composed of three views:
   - 1.1. the *information view* is concerned with the semantics of the content and how it can be represented for different purposes;
   - 1.2. the *user view*, which elaborates on how content should be presented in order to be interpreted correctly and fit the specific needs of the users; and
   - 1.3. the *systems view* focuses on systems as containers of the content, which are accessed by the users.
2. The *technology perspective* addresses the basic technologies used for ECMSs including, for example, hardware, software and standards.
3. The *enterprise perspective* 'considers organizational, social, and business issues' (Tyrväinen *et al*, 2006, p. 630).
4. The *process perspective* subsumes research about both the development and the deployment of ECMSs.

We added 'Research Field' as the seventh category for structuring the literature review, which denotes papers that also comment on ECM as an IS research field, for example by providing a definition of ECM or by categorizing ECM research. This paper for example can be categorized into the systems view and as commenting on ECM as a research field.

The papers in our research database are depicted in Table 1. They are clustered with respect to the perspectives they cover (i.e. excluding the column 'research field'). For simplifying the clustering, we collapsed the three content views into one column by using an OR function. Hence, the content column contains an 'X' in case either the information, user or system column contains an 'X'. In the next step, the papers are clustered based on similarity. Hence, papers that have the highest similarity, considering the number of perspectives they 'share', are positioned next to each other. Simply stated, this clustering process aims at creating the longest possible uninterrupted chains of 'X's within a column and across columns. Within the clusters, the papers are sorted based on their year of publication.

Focusing on the individual perspectives, the following observations can be made. First, it becomes apparent that nearly all papers (27) evaluate the content perspective. This largely confirms the claim from Tyrväinen *et al* (2006) that 'any piece of ECM research should include the content perspective' (Tyrväinen *et al*, 2006, p. 631). However, it should be noted that within the content perspective, the user view has received much less research attention than the other two views. This does not mean that there has not been much attention for this topic in general, but that the topic has not often been related to ECM (our main search key). Second, the other perspectives have not been studied as extensively as the content one: 14 papers include the technology perspective, 17 evaluate ECM from an enterprise perspective and 16 from the process perspective. Only 12 papers comment on ECM as an IS research field. Therefore, all perspectives are addressed, but the number of contributions in each perspective is still relatively modest and is far from an integrated body of knowledge on ECM. When focussing on the combinations of several perspectives, it can be noted that there are only five papers that focus on all four perspectives, namely paper 11 till 15. Besides these papers, mainly two other categories can be distinguished. One category focuses on the content and technology perspectives and mainly addresses technological issues of ECM (i.e. papers 2 till 8). The other category focuses on the content perspective and the enterprise and/or process perspective (i.e. papers 16 till 29) and hence the focus is more on the application of ECM within an organizational context. Finally, it is worth mentioning that we also tried to sort the papers based on their year of publication. However, this did not result in a clear pattern.

Defining ECM

In the identified papers, several definitions of the contemporary perception of ECM can be found. The definitions can broadly be divided into two different groups. The first group of papers (papers 2 till 8) concentrate on the content and technology perspectives, focusing 'on the premise that all forms of content or unstructured data should be managed in a repository, independent of the applications utilizing the information. These concepts parallel first principals [sic] of structured data management and database systems' (Reimer, 2002, p. 18). These papers describe general functional requirements and the technologies needed for

integrating content. Reimer (2002) clearly separates ECMSs from structured data management systems such as relational databases. We also found this perception in the evaluated practitioners' literature. For example, the AIIM (AIIM, 2005), an international industry association focusing on ECM, perceives ECM from a content and technical perspective, but already broadens its definition to include related methods and adds a strategic notion, by defining ECM as 'the technologies used to capture, manage, store, preserve, and deliver content and documents related to organizational processes. ECM tools and strategies allow the management of an organization's unstructured information, wherever that information exists. […] Content must be managed so that it is used to achieve business goals. Central to this strategy are the tools and technologies of ECM, which manage the complete lifecycle of content, birth to death' (ibid).

The second group of identified articles define ECM from an enterprise or process perspective (papers 16 till 28). Tyrväinen *et al* (2003) describe ECM as focusing 'on the management of textual and multimedia content across and between enterprises, emphasizing the coexistence of technical and social aspects within the content management. Methods and techniques applicable for managing textual and multimedia information with all sizes of content units, ranging from XML and database structures through web pages and documents to document collections, are studied as well as approaches focusing on specific content structures' (ibid, p. 2). Smith & McKeen (2003, pp. 647–648) similarly define ECM as an 'integrated approach to managing all of an organization's information including paper documents, data, reports, web pages and digital assets' and 'the strategies, tools, processes, and skills an organization needs to manage all its information assets (regardless of type) over their lifecycle'. This definition is also used by Reich & Behrendt (2007) and Rückel *et al* (2007). The process perspective has gained considerable attention from several researchers. Nordheim & Päivärinta (2006) define ECM as representing 'a modern concept of Information Resource Management in general, addressing the integration of semi- and unstructured data with the management of formal databases' (ibid, p. 649). Tyrväinen *et al* (2006) further specify the content lifecycle to include 'activities such as content creation and capture, content editing, review, approval, content indexing, classifying and linking, content distribution, publication and use, update, preservation, format transformation for long-term archival, and retention' (ibid, p. 631).

A notable difference in definitions is related to the use of structured data on the one hand and unstructured or semi-structured data and/or information on the other. The AIIM limits ECM to the management of 'unstructured information' (AIIM Europe, n.d.). The view of limiting ECM to unstructured or semi-structured data is not only shared in the practitioners' literature. Scientific literature such as Reimer (2002), O'Callaghan & Smits (2005) and Andersen (2008) also limit ECM to unstructured information. However, there are numerous academic papers that also consider structured data as content that can be managed by ECMSs. We decided to follow this perception, since it emphasizes that the scope of ECM covers all the 'information assets (regardless of type)' of an organization (Smith & McKeen, 2003, p. 648).

The broad range of subjects covered by ECM shows that it is more than 'the latest buzzword' (Mescan, 2004, p. 55). However, previous definitions vary and are at times contradictory. Therefore, we propose a more consistent and comprehensive definition of ECM:

> Enterprise Content Management comprises the strategies, processes, methods, systems, and technologies that are necessary for capturing, creating, managing, using, publishing, storing, preserving, and disposing content within and between organizations.

The proposed definition summarizes all relevant perspectives of ECM that have been mentioned in the first seven years of research on this topic and provides a common conceptual basis for further research in this field. It points out that ECM is not limited to technologies, but rather covers a wide range of subjects so that this definition is aligned well with the notion of ECM being its own field of IS research. Finally, the definition also includes a specification of the content lifecycle mentioned in previous definitions and therefore further illustrates the breadth of this concept.

A Functional ECM Framework

To our knowledge, there is no overview available in literature that summarizes the functionalities that an ECMS can provide. If contributions can be found, for example Grossniklaus & Norrie (2002), they do not have a focus on ECM, but a more narrow focus, such as (web) content management. The reviewed articles listed in the previous section mostly have a more informational or technological focus on content management. Developing an overview of ECMS functionalities addresses several scientific and practical purposes. First of all, a consensus about ECMS functionalities will serve to understand and communicate about ECMSs. Second, an overview of ECMS functionalities can direct future research concerning specific functionalities or concerning ECMSs in general. It can for example be used as a reference in case study research to describe which ECMS functionalities are used by a particular organization. Third, it can be the basis for a more formal reference architecture that lays the foundation for designing and building ECMSs. Finally, the FEF can be used as an assessment tool by practitioners for comparing the functionalities provided by existing ECMSs.

We refer to the ECMS functionalities overview as the FEF. The term 'functional framework' has been carefully selected. We prefer it over other terms such as taxonomy, reference architecture or reference model, because these terms have specific connotations in related research

domains. A taxonomy is by definition characterized by a strict hierarchical decomposition of elements (cf. Nagra *et al*, 2002). As will be shown later, the FEF is based on a number of guidelines derived from literature that only partially suggest a hierarchical decomposition. The terms reference architecture and reference model are established concepts in the field of software architecture and software development. While a reference model shows the functional requirements of an ECMS (Software Engineering Institute, n.d.), a reference architecture rather presents a technical implementation of functionalities in software components (Bordegoni *et al*, 1997; Grefen & De Vries, 1998; Angelov, 2006; Mellish *et al*, 2006; Software Engineering Institute, n.d.). As one of our foremost aims is to support the understanding of and the communication about ECMSs, we present a functional framework that leaves out the details of implementation. These details are mainly of interest for developers of an ECMS rather than, for example, for managers in an organization who need to make decisions about required ECMS functionalities. To summarize, the FEF is a representative of Orlikowski & Iacono's (2001) 'tool' view, that is, we aim at describing what an ECMS is and what it is intended to do.

Defining functionality

The terms 'functionality' and 'function' (which we perceive as synonyms in the context of information systems) are often used when describing information systems, but their definition is left implicit most of the time. However, we need a definition for labelling particular pieces of text as ECM functionality while scanning the literature.

Definitions for the term function can be found in general IS literature as well as in the Enterprise Modelling (cf. ARIS, DEM, Zachman Framework) literature. Generally speaking, a function transforms inputs into outputs (Zachman, 1987; Davis, 2001). In the information systems literature, a function is typically referred to as a capability of an information system (Rolland & Prakash, 2001). This means that certain information inputs are transformed into information outputs (Stair & Reynolds, 2006), for example customer-order data that is being transformed into a customer invoice by the invoice function. In the enterprise modelling literature, a (business) function typically relates to a particular business process or a cluster of business processes that can be broken down into activities and tasks (Zachman, 1987; Davis, 2001; Turban *et al*, 2005). Functions of information systems and business functions are directly related since an information system function should execute or support specific business functions (activities or tasks) for intended users (Nickerson, 2000). Summarizing the above for this research, we define functionality as a capability of an information system referring to a particular business function(s) that needs to be executed by the ECMS.

Creation guidelines

Considering the previously described aims of an FEF, we formulated design guidelines to guide the development of the FEF that are inspired by literature on reference architectures. Authors in this research field have been explicit about such guidelines, which is not the case for the (also less abundant) literature on functional taxonomies or frameworks.

The first and most important guideline is that the FEF is *comprehensible and usable*. The FEF needs to be 'understandable and usable by the communities targeted' (Bernus & Nemes, 1996, p. 180), which is in line with our main aim. In this case, the targeted communities are the ECM research and practitioner communities as they should be able to understand and use the FEF. Second, the FEF needs to be *complete*, that is, it has to include all possible functionalities currently described and has to be composed independently of the thought that there needs to be a concrete ECMS that includes every possible functionality (Williams, 1994; Grefen & De Vries, 1998; Angelov, 2006). Only if the FEF is able to describe a wide range of existing ECMS implementations, it is of use for both researchers and practitioners. Third, the FEF should be *generic* enough to be used for making comparisons among different ECMSs by making it supplier and solution independent. Consequently, it should hide low-level and supplier-specific details (Williams, 1994; Grefen & De Vries, 1998). Fourth, it needs to be *distinguishing* enough so that differences between implementations at different organizations can be captured and analysed (Grefen & De Vries, 1998). Fifth, the FEF needs to be *future-proof* and should be constructed in such a way that it is able to accommodate future developments (Bernus & Nemes, 1996). It should, in particular, support the integration of new functionalities that can be expected because the field is still in development.

Creating the FEF

We started the creation of the FEF by extracting a list of functionalities from the literature and, as mentioned before, we also included practitioners' literature in this extraction process. For the extraction, we used a technique similar to open coding. We scanned the collected literature, extracted pieces of text describing functionalities and labelled them. The label of each functionality is a description that best summarizes the functionality as interpreted by the researchers. For example, the text fragment 'many methods of imputing data and information into an application or database. Other methods include: on-line entry, input from other applications, Electronic Data Interchange, […]' (Dilnutt, 2006, p. 78) was labelled as 'capture: digital forms', 'capture: digital sources' and 'client application integration'. Another example is the sentence 'effective content creation and capture from heterogeneous external and internal sources (integrated production environments, scanning and imaging, conversion of file formats, forms-based data capture)' (Päivärinta & Munkvold, 2005, p. 4), which was

labelled as 'imaging', 'capture: digital sources' and 'capture: digital forms'. Labelling is typically an iterative process where labels are adapted if new labels are being defined. After labelling the potential functionalities, we eliminated duplicates and further harmonized the names. This resulted in the list as presented in Table A1 in the Appendix. However, a list by its very nature does not provide an intuitive overview and can also be impractical for comparing different ECMSs. For producing an overview of functionalities that fulfils the guidelines as mentioned above, we decided to proceed with a graphical approach.

Our next step was to divide the functionalities into main categories. We grouped labels pertaining to similar types of phenomena into categories, which we then regrouped by comparing them semantically. This was an iterative process in which we divided functionalities into preliminary categories, changed categories and re-assigned functionalities again until we felt we had an understandable and representative categorization.

We were also inspired by literature describing models for presenting functionality of information systems in layers. Fowler (2003) describes a four-layered presentation consisting of four layers: presentation (handling interaction with users), service (contains for example transaction control), domain (performs processing of input and generates outputs), and data source (communication with for example a database). Similarly, McKeever (2003) presents a Web Content Management (WCM) hierarchy consisting of the following four layers: Audience (groups of people interacting with the WCM system (WCMS)), Outlet (types of outlets through which the content can be accessed), Activity (activities involved in managing content) and Content (types of content).

Combining our grouping with the layers found in literature resulted in the four main categories of the FEF: 'Repository', 'Service', 'Process' and 'Access', which we describe as follows:

- *Access*: Functionalities for users and information systems to interface with the ECMS in order to retrieve content and/or to use/invoke other functionalities.
- *Process*: Functionalities related to control and coordination.
- *Service*: Functionalities related to capturing, manipulating, using and publishing content.
- *Repository*: Functionalities related to the storage and preservation of content.

Our next step was to refine the layers in order to enhance the clarity of the FEF. We analysed each layer to see whether it needed to be further divided into subcategories that then were created in a second round of clustering. After determining the content and names of the sub-categories, we re-checked and, if necessary, adapted these during several iterations. During this process, we also re-evaluated the literature in order to check if the initial labelling was still valid in the new context and to check whether the new understanding of ECM(Ss) provided additional evidence of functionalities.

The top layer ('Access') contains, among others, the functionalities intranet, extranet and organization's website. Although these four access methods are all based on very similar technologies, they are mentioned separately because each of them represents a different 'reach' of an ECMS that is expected to influence the impacts of the particular system. This is also in line with the notion of the tool view from Orlikowski & Iacono (2001). Next to human users, other information systems can interface with an ECMS. We labelled this access method as *EAI interface* (Enterprise Application Integration) in the FEF.

The second layer ('Process') is divided into three subcategories. The first one, 'Workflow Management', contains functionalities that are related to partly or fully automating business processes. The second sub-category 'Collaboration' includes functionalities that enable or support team work where users jointly work on content and content needs to be shared. Finally, the functionalities in the sub-category 'Analysis' can be used to analyse content (e.g. age of certain classes of documents) and to monitor process flows.

In the third layer ('Service'), there are three subcategories. The sub-category 'Capture' encompasses the functionalities related to 'inserting' content into the ECMS. Functionalities that are concerned with finding and managing specific types of content form the subcategory 'Management & Use'. The functionalities that provide means for content to leave the ECMS are placed in the sub-category 'Publication'. In the fourth layer ('Repository'), we considered the functionalities as being too distinct from each other for introducing sub-categories.

Another decision we took for improving the clarity was not to assign meaning to the size of boxes or evaluate the importance of functionalities within an ECMS. These can vary per vendor and ECMS implementation. By focusing on the availability of a type of functionality as such, different ECMS implementations can be compared with each other more easily. This process resulted in the current version of the FEF as presented in Figure 1. Functionalities are denoted as rectangular boxes with regular font and sub-categories are denoted as enclosing boxes with bold font and dashed lines.

The functionalities and categories of functionalities that are presented in the FEF are not necessarily the lowest level functionalities, or atomic functionalities, that can be defined. An example is the 'version management' functionality that is shown in the Repository layer and which can be broken down into lower level functionalities such as: check-in, check-out, version numbering, version history, etc. There are various reasons why we decided not to further decompose the functionalities. First of all, we wanted a framework that is quickly comprehensible and usable whereas introducing lower functionalities could undermine this criterion. Second, the literature is not always very specific about

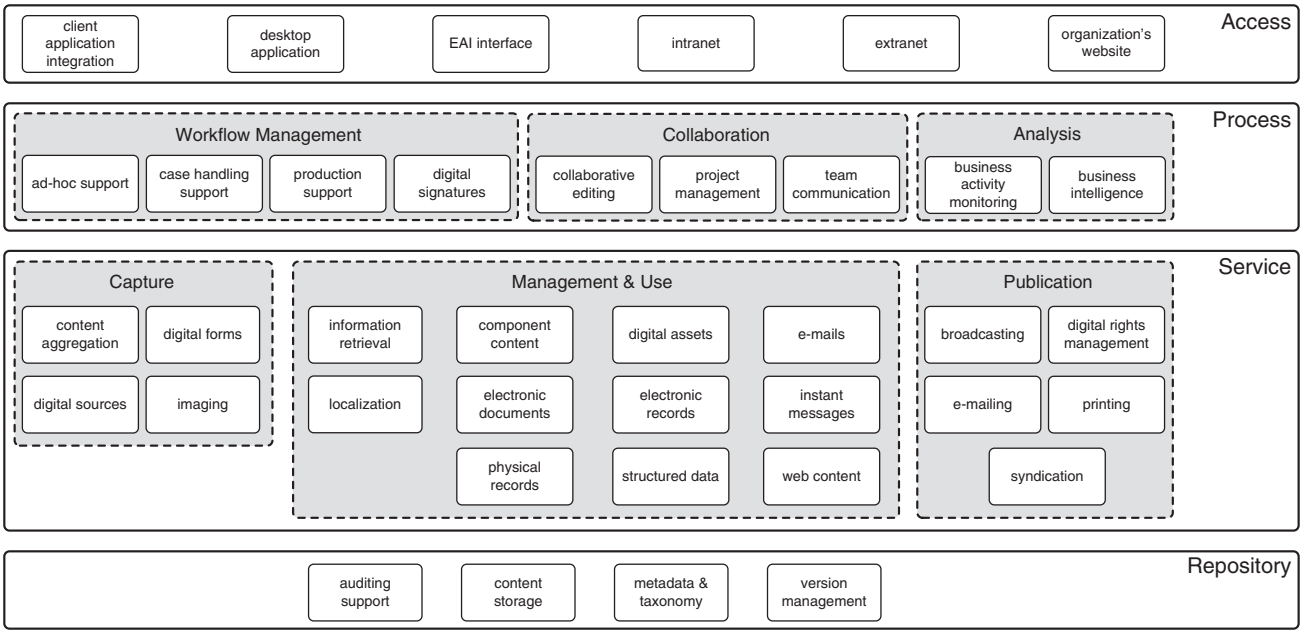

Figure 1 Functional ECM Framework.

the lower-level functionalities and also tends to speak of categories of functionalities rather than of atomic functionality. Finally, one runs the risk of describing functionalities that are vendor specific when describing functionalities at lower levels of detail that would make the FEF vendor specific.

Additional observations during literature review

During the literature review, we encountered three issues that are worth mentioning here.

ECMS as middleware In the interest of completeness, it is noteworthy to mention that a different view on the main purposes of an ECMS can be found in the literature. Although Bandorf *et al* (2004) agree that an ECMS includes, for example, the functionalities portal integration and information retrieval, the authors consider ECMSs to be mainly a middleware infrastructure for content. According to their perception, the ECMS itself only stores metadata that describes content that is stored in repositories managed by other systems (e.g. file systems, data bases and applications). The ECMS integrates the various repositories and provides other applications with access to these 'content stores' (Bandorf *et al*, 2004). Related to the functionalities mentioned above, this point of view would mean that the *EAI interface* functionality is the central element of an ECMS.

Management of structured data As described above, ECM(Ss) is/are also concerned with the management of so-called structured data. The functionalities *business intelligence* and *business activity monitoring* are often used for analysing structured data about workflow initiations, and therefore ECMSs already contain certain functionalities for managing structured data. However, hardly any source further elaborates on this topic, for example, by explaining how other sources of structured data are accessed and managed in practice. Smith & McKeen (2003) mention that databases and data warehouses can be used for managing structured data, but do not define whether these databases are part of the ECMS or whether an ECMS needs additional functionalities besides the ones already included in the FEF. Even exponents of the inclusion of structured data in ECM state that 'ECM and ERP systems [containing structured data, eds.] clearly represent two different approaches to such issues as workflow and data management' (Nordheim & Päivärinta, 2004, p. 7) or describe a project where the structured data remains in the Enterprise Resource Planning (ERP) system and is only linked to content stored in the ECMS (Päivärinta & Munkvold, 2005). These observations confirm the previous conclusion that the *EAI interface* functionality presumably plays an important role in the management of structured data. It is also assumed that this functionality needs to be combined with a special functionality for managing structured data, for example, for extraction, transformation and load operations (Doculabs, 2004).

ECMSs as multi-product software The dissimilar characteristics and the diversity of functionalities offered by an ECMS lead to the conclusion that although ECMSs are marketed under a single term, an ECMS implementation will be an integration of multiple software products (Reich & Behrendt, 2007). ECMSs can offer functionalities that are very different, if not entirely opposite, from

each other. The management of electronic records, for example, requires protecting content from changes: potentially for an unlimited period of time and even if the content has become outdated in the meantime. When managing electronic documents, changes are allowed to occur, but normally they need to be tracked so that old versions of a document can be reverted to. Digital assets such as, for example, video files require different user interfaces than text files. This view is supported by the history of ECMSs, which are rooted in different classes of information systems: some suppliers of traditional Electronic Document Management systems have extended their products with functionality for managing web content by acquiring specialized companies and their products, whereas some traditional suppliers of WCMS have done the opposite (Dilnutt, 2006). Böhm (2007) even argues that certain functionalities are not covered by products from the ECMS vendors, but rather by specialized third-party products. Therefore, a parallel can be drawn with the best-of-breed approach for implementing ERP systems (ERPSs): instead of introducing only a single ERPS that needs to cover all functionalities, several standard and customized products are integrated with each other. It has been shown that this approach requires a different implementation process than the introduction of a single system (Light *et al*, 2001) and it can be assumed that this is also true for ECMSs. However, the current literature on the implementation of ECMSs (e.g. Scott *et al*, 2004; Nordheim & Päivärinta, 2006) does not explicitly analyse the process of 'multi-product implementation' within the context of ECMSs and, therefore, this topic remains open to further research.

Applying the FEF in practice: case study research

Before creating the FEF, we had defined five guidelines, namely that the FEF is (1) *comprehensible and usable*, (2) *complete*, (3) *generic* enough to be used for making comparisons, (4) *distinguishing* enough for capturing differences, and (5) *future-proof*. After creating the FEF, our next step was to conduct initial practical tests whether it actually embraces these guidelines. Therefore, we applied the FEF in three case studies in which we studied the impacts of implementing ECMSs in organizations. Applying the FEF to actual ECMS implementations also provided us with an improved insight on potential interactions among the different (groups of) functionalities.

In the case study research (Grahlmann *et al*, 2010), we used the FEF to capture the functional scopes of ECMSs, being defined as 'the range of business functions' (Karimi *et al*, 2007, p. 105) offered by the ECMS. ECMSs at three organizations (A, B and C) were evaluated by conducting semi-structured interviews and by studying available documentation. Based on this information, the functionalities used in a particular organization were coded into the FEF by highlighting the applicable boxes. These codifications have been reviewed by the respondents, serving as a coding check. Two examples of the results are depicted in Figures 2 and 3.

Evaluation of using the FEF in practice

The practical application of the FEF during the case studies gave some first indications that the FEF follows the defined creation guidelines. The case studies indicate that the FEF is understandable to the practitioners' community. After reviewing the case study reports

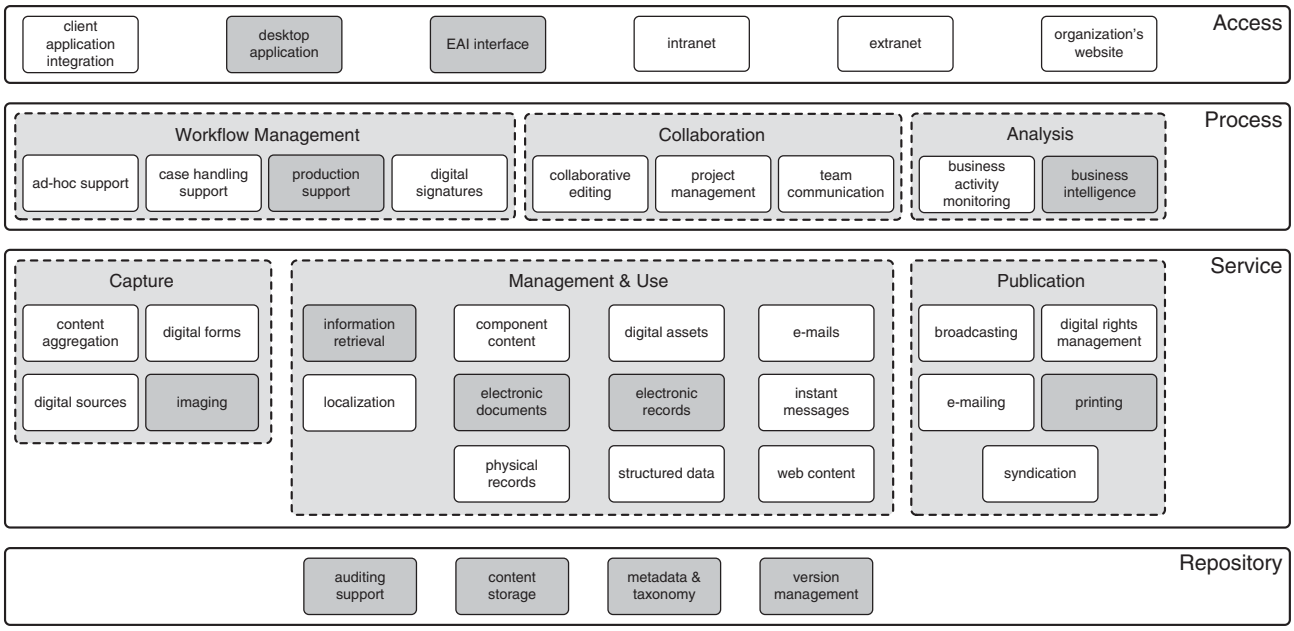

Figure 2 Functional scope of the ECMS at Organization A.

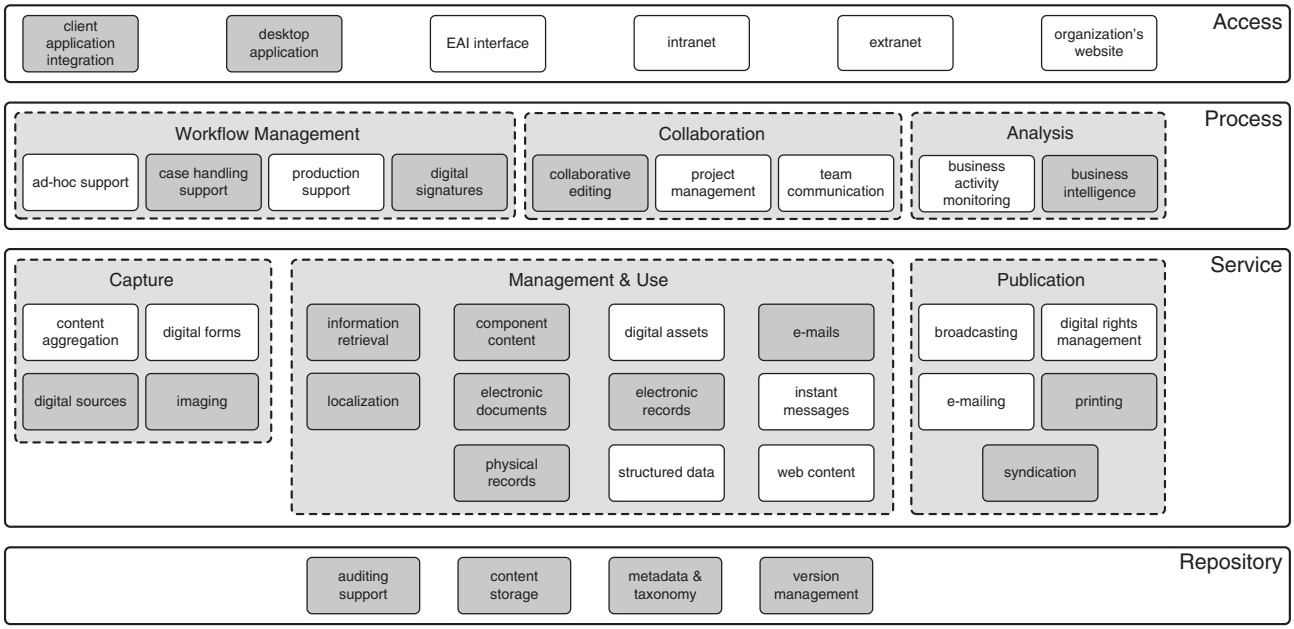

Figure 3 Functional scope of the ECMS at Organization B.

containing the visual representation of the FEF shown in Figure 1, all respondents confirmed the comprehensibility of the FEF. This can probably be attributed to the fact that the language used in the FEF is strictly based on relevant literature. The three case studies also provided an indication that the FEF appears to be complete, since all functionalities found at the three ECMSs studied were already included in the FEF. Admittedly, the scope of this research is limited. Furthermore, the FEF was shown to be generic and distinguishing enough to be used for comparison since notable differences were found across the cases. The chosen level of detail enabled the respondents to map functionalities of their particular ECMS on the FEF.

Figures 2 and 3 show that the chosen coding notation can be used to visualize differing functional scopes of ECMS implementations. The ECMS at Organization A is based on IBM Filenet and is relatively limited in scope since it only processes electronic documents and electronic records while offering little additional functionality.

The ECMS used at Organization B is based on OpenText LiveLink ECM and has an extended functional scope. Content is, for example, imported from digital sources (e.g. name and address data), many different types of content are managed, and content is published to a number of external receivers.

Evaluation by subject matter expert

In addition to the case studies, a subject matter expert (ECM consultant with more than 10 years of experience in the field) thoroughly reviewed the FEF. No additional adjustments were made to the FEF as a result of his review. The expert claimed that the FEF is in line with his experience from ECM-projects at various clients. Furthermore, the FEF was found to be easily mutable and considered future-proof, since its creation is partly based on a layered architecture. Therefore, it can be expected that the FEF can easily be extended with new functionalities and that it can also be broken down into more detail if necessary.

Analysis of an application landscape

Besides contributing to the evaluation of the FEF, the case studies also demonstrated another practical use of the FEF. As Böhm (2007) already indicated, ECMS implementations are likely to consist of several different software products. This is indeed what we found in the case studies that were analysed. Several different software products were found at each case study organization and each software product supports only a part of the required ECM functionality. During the case studies, we found that the FEF is helpful in describing which ECM functionality the different software products support. This can for example help in detecting possible overlaps in the supported ECM functionalities or point out possible omissions in the software products.

For this purpose, the FEF can be combined with application overlays (AOs) (Koning *et al*, 2008). An AO is an additional diagram layer on top of the FEF diagram. To produce it, the (existing) ECMS and other applications in an organization are examined for the ECM functionality they provide. These applications are depicted as semi-transparent boxes (including the application name) on top of the particular elements of the FEF. If an

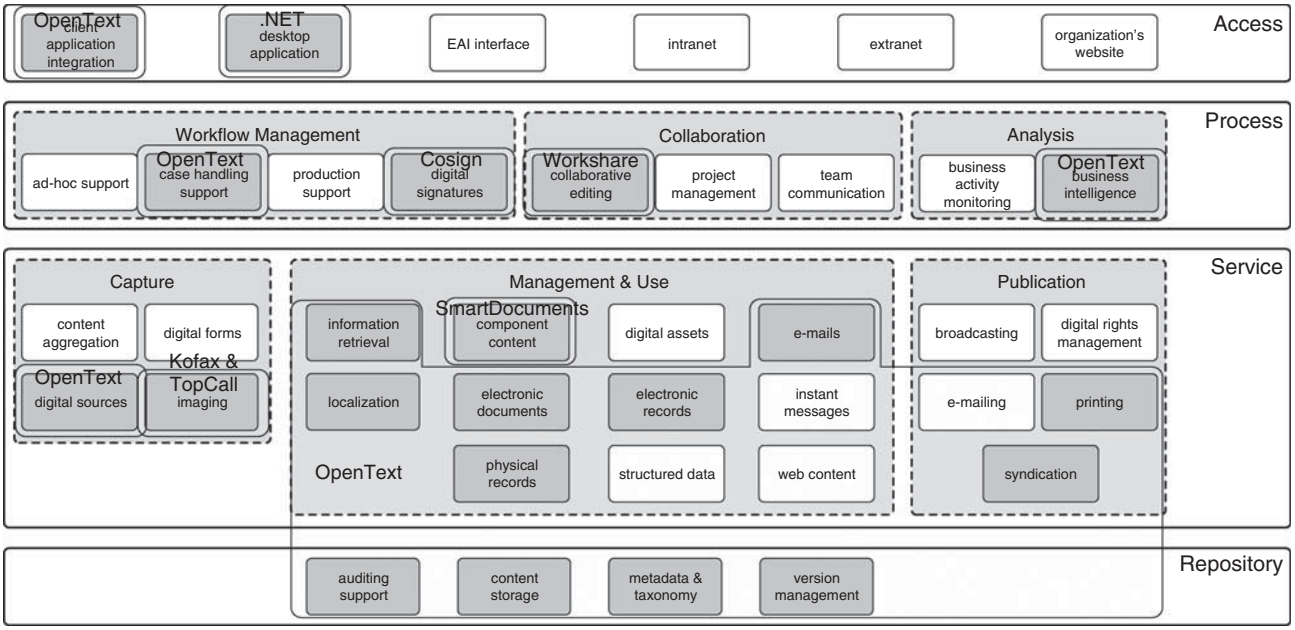

Figure 4 ECM application landscape at Organization B.

application includes several, non-adjacent functionalities, it is depicted by separate boxes. An example is provided in Figure 4.

In this particular example, the ECM application landscape shows that there are six different software products that provide ECM functionality. It also shows that there is no overlap in the functionalities provided here.

In general, we found that the FEF enriched with an application overlay is a helpful tool in application portfolio management practices. Compared with a list of all the organization's ECM requirements, the picture could also indicate missing functionalities and hence where investments are needed. Furthermore, the overview can also be useful in determining the interfaces or integrations that are required between different software products. Such integrations might be necessary to prevent that employees need to login to different information systems when accessing different types of content. Finally, the application landscape can also play a role when upgrading software products. In this particular example, an update of OpenText might make SmartDocuments obsolete because the new release may support similar functionality.

Discussion and conclusion

The research presented in this paper brings two main contributions. First, our literature review on ECM papers provides a more consistent and comprehensive definition of ECM. Second, it also leads to our Functional ECM Framework that summarizes the literature with regard to potential ECMS functionalities. We have also validated the FEF in two case studies that demonstrate the application of the FEF in practice. As with any literature study, this research gives an overview of previous research efforts in this field and can serve as an entry point for future research efforts. Our categorization of the current ECM literature provides an overview of the focus of previous research and gives an indication of where additional future research can be necessary. The literature study showed that no consistent definition of the term ECM had yet emerged. Our new definition of ECM is more consistent and comprehensive and explicitly relates to the content lifecycle. It has also been ascertained that a complete list of functionalities that can be provided by ECMSs does not yet exist in literature.

Based on the current state of research, the FEF we have created provides a conceptual division of potential ECMS functionalities (i.e. functional categories) in a graphically structured way. This functional overview helps to communicate and teach the concept of ECM by giving a visual impression of the breadth of potential functionalities offered by ECMSs as well as a visual representation of the claim that an ECMS should be able to manage all types of organizational content.

The application of the FEF in case study research demonstrated at least one practical implication of the research. It showed that it can help organizations to systematically describe their ECM efforts and detect possible overlap in terms of functionalities between different ECM solutions that are in place (using application overlays on the FEF). In addition, other practical implications can be envisioned. Organizations can for example use the FEF in the process of selecting an ECM

solution for their organization. The framework enables them to systematically describe the functionalities offered by different vendors and hence compare the different ECM offerings. Another example is the use of the framework as a reference when describing the ECM requirements at an early stage of the ECM implementation process.

A limitation of this research concerns the case studies in which the FEF has been applied. This is because we only studied two Dutch public agencies and one relatively small commercial organization with main operations in the Netherlands. None of them included a 'complete' ECMS installation, and also the combined functional scopes of all three case studies did not cover all potential functionalities of ECMSs. For this reason, it is not entirely sure whether the FEF really contains a complete list of potential functionalities.

Based on the results of the literature study, we have identified a number of fields for further research. Table 1 indicates that two elements have received little attention in research so far, namely the user view from the content perspective and ECM as a research field. Work on the latter could elaborate more on, for example, the differences and similarities of ECM with other fields of research. It could for instance be questioned whether the problems and challenges in the ECM field are very different from those in the more general field of Enterprise Information Systems such as ERP and Customer Relation Management. We also noted that different perceptions of the term 'content' exist in the ECM literature, and this deserves further analysis and standardization. Unification of the term can be approached from a theoretical perspective but might also include empirical evidence by studying the types of content actually managed by ECMSs. Developing such a definition might also affect the FEF since a broad interpretation of content has been used. In addition, we recommend that studies concerning the process perspective should pay particular attention to the implementation of ECMSs as multi-product software. It is known from the field of ERP research that such implementations require a different approach and therefore research in this area might result in useful insights for practice. Finally, we consider the FEF as a good first draft but acknowledge that the FEF requires extended evaluation by colleagues in the research field and by applying it to more diverse and a larger number of ECMS installations. The FEF can also serve as the basis for the development of a technical reference architecture for ECM(Ss). Together with the four informational concepts described by Grossniklaus & Norrie (2002), such an architecture can be the basis both for developing ECMSs and for a more in-depth comparison of commercially available ECMSs. Further research could produce an extended breakdown of the ECMS functionalities for being able to perform a more detailed comparison.

Acknowledgements

The authors thank the anonymous reviewers who have provided extensive feedback that has considerably improved this paper. Thanks also go out to a colleague researcher for pointing out the work of Schein. The authors also thank Johanna Stange for her language reviews.

About the authors

Knut R. Grahlmann works as a consultant at Ernst & Young IT Advisory, focussing on strategic and tactical IT topics. He holds an MSc in Business Informatics from Utrecht University where he wrote his Master's thesis in cooperation with PwC Advisory. Grahlmann holds a BSc from the University of Applied Sciences Nordakademie, Germany.

Remko W. Helms is an assistant professor in the Department of Information and Computing Sciences at Utrecht University. His research focuses on knowledge management and social networks applications in industry. He serves on several conference programme committees and acts as reviewer for several major IS conferences and journals.

Cokky Hilhorst is Director Technology Advisory at PwC Advisory in the Netherlands. She holds a Ph.D. in Information Management from Tilburg University. Her research focusses on flexibility and risk in IT decision making.

Sjaak Brinkkemper is Full Professor of organization and information at the Department of Information and Computing Sciences of Utrecht University. He leads a group of about 35 researchers specialized in the methodology of product software development, implementation and alignment, and entrepreneurship in software ecosystems.

Sander van Amerongen is Principal Manager at PwC Advisory in the Netherlands. The main focus of his consultancy work is on helping information-intensive organizations deal with information management challenges. He holds a Master's degree in Business Informatics from the Vrije Universiteit Amsterdam.

References

AIIM (2005) What is ECM? [WWW document] www.aiim.org/ResourceCenter/AboutECM.aspx (accessed 26 November 2008).

AIIM EUROPE (n.d.) What is ECM? [WWW document] www.aiim.org.uk/publications/roadmap/index.asp (accessed 5 March 2008).

ALEKSY M and SCHWIND M (2006) Using generic services for document life cycle management. In *Proceedings of the 10th IEEE on International Enterprise Distributed Object Computing Conference Workshops*, Hong Kong, China, 16–20 October. [WWW document] http://www.computer.org/portal/web/csdl/doi/10.1109/EDOCW.2006.73.

ANDERSEN R (2008) The rhetoric of enterprise content management (ECM): confronting the assumptions driving ECM adoption and transforming technical communication. *Technical Communication Quarterly* **17(1)**, 61–87.

ANGELOV S (2006) Foundations of B2B electronic contracting. Doctoral Thesis, Technische Universiteit Eindhoven.

BANDORF M, YOSHIZAWA T, TAKADA Y and MERBETH G (2004) Enterprise content management with interstage contentbiz. *Fujitsu Scientific & Technical Journal* **40(1)**, 61–73.

BECKER J, WINKELMANN A, BEVERUNGEN D and JANIESCH C (2007) Bereitstellung von Artikelstammdaten. *HMD – Praxis der Wirtschaftsinformatik* **258**, 45–56.

BELKIN NJ and CROFT WB (1992) Information filtering and information retrieval: two sides of the same coin? *Communications of the ACM* **35(12)**, 29–38.

BENTLEY K and YOONG P (2000) Knowledge work and telework: an exploratory study. *Internet Research* **10(4)**, 346–356.

BERNUS P and NEMES L (1996) A framework to define a generic enterprise reference architecture and methodology. *Computer Integrated Manufacturing Systems* **9(3)**, 179–191.

BÖHM S (2007) ECM-Markt – ein Strukturierungsansatz. *HMD – Praxis der Wirtschaftsinformatik* **258**, 16–24.

BORDEGONI M, FACONTI G, FEINER S, MAYBURY M, RIST T, RUGGIERI S, TRAHANIAS P and WILSON M (1997) A standard reference model for intelligent multimedia presentation systems. *Computer Standards & Interfaces* **18(6–7)**, 477–496.

CHEUNG SC and CHIU DKW (2003) A watermarking infrastructure for enterprise document management. In *36th Hawaii International Conference on System Sciences (HICSS-36 2003), CD-ROM/Abstracts Proceedings*, 6–9 January, IEEE Computer Society, Big Island, HI.

CHIU DKW and HUNG PCK (2005) Privacy and access control issues in financial enterprise content management. In *38th Hawaii International Conference on System Sciences (HICSS-38 2005), CD-ROM/Abstracts Proceedings*, 3–6 January, IEEE Computer Society, Big Island, HI.

DAVIS R (2001) *Business Process Modelling with ARIS: A Practical Guide*. Springer-Verlag, London, UK.

DE CARVALHO RA (2008) An enterprise content management solution based on open source. *Research and Practical Issues of Enterprise Information Systems* **254**, 173–183.

DILNUTT R (2006) Enterprise content management – supporting knowledge management capability. *The International Journal of Knowledge, Culture and Change Management* **5(8)**, 73–84.

DOCULABS (2004) Documentum's fit in an enterprise reference architecture for content management. [WWW document] www.documentum.ru/pdf/Reviews/doculabs_era_1204.pdf (accessed 20 November 2008).

DOCULABS (2005) Architecture for unified ECM and BPM. [WWW document] www.gcgest.com/filenet/pdf/enterprise/presentation/Doculab.pdf (accessed 20 November 2008).

DOURISH P, EDWARDS WK, LAMARCA A, LAMPING J, PETERSEN K, SALISBURY M, TERRY DB and THORNTON J (2000) Extending document management systems with user-specific active properties. *ACM Transactions on Information Systems* **18(2)**, 140–170.

DOYLE B (2007) Component content management. [WWW document] www.econtentmag.com/Articles/Column/I-Column-Like-I-CM/Component-Content-Management-19433.htm (accessed 16 December 2008).

ENGEL E, HAYES RM and WANG X (2007) The Sarbanes-Oxley Act and firms' going-private decisions. *Journal of Accounting and Economics* **44(1–2)**, 116–145.

ERICKSON J and BRICKEY J (2008) Increased knowledge transfer and content management. In *Proceedings of Americas Conference on Information Systems*, San Francisco, CA, USA, 6–9 August. [WWW document] http://aisel.aisnet.org/amcis2008/222/.

FORRESTER RESEARCH, INC (2007) *The Forrester Wave: Enterprise Content Management Suites* Q4 2007.

FOWLER M (2003) *Patterns of Enterprise Application Architecture*. Addison-Wesley, Boston, MA.

GEORGAKOPOULOS D, HORNICK M and SHETH A (1995) An overview of workflow management: from process modeling to workflow automation infrastructure. *Distributed and Parallel Databases* **3(2)**, 119–153.

GLAZER D, JENKINS T and SCHAPER H (2005) *Enterprise Content Management Technology*. Open Text Corporation, Waterloo, Ontario, Canada.

GOLFARELLI M, RIZZI S and CELLA I (2004) Beyond data warehousing: what's next in business intelligence? In *Proceedings of the 7th ACM International Workshop on Data Warehousing and OLAP* (DAVIS K and RONTHALER M, Eds), Washington, DC, 12–13 November [WWW document] https://dl.acm.org/citation.cfm?id=1031763&picked=prox.

GRAHLMANN KR, HILHORST C, VAN AMERONGEN A, HELMS RS and BRINKKEMPER S (2010) Impacts of implementing Enterprise Content Management Systems. In *18th European Conference on Information Systems*, 6–9 June (ALEXANDER PM, TURPIN M and VAN DEVENTER JP, Eds), Department of Informatics, Pretoria, South Africa.

GREFEN P and DE VRIES RR (1998) A reference architecture for workflow management systems. *Data and Knowledge Engineering* **27(1)**, 31–57.

GROSSNIKLAUS M and NORRIE MC (2002) Information concepts for content management. In *3rd International Conference on Web Information Systems Engineering Workshops (WISE 2002 Workshops)*, 11 December (BO HUANG, TOK WANG LING, MUKESH K MOHANIA, WEE KEONG NG, JI-RONG WEN and SHYAM K GUPTA, Eds), IEEE Computer Society, Singapore.

GRUDIN J (2006) Enterprise knowledge management and emerging technologies. In *39th Hawaii International Conference on Systems Science (HICSS-39 2006), CD-ROM/Abstracts Proceedings*, 4–7 January, IEEE Computer Society, Kauai, HI.

HERSCHEL RT and JONES NE (2005) Knowledge management and business intelligence: the importance of integration. *Journal of Knowledge Management* **9(4)**, 45–55.

INTERNATIONAL BUSINESS MACHINES CORPORATION (2008) IBM FileNet P8 – Version 4.5 – system overview. [WWW document] ftp://ftp.software.ibm.com/software/data/cm/filenet/docs/p8doc/45x/system_overview.pdf (accessed 26 November 2008).

ISO (2001) International Standard ISO 15489-1. [WWW document] www.whitefoot-forward.com/iso_15489-1.pdf (accessed 6 November 2008).

IVERSON J and BURKART P (2007) Managing electronic documents and work flows: enterprise content management at work in nonprofit organizations. *Nonprofit Management and Leadership* **17(4)**, 403–419.

JOHNSTON GP and BOWEN DV (2005) The benefits of electronic records management systems: a general review of published and some unpublished cases. *Records Management Journal* **15(3)**, 131–140.

KAMPFFMEYER U (2006) Enterprise content management. [WWW document] www.project-consult.net/Files/ECM_White%20Paper_kff_2006.pdf (accessed 25 November 2008).

KARIMI J, SOMERS TM and BHATTACHERJEE A (2007) The impact of ERP implementation on business process outcomes: a factor-based study. *Journal of Management Information Systems* **24(1)**, 101–134.

KITTL C and ZEIDLER C (2007) User generated content und metadatenmanagement. *HMD – Praxis der Wirtschaftsinformatik* **258**, 57–67.

KONING H, BOS R and BRINKKEMPER S (2008) A lightweight method for the modelling of enterprise architectures. In *Service-Oriented Computing – ICSOC 2008 Workshops. Lecture Notes in Computer Science* (FEUERLICHT G and LAMERSDORF W, Eds), Vol. 5472, pp 375–387, Springer, Berlin/Heidelberg.

KUECHLER WL and VAISHNAVI V (2006) So, talk to me: the effect of explicit goals on the comprehension of business process. *MIS Quarterly* **30(4)**, 961–A16.

KWOK KH and CHIU DKW (2004) A web services implementation framework for financial enterprise content management. In *37th Hawaii International Conference on System Sciences (HICSS-37 2004), CD-ROM/Abstracts Proceedings*, 5–8 January, IEEE Computer Society, Big Island, HI.

LIGHT B, HOLLAND CP and WILLS K (2001) ERP and best of breed: a comparative analysis. *Business Process Management Journal* **7(3),** 216–224.

LIU Q, SAFAVI-NAINI R and SHEPPARD NP (2003) Digital rights management for content distribution. In *Proceedings of the Australasian information security workshop conference on ACSW frontiers 2003 – Volume 21* (JOHNSON C, MONTAGUE P and STEKETEE C, Eds), 1 February, Australian Computer Society, Adelaide, Australia.

MCKEEVER S (2003) Understanding Web content management systems: evolution, lifecycle and market. *Industrial Management & Data Systems* **103(9),** 686–692.

MELLISH C, SCOTT D, CAHILL L, PAIVA D, EVANS R and REAPE M (2006) A reference architecture for natural language generation systems. *Natural Language Engineering* **12(01),** 1–34.

MESCAN S (2004) Why content management should be part of every organization's global strategy. *The Information Management Journal* **38(4),** 54–57.

MUNKVOLD BE, PÄIVÄRINTA T, HODNE AK and STANGELAND E (2003) Contemporary issues of enterprise content management: the case of Statoil. In *Proceedings of the 11th European Conference on Information Systems*, 19–21 June, Naples, Italy.

MUNKVOLD BE, PÄIVÄRINTA T, HODNE AK and STANGELAND E (2006) Contemporary issues of enterprise content management: the case of Statoil. *Scandinavian Journal of Information Systems* **18(2),** 69–100.

NAGRA J, THOMBORSON C and COLLBERG C (2002) A functional taxonomy for software watermarking. *Australian Computer Science Communications* **24(1),** 177–186.

NICKERSON RC (2000) *Business and Information Systems*, 2nd edn, Upper Saddle River, NJ, Prentice Hall.

NORDHEIM S and PÄIVÄRINTA T (2004) Customization of enterprise content management systems: an exploratory case study. In *37th Hawaii International Conference on System Sciences (HICSS-37 2004), CD-ROM/Abstracts Proceedings*, 5–8 January, IEEE Computer Society, Big Island, HI.

NORDHEIM S and PÄIVÄRINTA T (2006) Implementing enterprise content management: from evolution through strategy to contradictions out-of-the-box. *European Journal of Information Systems* **15(6),** 648–662.

O'CALLAGHAN R and SMITS M (2005) A strategy development process for enterprise content management. In *Proceedings of the 13th European Conference on Information Systems*, 26–28 May, Regensburg, Germany.

OKOLI C and SCHABRAM K (2010) A guide to conducting a systematic literature review of information systems research. *Sprouts: Working Papers on Information Systems* **10(26).**

ORLIKOWSKI WJ and IACONO CS (2001) Desperately seeking the 'IT' in IT research – a call to theorizing the IT Artifact. *Information Systems Research* **12(2),** 121–134.

OSL P and OTTO B (2007) Framework für die Nutzenargumentation des Produktinformationsmanagements. *HMD – Praxis der Wirtschaftsinformatik* **258,** 35–44.

PÄIVÄRINTA T and MUNKVOLD BE (2005) Enterprise content management: an integrated perspective on information management. In *38th Hawaii International Conference on System Sciences (HICSS-38 2005), CD-ROM/Abstracts Proceedings*, 3–6 January, IEEE Computer Society, Big Island, HI.

PELZ-SHARPE A (2008) The tools of enterprise content management. In *AIIM Guide to ECM Purchasing*, pp 41–52, AIIM Publications, Silver Spring, MD.

REGLI T and KAS T (2008) Digital asset management systems vs. web content management systems: do you really understand the difference? [WWW document] www.aiim.org/Infonomics/ArticleView.aspx?ID=35389 (accessed 9 December 2008).

REICH S and BEHRENDT W (2007) Technologien und Trends für Wissensarbeit und Wissensmanagement. *HMD – Praxis der Wirtschaftsinformatik* **258,** 6–15.

REIMER JA (2002) Enterprise content management. *Datenbank-Spektrum* **2(4),** 17–22.

ROLLAND C and PRAKASH N (2001) Matching ERP system functionality to customer requirements. In *Proceedings of the Fifth IEEE International Symposium on Requirements Engineering*, pp 66–75, Toronto, Canada. [WWW document] http://www.interaction-design.org/references/conferences/5th_ieee_international_symposium_on_requirements_engineering_re_2001.html.

RÜCKEL DC, STEININGER K, RIEDL R and ROITHMAYR F (2007) Fallstudie: Einführung eines enterprise-content-management-systems. *HMD – Praxis der Wirtschaftsinformatik* **258,** 78–88.

SALMINEN A, TYRVÄINEN P and PÄIVÄRINTA T (2005) Introduction to the enterprise content management and XML minitrack. In *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, Waikoloa, HI, 3–6 January. [WWW document] http://www.interaction-design.org/references/conferences/5th_ieee_international_symposium_on_requirements_engineering_re_2001.html.

SCHEEPERS R (2006) A conceptual framework for the implementation of enterprise information portals in large organizations. *European Journal of Information Systems* **15(6),** 635–647.

SCHEIN EH (1987) *The Clinical Perspective in Fieldwork*. SAGE, Newbury Park, CA.

SCOTT J, GLOBE A and SCHIFFNER K (2004) Jungles and gardens: the evolution of knowledge management at J.D. Edwards. *MIS Quarterly Executive* **3(1),** 37–52.

SINGHAL A (2001) Modern information retrieval: a brief overview. *Bulletin of the IEEE Computer Society Technical Committee on Data Engineering* **24(4),** 35–42.

SMITH HA and MCKEEN JD (2003) Developments in practice VIII: enterprise content management. *Communications of the Association for Information Systems* **11(33),** 647–659.

SMOLNIK S (2007) Nutzenpotenziale und Performanzmessung. *HMD – Praxis der Wirtschaftsinformatik* **258,** 25–34.

SOFTWARE ENGINEERING INSTITUTE (n.d.) Software architecture glossary. [WWW document] http://www.sei.cmu.edu/architecture/start/glossary/ (accessed 14 December 2010).

SPRAGUE RH (1995) Electronic document management: challenges and opportunities for information systems managers. *MIS Quarterly* **19(1),** 29–49.

SPREHE JT (2005) The positive benefits of electronic records management in the context of enterprise content management. *Government Information Quarterly* **22(2),** 297–303.

STAIR R and REYNOLDS G (2006) *Fundamentals of Information Systems*, 3rd edn, Thomson Course Technology, Boston, MA.

STOHR EA and ZHAO JL (2001) Workflow automation: overview and research issues. *Information Systems Frontiers* **3(3),** 281–296.

STRADER TJ, LIN F and SHAW MJ (1998) Information infrastructure for electronic virtual organization management. *Decision Support Systems* **23(1),** 75–94.

STRAUSS AL and CORBIN J (1990) *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publications, Newbury Park, CA.

TRIPPE B (2005) Component content management in practice – meeting the demands of the most complex content applications. [WWW document] http://www.single-source-forum.de/rueckblicke/2005/folien/ssf05_folien_kuppers.pdf (accessed 16 December 2008).

TURBAN E, LEIDNER D, MCLEAN E and WETHERBE J (2005) *Information Technology for Management: Transforming Organizations in the Digital Economy*, 5th edn, Wiley, Hoboken, NJ.

TYRVÄINEN P, PÄIVÄRINTA T, SALMINEN A and IIVARI J (2006) Characterizing the evolving research on enterprise content management. *European Journal of Information Systems* **15(6),** 627–634.

TYRVÄINEN P, SALMINEN A and PÄIVÄRINTA T (2003) Introduction to the enterprise content management minitrack. In *36th Hawaii International Conference on System Sciences (HICSS-36 2003), CD-ROM/Abstracts Proceedings*, 6–9 January, IEEE Computer Society, Big Island, HI.

USMAN M, ZULFIKAR S and BHUTTO A (2009) Enterprise Content Management (ECM): needs, challenges and recommendations. In *Proceedings of 2nd IEEE International Conference on Computer Science and Information Technology*, IEEE Press, Piscataway: Beijing, China.

VAN DER AALST WMP (2004) Business process management demystified: a tutorial on models, systems and standards for workflow management. In *Lectures on Concurrency and Petri Nets* (DESEL J, REISIG W and ROZENBERG G, Eds), Vol. 3098/2004 of Lecture Notes in Computer Science, pp 1–65, Springer, Berlin/Heidelberg.

VAN DER AALST WMP and BERENS PJS (2001) Beyond workflow management: product-driven case handling. In *Proceedings of the International ACM SIGGROUP Conference on Supporting Group Work*, Boulder, CO, 30 September – 3 October. [WWW document]

http://www.interaction-design.org/references/conferences/proceedings_of_the_international_acm_siggroup_conference_on_supporting_group_work_2001.html.

VAN HECK E (2009) The Next Generation Workplace. In Research Briefing, Center for Information Systems Research, MIT Sloan School of Management, Volume IX, Number 9B.

VIDGEN R, GOODWIN S and BARNES S. (2001) Web content management. In *Proceedings of the 14th Bled Electronic Commerce Conference* (O'KEEFE B *et al*, Eds), 25–26 June, Moderna Organizacija, Kranj: Bled, Solvenia.

VOM BROCKE J and SIMONS A (2008) Towards a process model for digital content analysis – the case of Hilti. In *Proceedings of 21st Bled eConference*, 15–18 June, Bled, Slovenia.

VOM BROCKE J, BECKER J, SIMONS A and FLEISCHER S (2008a) Towards the specification of digital content – the Enterprise Content Modeling Language (ECML). In *Proceedings of 21st Bled eConference*, 15–18 June, Bled, Slovenia.

VOM BROCKE J, SIMONS A and CLEVEN A (2008b) A business process perspective on enterprise content management: towards a framework for organisational change. In *16th European Conference on Information Systems* (GOLDEN W, ACTON T, CONBOY K, VAN DER HEIJDEN H and TUUNAINEN VK, Eds), pp 1680–1691, National University of Ireland, Galway, Ireland.

VOM BROCKE J, SIMONS A and CLEVEN A (2009) Towards a business process-oriented approach to enterprise content management: the ECM-blueprinting framework. *Information Systems and E-Business Management*. [WWW document] http://dx.doi.org/10.1007/s10257-009-0124-6, 1–22.

WEBSTER J and WATSON RT (2002) Analyzing the past to prepare for the future: writing a literature review. *MIS Quarterly* **26(2),** xiii–xxiii.

WILLIAMS TJ (1994) The Purdue enterprise reference architecture. *Computers in Industry* **24(2–3),** 141–158.

ZACHMAN JA (1987) A framework for information systems architecture. *IBM Systems Journal* **26(3),** 276–292.

Appendix

The column AIIM refers to AIIM (2005), Pelz-Sharpe (2008) and Regli & Kas (2008). This table does not contain all papers from Table 1 since some of them did not explicitly comment on potential ECMS functionalities.

Table A1 Descriptions of FEF elements and works mentioning them

Functionality	*Explanation*	Andersen (2008)	Böhm (2007)	Chiu & Hung (2005)	De Carvalho (2008)	Dilnutt(2006)	Iverson & Burkart (2007)	Munkvold *et al* (2003)	Munkvold *et al* (2006)	Nordheim & Päivärinta (2004)	O'Callaghan & Smits (2005)	Päivärinta & Munkvold (2005)	Reich & Behrendt (2007)	Reimer (2002)	Scheepers (2006)	Scott *et al* (2004)	Smith & McKeen (2003)	Sprehe (2005)	Tyrväinen *et al* (2006)	Usman *et al* (2009)	vom Brocke *et al* (2008a)	vom Brocke & Simons (2008)	vom Brocke *et al* (2009)	AIIM (2005)	Doculabs (2004)	Doculabs(2005) IBM(2008)	Kampffmeyer (2006)	Glazer *et al* (2005)	Forrester Research, Inc. (2007)
Auditing support	Provision of 'unchangeable storage, protection against manipulation and erasure' (Kampffmeyer, 2006, p. 64) and the 'generation of logs and journals on information usage and edits' (Kampffmeyer, 2006, p. 58)		X			X	X													X	X	X	X	X			X	X	X
Broadcasting	Audio and video streams can be broadcasted either to the Internet or to regular TV networks																							X			X	X	X
Business activity monitoring	'The analysis from historical data is supplemented by real time monitoring (Business Activity Monitoring)' (Böhm, 2007, p. 19; translation from German by the authors); BAM is defined in the respective literature as the continuous 'monitoring [of] time-critical operational processes' (Golfarelli *et al*, 2004, p. 3), supporting for example the detection of rule interference and dashboards		X																										
Business intelligence	See previous description; 'essentially helps managers to understand their [organizations] by supporting bottom-up extraction of information from data' (Golfarelli *et al*, 2004, p. 1) and is aimed at improving decision making		X		X		X											X			X	X		X	X	X	X	X		
Client application integration	Separate applications (e.g. an e-mail client) that are not part of the ECMS package are accessed by the ECMS or vice versa. They usually run on a client machine and require some interaction with an end-user		X				X	X	X	X		X						X						X		X		X		
Collaborative editing	'Controlled editing, review, approval, and (multichannel) informing, distribution, publication and update of content' (Päivärinta & Munkvold, 2005, p. 4) with a team of users							X			X	X											X	X	X		X	X		
Component content	Content should not only be manageable at a document level, but also on a component one, a 'fine granular level, in ways that allow the [content] components to be easily used, reused, versioned, linked, assembled, and reassembled into different content products' (Trippe, 2005, p. 2). For example, a legal copyright statement could be managed in a central place and be re-used in different publications (Doyle, 2007; Andersen, 2008)	X			X			X	X		X	X		X		X													X
							X																	X	X		X			

Table A1 Continued

Functionality	*Explanation*	Andersen (2008)	Böhm (2007)	Chiu & Hung (2005)	De Carvalho (2008)	Dilnutt(2006)	Iverson & Burkart (2007)	Munkvold *et al* (2003)	Munkvold *et al* (2006)	Nordheim & Päivärinta (2004)	O'Callaghan & Smits (2005)	Päivärinta & Munkvold (2005)	Reich & Behrendt (2007)	Reimer (2002)	Scheepers (2006)	Scott *et al* (2004)	Smith & McKeen (2003)	Sprehe (2005)	Tyrväinen *et al* (2006)	Usman *et al* (2009)	vom Brocke *et al* (2008a)	vom Brocke & Simons (2008)	vom Brocke *et al* (2009)	AIIM (2005)	Doculabs (2004)	Doculabs(2005) IBM(2008)	Kampffmeyer (2006)	Glazer *et al* (2005)	Forrester Research, Inc. (2007)
Content aggregation	'Process of combining data entries from different creation, capture, and delivery applications. The goal is to combine and unify data from different sources, in order to pass them on to storage and processing systems with a uniform structure and format' (Kampffmeyer, 2006, p. 34)																												
Content storage	'Content units may reside' (Tyrväinen *et al*, 2006, p. 630) in an ECMS		X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X
Desktop application	A stand-alone client application and is usually provided by the ECMS supplier for accessing the ECMS's functionality		X																					X	X	X	X		X
Digital assets	'Eich media documents, as for example videos, logos and photographs' (Kampffmeyer, 2006, p. 42)				X	X	X				X			X									X	X		X	X	X	X
Digital forms	For example 'automation of the process where paper forms are eliminated' (Dilnutt, 2006, p. 78)					X	X					X												X	X	X	X	X	X
Digital rights management	'Aystem to protect high-value digital assets and control the distribution and usage of those digital assets' (Liu *et al*, 2003)		X	X								X	X	X						X				X	X	X	X		
Digital signatures	Can be part of a workflow for authenticating digital content		X									X					X			X				X	X	X	X	X	
Digital sources	Integration of content that already exists in digital form as for example in an XML file					X						X													X	X	X		X
Enterprise Application Integration (EAI) interface	An ECMS can be functionally integrated with, for example, the organization's ERPS or e-mail server. The practitioners' literature provides more detailed examples: displaying of an order status managed by the ERPS via the organization's website, linking an invoice in the ERPS with an image of the invoice in the ECMS											X		X				X						X		X	X	X	
Electronic and physical records	'Information created, received, and maintained as evidence and information by an organization or person, in pursuance of legal obligations or in the transaction of business' (ISO, 2001, p. 3). Although physical records are not digital, metadata about them supports organizations in reaching record management goals such as risk reduction and operational simplifications (Johnston & Bowen, 2005). Different from the electronic documents with regard to the time frame ('retention, preservation and format transformation for long-term archival' (Päivärinta & Munkvold, 2005, p. 4))		X			X	X	X	X		X	X	X	X				X			X	X	X	X	X	X	X	X	X

Electronic documents	Sets 'of information pertaining to a topic, structured for human comprehension, represented by a variety of symbols, stored and handled as a unit' (Sprague, 1995, p. 32)		X		X	X	X	X	X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X
E-mailing	Sending e-mails to individual or multiple recipients		X																				X		X	X	X	
E-mails	An ECMS can be integrated with the e-mail server(s) of an organization so that incoming and outgoing e-mails can be captured		X			X		X		X												X	X	X	X	X	X	X
Extranet	An extranet is meant to provide access to the ECMS to a limited group of people, for example suppliers					X									X								X			X	X	
Imaging	The activity of creating a digital image of an existing paper document, for example by scanning it		X		X					X	X		X										X	X	X	X	X	X
Information retrieval	Assists users in finding the content that is needed to satisfy their need for information (Belkin & Croft, 1992). Examples are simple Boolean or ranked retrieval systems that can make use of various mathematical models for defining relevance (Singhal, 2001)		X		X	X	X	X	X	X	X	X			X	X							X	X	X	X	X	X
Instant messages	Organizations might for example want or need to create audit trails of instant messages (Glazer *et al*, 2005)																						X				X	
Intranet	The ECMS is accessed from within an organization		X			X					X			X	X	X									X	X	X	
Localization	Possibility to edit and manage content in different languages; 'adaptation of content to the cultural and linguistic needs of different global markets' (Kampffmeyer, 2006, p. 58)														X								X			X	X	X
Metadata & taxonomy	'Logical and conceptual structuring of the content' (Päivärinta & Munkvold, 2005, p. 4). Taxonomies can contain a list of all content types managed by the ECMS together with, for example, definitions of metadata fields (Munkvold *et al*, 2003). Their main goal is therefore to allow users to access and navigate through the content (Päivärinta & Munkvold, 2005)					X		X	X		X	X		X		X	X		X	X				X	X	X	X	X	X
Organization's website	The general public can access the ECMS					X						X			X			X				X	X			X	X	X	
Printing	Letters (e.g. the automatic production of letters to clients; Andersen, 2008), brochures or catalogues; Output Management (Böhm, 2007)	X	X																				X			X	X	X	X
Project management	No further explanation is given in the sources				X								X										X	X			X		
Structured data	For example content in 'old legacy databases' (Iverson & Burkart, 2007)					X	X	X	X	X							X												
Syndication	'Reuse and integration [of content] into other content' (AIIM, 2005), for example through RSS feeds or through files such as workflow information contained in EDI-or XML-files																						X	X	X	X			X
Team communication	For example forums, chat-rooms, instant messaging, digital whiteboards and videoconferencing					X			X			X	X										X	X	X	X	X	X	X
Version management	File control mechanisms such as check-in/-out, version control, keeping a version history, or managing the access to documents (Sprague, 1995)		X		X	X	X	X	X	X			X							X	X	X	X	X	X	X	X	X

Table A1 Continued

Functionality	*Explanation*	Andersen (2008)	Böhm (2007)	Chiu & Hung (2005)	De Carvalho (2008)	Dilnutt(2006)	Iverson & Burkart (2007)	Munkvold *et al* (2003)	Munkvold *et al* (2006)	Nordheim & Päivärinta (2004)	O'Callaghan & Smits (2005)	Päivärinta & Munkvold (2005)	Reich & Behrendt (2007)	Reimer (2002)	Scheepers (2006)	Scott *et al* (2004)	Smith & McKeen (2003)	Sprehe (2005)	Tyrväinen *et al* (2006)	Usman *et al* (2009)	vom Brocke *et al* (2008a)	vom Brocke & Simons (2008)	vom Brocke *et al* (2009)	AIIM (2005)	Doculabs (2004)	Doculabs(2005) IBM(2008)	Kampffmeyer (2006)	Glazer *et al* (2005)	Forrester Research, Inc. (2007)
Web content	Created for and deployed 'to Web based audiences' (McKeever, 2003, p. 688) inside and outside the organization		X			X	X			X	X	X	X	X		X	X				X	X	X	X	X	X	X	X	X
Workflow management	'Workflows for technical content production, processing, and publication tasks (including policies for all levels of "publishing": in groups or teams, within organization, for external partners or targeted customers, or for the public in general)' (Päivärinta & Munkvold, 2005, p. 4). For structuring this category, three WfM types from van der Aalst (2004) have been adopted. *Ad hoc* workflows represent processes 'where there is no set pattern for moving information among people [and whose] tasks typically involve human coordination, collaboration, or co-decision. Thus, the ordering and coordination of tasks […] are not automated but instead controlled by humans' (Georgakopoulos *et al*, 1995, p. 125). They are usually performed in knowledge-intensive environments (Stohr & Zhao, 2001). Case-handling systems place a single case in the centre of attention and 'not the activities or the routing from one [employee to another]' (van der Aalst & Berens, 2001, p. 43). They provide all information available to the user who decides what to do next and who bases her/his decision on this information rather than on the activities performed prior (van der Aalst & Berens, 2001; van der Aalst, 2004). Production workflows are used in 'routine, clerical situations that demand efficient, consistent and accurate execution of fairly standard processes' (Stohr & Zhao, 2001, p. 286). The order of the tasks is defined beforehand and their coordination can be automated		X		X	X	X	X			X	X	X	X		X	X			X			X	X	X	X	X	X	X