
Designing a maturity model for analyzing information and knowledge management in the public sector

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Structured abstract

Purpose – This study reports the design and testing of a maturity model for information and knowledge management in the public sector, intended for use in frequent monitoring, trend analysis, and in-depth analysis of the contemporary information and knowledge management practices of an organization.

Design/methodology/approach – A design science approach was used to develop the proposed model. Creation of the model was based on an extensive literature review. Testing of the model was implemented as a survey receiving 37 responses from nine organizations organizing and purchasing public services.

Findings – The study presents four alternative profiles for an organization's status: Novice, Experimenter, Facilitator, and Advanced exploiter and investigates the differences between these profiles on the basis of the empirical data gathered. The model was found to be both

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a valid and practical way to determine the state of an organization's information and knowledge management and identify development needs.

Research implications and limitations – Testing was conducted in the Finnish public sector and further studies applying the model could be implemented in (some) other countries. The model presented was designed specifically for the public sector and more research is needed to test its applicability in the private sector.

Originality/value – Maturity models are useful when evaluating information and knowledge management status in an organization, and beneficial for improving organizational performance. The proposed maturity model combines the fields of knowledge management and information management and contributes to the literature with an overarching maturity model that includes a dimension of satisfaction with the organizational maturity level. While many earlier models originate from the consultancy business, the model presented here was also designed for research purposes and tested in practice.

Keywords – Knowledge management, Maturity model, Performance, Information management, Public sector

1 Introduction

Maturity models have been introduced in various managerial fields such as strategy management, information management, software engineering, and performance management (e.g. Aho, 2012; Becker et al., 2009; Jääskeläinen and Roitto, 2015; Kruger and Johnson, 2010; Paulk et al., 1993; Van Aken et al., 2005; Wettstein and Kueng, 2002). These models have been designed for both researchers and practitioners. The purpose of maturity models is to use a set of criteria and related evaluation methods to provide an understanding of the status of an organizations' capabilities (Maier et al., 2012) in a given managerial area. This study describes a new maturity model designed for information and knowledge management (IKM) in the public sector.

At their best, maturity models support in identifying strengths and most critical development areas (Jääskeläinen and Roitto, 2015). They can also serve as powerful tools supporting benchmarking between organizations or networks with comparable criteria (Garengo et al., 2005). Maturity models can also be used to study how the status of IKM is related to organizational performance. Earlier research indicates that maturity models can have a positive effect on the performance of organizations (Bititci et al. 2015) by describing desirable features for operations, also usually leading to better job satisfaction and work performance.

Since the birth of knowledge management and information management as research fields, a few maturity models for analyzing these areas of management have been developed both in academic and practitioner settings (e.g. APQC, 2017; Hsieh et al., 2009; Lin et al., 2012; Pee and Kankanhalli, 2009; Poepplbush et al., 2011, Serenko et al., 2016; Teah et al., 2006). This study contributes to the literature by combining the existing models and balancing the technical aspects of information management and performance measurement (cf. Van Aken et al., 2005; Wettstein and Kueng, 2002) with factors supporting organizations and ecosystems in the adoption of new knowledge-related technologies as well as in factors supporting the actual use of those technologies from the human side. Hence, this study answers to the lack of evaluation tools for knowledge management including both technical and human aspects (Edwards et al. 2003). Such overarching approach has gained surprisingly little attention in recent years due to the fragmented nature of the literature distinguishing research streams of information management (information systems research) and knowledge management (see e.g. Bouthillier & Shearer, 2002).

The model proposed provides a means to overcome the challenges identified in recent knowledge management studies in the public sector (see e.g. Mc Evoy et al., 2019, Vines et al., 2015). Specific research attention to IKM in the public sector has been called for due to that sector's many specific characteristics and demands for understanding the effectiveness of related systems and practices (Klievink et al., 2017; Massaro et al., 2015; Tonelli et al., 2015). Hence, the maturity model presented was designed for the public sector, specifically for those organizations which purchase and are responsible for the provision of public services. These organizations are in a crucial role in developing and aligning the practices of regional ecosystems. Developing IKM and improving decision-making in these organizations therefore affect the whole ecosystem. These also serve as an employer for great number of knowledge workers regionally.

This study reports the development and testing of a maturity model for IKM. The model combines the status of evaluated practices and perceived employee satisfaction in order to propose four profiles for maturity. The evaluation instrument of the model is based on a survey, which can be implemented by either interviews or a questionnaire. In this study, the survey was sent to 109 employees of nine Finnish public organizations. As its result, this study presents the contents and test results of the model designed.

2 Methodology

A design science approach was used to scrutinize the development of scientific knowledge and solving of practical problems (Andriessen, 2004; Van Aken, 2007). The solutions created by the process of design science are evaluated by both researchers and users in the field of model application. The study follows the process model for designing maturity models based on the design science approach (de Bruin et al., 2005) described in Figure 1, which connects both to the practical understanding of designing maturity models (Maier et al., 2012) and to the more generic characteristics of a design science process (Peffer et al., 2007). The present research contains the first four steps of the process. According to de Bruin et al. (2005), each of these steps has several options which may be adopted. This section concentrates on presenting the options utilized in this study.

In the first phase, decisions regarding purpose and focus of the model were taken. The model was developed to support the IKM of public sector organizations organizing service provision. Thus, the focus of the model is domain specific. The main purpose of this model is to provide a description of the state of IKM in organizations operating in the selected

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sector. The model was viewed as a diagnostic tool in order to identify development needs which could be supported by objectives and results from other similar organizations. Thus, the model is not merely descriptive, but also includes prescriptive elements. Regarding the scope of the model designed, the expected users of the model regarded the presented conceptual framework (presented in section 3.2) as a suitable starting point meeting their managerial requirements.



Figure 1 Main phases in designing a maturity model (adapted from de Bruin et al., 2005)

The design phase includes the decisions regarding audience and respondents, and methods of application. In this research, individuals responsible for IKM in public sector organizations were chosen as target informants. More specifically, the informants included both experts responsible for developing data storage and processing tools as well as managers using information to support their decision-making. Because the primary purpose of the model is to support organizations' internal development and needs in IKM, the evaluation instrument was constructed as a self-evaluation including a 5-point Likert scale.

In the third phase Bruin et al. (2005) recommend identifying perspectives and attributes to be evaluated (content) and how these can be evaluated. Also, the implementation plan of the model is decided. It was deemed important that each of the evaluated perspectives in the designed model should have several attributes in order to improve the reliability and validity of the results. The evaluation consisted of two main categories: 1) survey statements reflecting IKM practices and 2) perceived satisfaction regarding the main perspectives of IKM. The design and content of the model synthesize the existing literature and therefore assume a bottom-up approach.

The model designed creates the content for final maturity profiles on the basis of the empirical data gathered. This follows the idea of Rasch analysis in which the data gathered is used for creating maturity levels in order to avoid subjectivity in creating eventual maturity levels before data gathering (Marx et al., 2012). However, this also requires a sufficient number of employees participating in the evaluation when the model is applied for the first time. This part of model content development is connected to the testing phase of this study.

This paper reports the testing phase of the model as conducted by the potential users. The testing is was accomplished by using a list of criteria for the model to be designed (Whitten et al. 2001). First, a web-based self-evaluation survey was carried out in nine organizations in three different regions of Finland. The survey included the statements of the maturity model and also feedback questions related to the criteria selected. Second, the results of the survey were discussed and more detailed feedback related to the model and its usability was collected in a focus group interview in one large participating organization. Third, statistical tests were applied to evaluate the validity and reliability of the evaluation instrument created. This phase is described in section 5.

3 Theoretical premises of the model designed

3.1. Maturity models

The maturity model idea originating from software engineering (Paulk et al., 1993) has spread widely to various management areas, such as process management and performance management (Bititci et al., 2012). The maturity model can be seen an umbrella concept consisting of various elements (Jääskeläinen and Roitto, 2015). The conceptual framework for the maturity model consists of the main evaluation perspectives. The evaluation instrument clarifies how these perspectives and their attributes are measured. The maturity profile presents an organization's overall status created on the basis of the information gathered through the maturity model instrument.

Maturity is often considered ambiguous. When formal systems such as information systems are examined, similar terms include sophistication level (e.g. Evans, 2004), comprehensiveness and scope (e.g. Evans, 2004; de Waal et al., 2009) and the system evolution status (e.g. Speckbacher et al., 2003). Another perspective on maturity is the relevance to managers of the processes or systems examined (Hatry, 2006) which is the ultimate test of the usefulness of IKM systems, practices and models. This also relates to the context in which the process or system under scrutiny is used. It has therefore also been proposed that employee satisfaction with the system or process examined should be included in the maturity analysis (Jääskeläinen and Roitto, 2015).

The model designed considers maturity as a multidimensional concept, consisting of scope, sophistication, and perceived satisfaction of employees, which can be used in profiling organizations.

In this study, the scope is defined according to the original conceptual framework (Choo, 2002). Sophistication is related to both information systems (Salleh et al., 2010) and the ability to provide and utilize more detailed information (Schl afke et al., 2013).

3.2. Conceptual framework for information and knowledge management

The maturity model described in this study includes both the technical side of information handling and the utilization of the information by humans as part of IKM. It takes into account employee viewpoints representing different functions and different hierarchical positions in organizations. We define IKM as a systematic process that supports both the employees' work and the competitiveness of the organization by integrating technology and human aspects. Such a holistic approach is needed in practice for organizations to find for new ways to create value from data, information, and knowledge to improve their decision-making ability and productivity.

Organizations need to distinguish which information is relevant, how information should be processed, how information should be shared within the organization, and, where appropriate, with other stakeholders, and how information can be used in decision-making (Thierauf, 2001, Choo 1998). Knowledge which is ultimately used in human decision-making and action is processed from data through information into knowledge by the addition of structure and meanings (Choo, 2002; Thierauf, 2001). This chain from data to knowledge emphasizes the importance of enrichment. Thus, knowledge does not appear from nowhere; it is created by enriching data and information. To ensure optimal functioning of this chain, both the technical and the softer, more human side, of IKM are needed in organizations.

The maturity model designed followed the comprehensive definition of IKM. Firstly, the general information process management framework (Choo, 2002) was selected as the backbone of the conceptual framework of IKM in this study in order to capture employees' information processing phases. This framework also fulfilled the practical requirements (e.g. relevance, clarity) imposed by experts external to the research team.

Choo's model is generally applied in the information management field as it includes common phases that are needed in information handling, such as gathering, organizing, storing, and utilization. However, this process model has also been applied in managing knowledge (e.g. K ans akoski, 2017; Laihonen and Sillanp aa, 2014), as knowledge is ultimately enriched from data and information. As Choo (2002, p.8) states "An organization

behaves as an open system that takes in information, material and energy from the external environment, transforms these resources into knowledge, processes and structures that produce goods or services.”

Choo’s model (2002) begins by defining information needs. The information needs are first identified so that they can later be met as well and efficiently as possible. Information is obtained and collected both from external sources, such as competitors and customers, and from internal sources, such as operational databases and information systems. The data collected will be stored in the organization’s archives and possibly analyzed by combination with other data sources. This refers to the stage of analyzing and organizing the data which facilitates the stages of information sharing and utilization. However, information only acquires its final meaning when it is used, for example, in decision-making and operational development, and when real changes occur in the organization's operations. By measuring and verifying the changes that have taken place and learning from what has happened and thereby identifying new development needs, the cycle starts from the beginning.

Choo (2002, p. 8) points out that “An organization uses information strategically to make sense of changes in its setting, to create new knowledge for innovation and to make decisions about its course of action”. To pinpoint the strategic nature of IKM the original process model by Choo was supplemented by the key elements of strategic management process (e.g. Wooldridge et al., 2018) – vision, strategy, organization, process, and measures - in order to include more organization level goals for insights and understanding to support decision-making and strategic planning. The conceptual framework of IKM presenting the dimensions of the model designed in this study is presented in Figure 2.

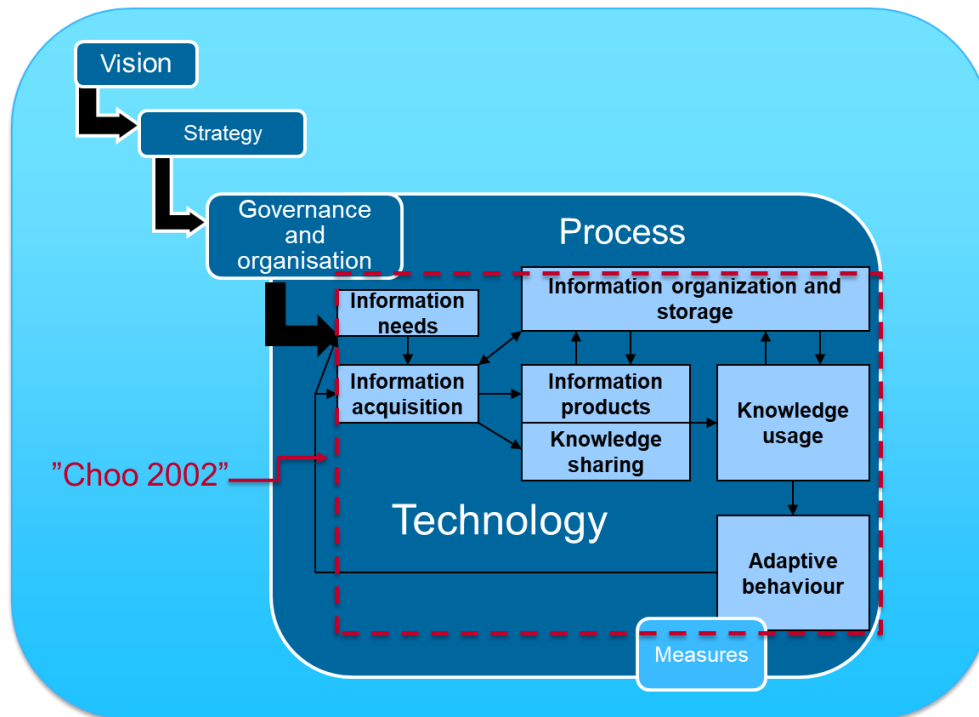


Figure 2. Conceptual framework used as the basis for the maturity model construction. (Extended based on Choo, 2002)

4 Designing the content of the new model

4.1 Overview of existing maturity models in information and knowledge management

The design work started by reviewing the literature. Google scholar search was used to identify existing maturity models in the area of IKM. Search terms ‘maturity, maturity model, effective, effectiveness’ were used in different fields of research. These fields included information management, information systems, knowledge management, knowledge-based management, performance management and business intelligence. The initial search identified hundreds of articles. After a review of titles and abstracts, articles not clearly referring to maturity evaluation were excluded, 24 potential publications were found in the following fields:

- information management (1 article)
- information systems (1 article)
- knowledge management (7 articles)
- knowledge-based management (no hits)

- performance management (9 articles)
- business intelligence (6 articles)

The analysis of articles was conducted by three experienced researchers in the field of IKM. Both the characteristics of the articles and their content were analyzed. The descriptive analysis included the type of article (literature review, empirical analysis, model presentation) and evaluation type of the model (e.g. maturity grid, Likert scale). Content-wise the main task was to identify critical variables included in the existing models which could fit into the conceptual research framework. In the first phase the fit between the conceptual research framework and the models reviewed was analyzed. The conceptual framework of IKM facilitated the selection and focusing of attributes from the existing literature, although the concepts and terms were sometimes different. Harmonization of the terminology with the original conceptual framework was carried out jointly by the three researchers. It is noteworthy that only 19 studies were eventually used since some of the studies reviewed did not present a new maturity model. It was found that four studies were purely literature reviews and one examined the benefits of maturity models in management. It was somewhat surprising how few studies openly presented the content of the models discussed. Only three studies presented an evaluation tool for empirical analysis related to IKM.

The maturity models reviewed varied in background, research fields, and implementation areas. The scope of the model was intentionally large since this paper aims at presenting an overarching maturity model of IKM. However, even within a more specific sub-field such as performance management, the scope of models varied from the content of measurement systems (Cocca and Alberti, 2010; Van Aken et al., 2005; Wettstein and Kueng, 2002) to the use of measurement information in management (Aho, 2011). Most of the models aimed at being generalizable to any contexts, with a few exceptions. The model by Brooks et al. (2015) was designed for the health care sector and the model by Cocca and Alberti (2010) for SMEs.

The models were implemented either as interactive evaluations in a few companies (e.g. Khatibian et al., 2010; Teah et al., 2006) or extensive questionnaires for employee self-evaluation (e.g. Tung et al., 2011; Jääskeläinen and Roitto, 2015). The evaluation instruments varied between the models reviewed. Nine studies utilized a traditional survey with Likert scales, six studies presented a maturity grid for the evaluation of maturity levels in selected areas (typically ten or less) and two relied on the hybrid of the two former

evaluation approaches. Some of the studies did not clearly present how the aspects presented should be evaluated.

Half of the models presented had not been tested in practice. Significantly, none of the information management/system models reviewed had been tested in practice. The way of testing varied from single case studies to large-scale surveys. Studies implementing and testing the models presented included the following:

- Aho, 2011, Jääskeläinen & Roitto, 2015, Marx et al. 2012; Wettstein & Kueng, 2002; Tung et al. 2011 (performance management models),
- Hsieh et al. 2009; Khatibian et al. 2010; Kruger and Johnson 2010; Pee and Kankaanhalli 2009, Teah et al. 2006 (knowledge management models),
- Lahrmann et al. 2011, Popovits et al. 2012 (business intelligence models).

This study intentionally concentrated on the models presented in the academic literature since the aim was to design an overarching model which could be utilized as a survey. This excluded several models with consultative background, such as the Capability Maturity Model (CMM and CMMI) in information management or APQC's Levels of Knowledge Management MaturitySM. These models present a list of evaluation perspectives (around ten at maximum), which are assessed with written descriptions linked to grades or maturity levels, and these descriptions typically fit into one A4 page. However, since more specific contents of the models (i.e., actual questionnaires or evaluation attributes) have not been published they did not support the objective of this study, i.e., to design a public model with an overarching survey instrument for evaluating IKM allowing a quantitative, data-driven approach for creating maturity profiles.

4.2 Selecting attributes to be evaluated in the maturity model

The attributes for the perspectives of the model and the specific evaluation statements were selected on the basis of their recurrence in the studies reviewed, empirical testing, and the diversity and extent in light of the perspectives of the conceptual research framework. It was deemed important that a balanced set of attributes could be identified for different perspectives of the model. The three researchers first carried out independent work by creating their own lists of attributes which was followed by the joint synthesis of the results. Overlapping attributes were combined and the most appropriate perspective for each attribute was determined. At this stage 54 different attributes were identified. Although the attributes in the list were deemed mostly appropriate, the list was considered too extensive

to be implemented in practice. The next phase was to prioritize the list of attributes. The whole research team of seven researchers developed the critical attributes in a researcher workshop. This larger researcher group also included a practitioner view through participants working outside academia. Every researcher voted on the 20 critical attributes with the emphasis on their relevance and clarity. Attributes with most votes were taken into the next version. At least three votes were required for inclusion. This exercise reduced the number of attributes to 25. The resulting critical attributes identified are presented in Table 1. In addition to the attributes presented, each of the perspectives (excluding outcomes) was included in the evaluation of perceived satisfaction in accordance with Jääskeläinen and Roitto (2015) thereby raising the number of attributes into 34.

Table 1 Perspectives and evaluation attributes of the designed model

Perspectives of the conceptual framework	Evaluation attributes	Source
Vision and strategy	Existence of IKM strategy and targets	Aho, 2011; Brooks et al., 2015
	Strategic alignment of IKM	Aho, 2011; Lahrmann et al., 2011
	Extent and significance of IKM	Lahrmann et al., 2011; Teah et al., 2006
	Systematic approach to the development of IKM	Aho, 2011; Lahrmann et al., 2011; Van Aken et al., 2005; Teah et al., 2006; Wettstein and Kueng, 2002
Governance and organization	Top management support	Brooks et al., 2015; Jääskeläinen & Roitto, 2015; Lahrmann et al., 2011; Pee and Kankaanhalli 2009; Teah et al., 2006, Tung et al., 2011
	Commitment of employees	Jääskeläinen and Roitto, 2015; Tung et al., 2011
	Expertise and knowledge of employees	Aho, 2011; Becker and Knacksted, 2009; Lahrmann et al., 2011; Popovic et al., 2012

	Resources	Van Aken et al., 2005
Information needs	Identification of information needs (e.g. link between technology and management needs, needs of different stakeholders)	Aho, 2011
	Understanding of information needs	Aho, 2011
Information acquisition	Information gathering and availability	Teah et al., 2006; Van Aken et al., 2005
	Availability of information	Aho, 2011; Jääskeläinen and Roitto, 2015; Popovic et al., 2012
Information organization and storage	Enterprise architecture	Aho, 2011; Lahrman et al., 2011
	Data storage in information systems	Aho, 2011; Jääskeläinen and Roitto, 2015; Wettstein and Kueng, 2002
	Data integration	Becker and Knacksted, 2009; Brooks et al., 2015; Marx et al., 2012; Lahrman et al., 2011, Popovic et al., 2012
Information products	Information systems supporting reporting and analytics	Aho, 2011; Jääskeläinen and Roitto, 2015; Marx et al., 2012; Popovic et al., 2012
Knowledge sharing	Communication of information	Aho, 2011; Wettstein & Kueng, 2002; Teah et al., 2006; Van Aken et al., 2005
	Real time delivery of information	Aho, 2011; Popovic et al., 2012; Van Aken et al., 2005
Knowledge usage	Performance management process	Aho, 2011; Marx et al., 2012; Popovic et al., 2012; Wettstein and Kueng, 2002
	Knowledge use in decision-making	Aho, 2011
Adaptive behavior	Knowledge use in resource allocation	Jääskeläinen and Roitto, 2015

Measures	Link between measures and strategy	Aho, 2011; Jääskeläinen ja Roitto, 2015; Van Aken et al., 2005
	Scope of measures	Aho, 2011; Jääskeläinen and Roitto, 2015; Marx et al., 2012; Tung et al. 2011; Van Aken et al., 2005; Wettstein and Kueng, 2002, Pee and Kankaanhalli, 2009
	Quality and reliability of measurement information	Aho, 2011; Jääskeläinen and Roitto, 2015; Popovic et al., 2012
Outcomes	Performance outcomes of IKM	Lahrmann et al. 2011

The number of attributes per perspective varies. It was especially difficult to identify attributes for the “information needs” and “adaptive behavior” perspectives.

The evaluation statements for the attributes were identified from the literature and original sources for the attributes were used whenever possible. However, the design of new evaluation statements was also needed since for some attributes only limited evaluation statements could be identified from the literature. The researchers designed these statements based on their knowledge of IKM in public organizations. Finally, duplicates were removed, after which some balancing between attributes was done so that the number of statements per attribute would be similar across attributes. 95 evaluation statements were left in total. To improve the reliability of the measurement, there were typically more than one statement per one attribute. Evaluation statements are presented in the Appendix.

5 Testing the model

The maturity model was first assessed by a steering group consisting of 12 Finnish national experts in the field of governing and managing public services. This commentary led to some changes in order to streamline the maturity model and clarify its content. The experts had also the opportunity to propose new contents for the model but the content presented was deemed sufficient.

Second, a self-evaluation in the form of a web-based survey was sent to 109 respondents in nine Finnish public sector organizations including senior managers (excl. political management), middle managers responsible for IKM and ICT experts in the social and healthcare sector and employment services. These organizations were selected to ensure

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many sided representation of different locational areas and different statuses in IKM based on an interview pre-study. Altogether 37 people responded to the survey, resulting in a response rate of 34%. The survey was conducted in February 2019 and was open for three weeks.

In the survey, respondents were asked to evaluate their own organization through the evaluation statements on a 5-point Likert scale. Respondents were not compelled to choose an option on the Likert scale, but could select the response option 'not able to answer' if they did not know the answer or note '?' if they considered the statement unclear or ambiguous. In addition, for purposes of obtaining feedback, respondents were asked to give feedback in their own words on each section of the survey.

Of the respondents 46% provided feedback in their own words on the survey, either concerning the main perspectives or the survey as a whole. After the survey was closed, the researcher team held an internal workshop to analyze the results and assess the model constructed and the survey. The authors analyzed the feedback in respondents' own words paying attention to aspects criticized and suggestions for improvements then made some modifications to the survey. In response to the feedback, the sections 'Knowledge usage' and 'Adaptive behavior' were combined into one section 'Knowledge usage'. In addition, focal concepts of the survey (data, measure, measurement, measure information, knowledge management) were defined more specifically and the formulations of a couple of questions were modified. Two questions were also removed from the survey since the respondents deemed them ambiguous.

As suggested in the design science literature, two criteria were used to assess the model: academic rigor and managerial relevance (Van Aken, 2007). A perceptual scale between 1 (very poor) and 5 (very good) was included in the survey to assess the criteria of validity, clarity, practicality, and relevance. Furthermore, SmartPLS 3.0 was used to statistically test the reliability and validity of the survey instrument developed, more specifically its main perspectives. Clarity, reliability, and validity were used to assess academic rigor whereas practicality and relevance were used in analyzing managerial relevance.

Most respondents (65%) regarded the survey as a comprehensive and valid tool for evaluating the state of KM. Most of the criticism related to the length of the survey, and lack of common definitions of central concepts. However, the average response time was 15 min as planned, and this can be regarded as fairly normal for a survey-based tool. Table

2 presents the results of the testing in greater detail. Critical responses were those giving an assessment of 1 or 2.

Table 2. Feedback on the model

Criterion	Percentage of respondents giving critique	Examples of open comments
Validity	11%	<i>“The survey raised good, comprehensive, and unifying issues related to information and knowledge management that organizations organizing public services should pay attention to.”</i> <i>“A good set of questions.”</i>
Clarity	24%	<i>“Information and knowledge management has not been strategically and comprehensively explicated throughout our organization, so that we could have a good sense of information and knowledge management in our organization”</i> <i>“Some of the concepts should be explained in more detail.”</i>
Practicality	35%	<i>“The questions worked well. In our organization information management is an ongoing process.”</i> <i>“Difficult questions and lots of them.”</i>
Relevance	23%	<i>“Important things to pay attention to.”</i> <i>“The capabilities needed are only being built and planned.”</i>

Table 3 summarizes the results of statistical evaluation of the survey. Composite reliability (CR) (Fornell and Larcker, 1981; Wetzels et al., 2009) was between 0.894 and 0.948, clearly above the threshold of 0.7 (Nunnally, 1978). Cronbach’s alphas varied between 0.852 and 0.926 and hence above 0.7 (Hair et al., 2014). Most of the average variances extracted (AVE) were above the threshold of 0.5 (Fornell and Larcker, 1981). ‘Vision and strategy’ and ‘governance and organization’ remained below 0.5 but were still above 0.4.

Since their CRs were clearly above 0.6, the convergent validity of the constructs can still be regarded as adequate (Fornell and Larcker, 1981).

Table 3. Statistical testing of the survey instrument

Perspective	CR	Cronbach's alpha	AVE
A. Vision and strategy	0.894	0.870	0.405
B. Governance and organization	0.900	0.869	0.415
C. Information needs	0.929	0.900	0.604
D. Information acquisition	0.905	0.852	0.655
E. Information organization and storage	0.906	0.860	0.520
F. Information products	0.904	0.857	0.580
G. Information and knowledge sharing	0.942	0.914	0.650
H. Knowledge usage	0.937	0.912	0.521
I. Measures	0.948	0.926	0.588

In the third phase of the testing, a focus group interview was conducted in one large participating organization. Altogether six people in managerial positions (either top management or middle management) in the field of IKM, ICT, and general management participated in the focus group interview, where the results of the analysis and feedback related to the model and its usability were collected.

According to participants, the survey forms a comprehensive picture of IKM in an organization and specifies various competence areas needed for IKM, i.e., ICT, measurement, and management. The results described the state of the organization quite well, thus reflecting validity of the tool; for example, low scores in the section 'Information organization and storage' was no surprise, but rather a well-known issue in the organization. The survey was considered a good tool to describe the current, (as-is) state of IKM, serving as a basis for discussions and the identification of development needs. Hence, its relevance was seen to be high.

Participants were interested in seeing the overall results of the survey (comparative data from all participating organizations) for purposes of benchmarking. When comparing the results, some limitations were identified in the self-assessment method. For example, one organization's scores were relatively low compared to those of the others, even though they are known for their efforts in IKM development. This may be due to the high standards of

the respondents in the organization making them more critical than other organizations participating in the study. Hence, one potential approach for using the survey could be an auditing approach where trained auditors evaluate different organizations with well-specified instructions and specifications supporting the model. This would ensure that benchmarking of results would be based on more consistent evaluation results.

6 Proposed approach and practices for using the model

The maturity model can be used for multiple purposes. First and foremost, it can serve as a tool for the assessment of organizational IKM for the purpose of developing a common understanding, and to identify and prioritize IKM development activities. Secondly, it can be used to monitor the impact of the chosen development activities. Thirdly, it can be used for benchmarking purposes, for example in a public service network, yet this would require an auditor to ensure a systematically similar evaluation.

An important aspect in the use of the maturity model presented is the comparison between evaluated maturity level and employee satisfaction on each main dimension of the model. This comparison enables the evaluation of the purposefulness of different development areas and prioritizing development objects.

Table 4 presents an example of interpreting the results including four different maturity profiles based on different combinations of maturity level and employee satisfaction. The profiling can be based on the averages of Likert scale (1-5) results in different areas of the model. For example, results above 3 can be interpreted as high satisfaction or advanced practices and vice versa. This threshold can also be defined differently in alignment with the data characteristics gathered.

If an organization's IKM practices and satisfaction are both scored low, the organization can be regarded as 'Novice' in relation to these perspectives, and these areas should be high-priority development targets. On the other hand, if the respondents are satisfied with some IKM practices, these are then not the first priority for development regardless of the maturity level. This way the model allows for variation between organizations: not all organizations need to reach the highest level of maturity. This may be due to the small size of the organization or low complexity in the operating environment.

Table 4 Example of interpreting the results of the model

<p>High employee satisfaction and basic IKM practices, “Facilitator”</p> <p>The organization is able to exploit the current IKM practices. The basics of IKM are covered. This area need not be prioritized in development work.</p>	<p>High employee satisfaction and advanced IKM practices, “Advanced exploiter”</p> <p>This is the desired situation in most cases. The IKM practices are advanced and the organization is able to exploit them fully.</p>
<p>Low employee satisfaction and basic IKM practices, “Novice”</p> <p>The area examined is overall at the rather primitive level. This area should be prioritized in the development work.</p>	<p>Low employee satisfaction and advanced IKM practices, “Experimenter”</p> <p>IKM in this area is characterized by the development of and experimenting with novel models and systems. However, the organization has not invested in taking the new ideas and system into use. It may also be that the systems developed do not serve the needs of employees.</p>

The descriptions presented illustrate the use of the maturity model for managerial purposes. It highlights the importance of managerial relevance as a criterion for mature practices as suggested by Hatry (2006) and Jääskeläinen and Roitto (2014).

In order to gain a more detailed understanding of the potential differences between the profiles presented, analysis of variance was conducted to compare the means in the evaluation perspectives in relation to the main axes of the model, i.e., high vs. low employee satisfaction and high vs. low overall status of IKM practices. Table 5 summarizes the results. It presents the perspectives with statistically significant differences and differences observed in the averages between high (average > 3.0) and low (average < 3.0) groups.

Table 5 Statistical comparisons of maturity profiles

Element investigated in the maturity profile	Evaluation perspectives with statistically significant differences	Observed difference in the averages of the evaluation perspective
High satisfaction (> 3.0) vs. low satisfaction (< 3.0)	Vision and strategy p < 0.01 F = 5.044	Low 3.2 High 3.7
	Governance and organization p < 0.05 F = 3.279	Low 2.9 High 3.6
	Information organization and storage p < 0.05 F = 2.959	Low 2.9 High 4.0

	Information products p < 0.05 F = 3.233	Low 2.6 High 3.8
	Performance measures p < 0.01 F = 4.811	Low 3.0 High 4.1
High (> 3.0) vs. low (< 3.0) overall status in IKM	Information products p < 0.05 F = 256.816	Low 2.12 High 3.40

It can be seen that organizations with high employee satisfaction tend to link their IKM better to strategy, have better organizations and structures supporting IKM, better systems for structuring and storing knowledge, more advanced information products as well as performance measures.

These aspects can therefore be regarded as the most essential since they promote employee satisfaction and advancement into the profiles ‘facilitator’ and ‘advanced exploiter’. In turn, information products appear as the most significant factor when an organization advances to the right in the model, i.e. towards the profiles ‘advanced exploiter’ and ‘experimenter’.

The primary purpose of the maturity model is to function as a diagnostic tool implemented by a self-evaluation survey. It is recommended that representatives from different functional entities in the organization (e.g. IT function, operations/service, management) and different levels in the organization (operational, tactical, strategic) take part in the assessment. The model also serves as a checklist of all the aspects to be considered when building or developing IKM. In this respect, the model can be used to provide a structure for discussions within the organization (e.g. in interviews or workshops) and help harmonize the terminology used in the internal discourse.

The target group of the model is ideally wide-ranging and includes managers, supervisors, and experts in the fields of ICT and IKM. In a survey implementation, at least 5-10 respondents should participate. In large organizations the number of respondents should be higher, around 5-10 per individual department.

7 Conclusions

The review of the literature concluded that there are no established academic models for maturity analysis of IKM. Although different models have been presented in the literature, especially in the area of knowledge management, a comprehensive overview of

IKM process has been lacking. Those maturity models described in academic publications seem to focus on more narrow areas of knowledge management, such as knowledge flows and challenges or barriers related to that area (e.g. Lin et al., 2012). The purpose of the new model is also to identify strengths related to IKM. Due to the origins of many models in consultancy, the evaluation instruments of the models have rarely been explicitly presented and the grounds for choosing evaluation perspectives have not always been clear. The purpose of this study was to combine practical relevance with an academically rigorous design science approach. More specifically, the model presented aims to fill the following gaps in the literature.

Most of the existing maturity models assume that more is better, i.e., that it is always desirable to obtain more sophisticated technologies and practices (Marx et al., 2012; Wettstein and Kueng, 2002). The model developed in this study creates maturity profiles which combine employee satisfaction and the maturity of practices. Employee satisfaction eventually determines whether the IKM systems and practices are beneficial to the organization. By capturing satisfaction, the new model highlights purposeful objectives in developing IKM. It acknowledges that lower maturity levels may also suffice if employees are satisfied. In this way the model captures different contextual criteria for IKM practices.

Most of the existing models are generic and not segmented to specific types of industries. Implicitly they support the purposes of private companies. This study contributes by segmenting the model for use in the public sector.

This study contributes to the literature by testing the maturity model designed. Earlier studies report the use of maturity models in the interactive audits of individual organizations (Bititci et al., 2012). However, studies reporting wider testing with empirical data are rare (Marx et al., 2012; Tung et al., 2011). This study utilized several criteria assessed with both perceptual measures and statistical methods to demonstrate the rigor and relevance of the model presented.

The testing phase and empirical data gathered were used to propose more detailed content for the four maturity profiles. In the profiles with high employee satisfaction ('facilitator' and 'advanced exploiter'), the administrative support for IKM is better, while information systems and performance measures are also more advanced and effective. In turn, information products appear as a perspective supporting the advancement into profiles with more advanced IKM practices, i.e. 'advanced exploiter' and 'experimenter'.

This study identified a need for various versions and uses for the maturity model. Different versions of the model will serve two different purposes in management: the shorter version (1 evaluation statement per attribute) for frequent monitoring for the trend analysis of factors supporting contemporary IKM. The longer version provides more in-depth information explaining the potential causes of changes in the results. The use of such information requires more in-depth discussion combining a wide range of expertise, for example a workshop, in order to identify the main targets for development. The self-evaluation survey serves as a diagnostic tool, whereas evaluations conducted by external auditors cater for benchmarking purposes.

The main limitation of this study is the rather small sample of respondents, thus further testing of the model and the related survey should be done in the future. The content of the four maturity profiles proposed should be regarded as indicative. More experiences of using the model are needed in order to present content for profiles created on the basis of evaluation data. Furthermore, the model presented was designed here for the public sector context, and this needs to be borne in mind if applying the model in the private sector. With specific considerations, however, it may also be applicable in private companies. Further research could further develop and test the model presented in the private sector and/or public-private networks. The model presented was created on the basis of an extensive review of the literature, but it is acknowledged that not all the potential models were included in the analysis. Notably, consultancy-oriented models were excluded. The model created nevertheless synthesizes the contents of several relevant studies in the broad field of IKM.

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Appendix: Survey instrument

A. Vision and strategy

1. In our organization we have an official information and knowledge management strategy (modified from Aho, 2011)
2. The objectives of information and knowledge management are recognized throughout our organization (Teah et al., 2006)
3. Information and knowledge management is part of the organization's strategy (Teah et al., 2006)
4. Information and knowledge management is part of our organization's management system (modified from Aho, 2011)
5. Information and knowledge management practices are widespread throughout the organization (Larhmann et al., 2011)
6. The IT team works together with the organization to determine the needs for information and knowledge management solutions (modified from Aho, 2011)
7. Information and knowledge management is identified as a key capability/area of expertise (Teah et al., 2006)
8. Our organization has a systematic plan to develop the information and knowledge management capabilities (modified from Aho, 2011)
9. Information and knowledge management is no mere information system project in our organization (Aho, 2011)
10. We have named the persons in charge of information and knowledge management (Teah et al., 2006)
11. The systems for information and knowledge management are constantly developed (Teah et al., 2006)
12. Information and knowledge management development is an ongoing process (Teah et al., 2006)
13. Overall, I'm satisfied with how information and knowledge management is reflected in the strategic management of our organization (modified from Jääskeläinen and Roitto, 2015)

B. Governance and organization

1. Top management is committed to developing information and knowledge management (modified from Aho, 2011)
2. Managers encourage employees to utilize information better (modified from Jääskeläinen and Roitto, 2015)
3. Top management has clearly voiced their support for the development of information and knowledge management (modified from Tung et al., 2011)
4. Our employees participate in the development of information and knowledge management (modified from Tung et al., 2011)
5. The people who will use the information and knowledge management solutions are engaged in the development of the solutions (modified from Aho, 2011)
6. The attitude towards information and knowledge management in our organization is positive (modified from Aho, 2011)
7. The personnel understands what information and knowledge management means (modified from Aho, 2011)
8. The personnel understands what benefits can be achieved through information and knowledge management (modified from Aho, 2011)
9. The personnel knows how to use the information and knowledge management solutions (modified from Aho, 2011)
10. We have enough resources for data processing (Van Aken et al., 2005)
11. We have enough resources for utilizing the data (Van Aken et al., 2005)

12. There are enough resources available for information and knowledge management (modified from Jääskeläinen and Roitto, 2015)
13. Sufficient training in information and knowledge management is offered (modified from Jääskeläinen and Roitto, 2015)
14. Overall, I'm am satisfied with the governance structure supporting information and knowledge management and the organization of information and knowledge management (modified from Jääskeläinen and Roitto, 2015)

C. Information needs

1. We regularly identify the needs for information arising from our strategy and objectives Designed for this study
2. We regularly monitor the impact of changes in our operational environment on our information needs Designed for this study
3. We consider our stakeholders when identifying information needs (e.g. customers, political decision makers, ministries, tax payers) Designed for this study
4. We actively inform service producers of our information needs Designed for this study
5. We understand the information needs of our external stakeholders Designed for this study
6. We understand the information needs for steering service production Designed for this study
7. We understand the information needs for comparing regions Designed for this study
8. We have a holistic understanding of our organization's information needs Designed for this study
9. Overall, I'm am satisfied with the way we identify needs for information and knowledge management (modified from Jääskeläinen and Roitto, 2015)

D. Information acquisition

1. Our processes for data collection are efficient (Van Aken et al., 2005)
2. Our processes for data collection are automatized
3. The processes related to data collection are clearly documented (including best practices) (Teah et al., 2006)
4. The required data is easily available (modified from Jääskeläinen and Roitto, 2015)
5. Overall, I am satisfied with our practices for data collection (modified from Jääskeläinen and Roitto, 2015)

E. Information organization and storage

1. Our organization has a platform or system that integrates information and knowledge management (modified from Aho, 2011)
2. We have a standardized enterprise architecture to support information and knowledge management (Lahrman et al., 2011)
3. Our IT architecture is flexible for changing information needs (modified from Aho, 2011)
4. There are no overlaps in our IT architecture (modified from Aho, 2011)
5. Our organization has data warehouse, which contains data across the organization Designed for this study
6. Our organization has master data for key entities, such as customers and services (modified from Aho, 2011)
7. The integration of data from different data sources is systematic and controlled (modified from Aho, 2011)
8. Data is consistent across systems (modified from Aho, 2011)
9. Data enables real-time reporting and analysis (Popovic et al., 2012)

10. Overall, I'm satisfied the organization and storage of our data and information

(modified from Jääskeläinen and Roitto, 2015)

F. Information products

Our organization utilizes mainly

a) paper reports

a) - f) (Popovic et al., 2012)

b) digital reports

c) interactive reports

d) online analytical processing (OLAP)

e) data mining

f) dashboards (key performance indicators)

1. Our information system enables reviewing data on different levels of precision

(modified from Aho, 2011)

2. We have management desktop solution (dashboard) that can be adjusted according to needs

(Marx et al., 2012)

3. The management desktop solution enables drilling into data

(Marx et al., 2012)

4. We have good enough analytic services for information and knowledge management

5. Our current information management solution provides enough support for information and knowledge management

(modified from Aho, 2011)

6. The analytics we use will create significant added value for our organization

(modified from Aho, 2011)

7. Overall, I'm satisfied with the systems we have for information reporting

(modified from Jääskeläinen and Roitto, 2015)

G. Knowledge sharing

1. Our employees receive information about objectives related to them

(modified from Jääskeläinen and Roitto, 2015)

2. Our employees receive information about performance measures related to them

(modified from Aho, 2011)

3. Our employees receive information about measurement results related to them

(modified from Aho, 2011)

4. Service providers receive information about objectives related to them

Designed for this study

5. Service providers receive information about performance measures related to them

Designed for this study

6. Service providers receive information about measurement results related to them

Designed for this study

7. We have well-established practices on communicating reported information

(modified from Wettstein ja Kueng, 2002)

8. Information systems in our organization produces timely information

(modified from Aho, 2011)

9. The systems used for information and knowledge management is up to date

(modified from Aho, 2011)

10. Measurement information is shared in real time

(Van Aken et al., 2005)

11. Overall, I'm satisfied with our information and knowledge sharing practices

(modified from Jääskeläinen and Roitto, 2015)

H. Knowledge usage

1. We have defined objectives clear enough for the management control of our organization

Designed for this study

2. We have defined objectives clear enough for the management control of our suppliers (modified from Aho, 2011)
3. Information and knowledge management solutions support budgeting and planning (Popovic et al., 2012)
4. Existing information supports in the identification of problems in our operations (Popovic et al., 2012)
5. Existing information supports us in evaluating our results in relation to standards and objectives (modified from Aho, 2011)
6. Measurement information is utilized in the strategic decision-making of our organization (modified from Aho, 2011)
7. Measurement information supports decision-making (modified from Aho, 2011)
8. Employees make decisions based on understanding created by information and knowledge management (modified from Aho, 2011)
9. Measurement information is used to monitor the use of resources (modified from Jääskeläinen and Roitto, 2015)
10. Allocation of resources (e.g. decisions on employee training) is rationalized with measurement information (modified from Jääskeläinen and Roitto, 2015)
11. Decisions on resource allocation (e.g. budgeting) are made based on measurement information (modified from Jääskeläinen and Roitto, 2015)
12. Overall, I'm am satisfied with our utilization of information (modified from Jääskeläinen and Roitto, 2015)

I. Measures

1. Our performance measures are directly linked to the overall strategy of our organization (modified from Jääskeläinen and Roitto, 2015)
2. Performance measures are defined according to the strategic objectives (modified from Jääskeläinen and Roitto, 2015)
3. Links between measurement objects have been analyzed and modeled (modified from Jääskeläinen and Roitto, 2015)
4. There is a wide understanding in the organizations on how to affect the key measurement results (modified from Jääskeläinen and Roitto, 2015)
5. Our performance measurement consists of both financial and non-financial measures (modified from Jääskeläinen and Roitto, 2015)
6. Measures are balanced (modified from Aho, 2011)
7. The needs of different stakeholders (e.g. legislation, citizens, standards, partners) have been taken into account in the design of measures (modified from Aho, 2011)
8. We do not have too many performance measures (modified from Aho, 2011)
9. Measurement information is of high quality (modified from Aho, 2011)
10. Our organization relies on measurement information (modified from Aho, 2011)
11. Measurement information is easy to understand (Popovic et al., 2012)
12. Measurement information is consistent (Popovic et al., 2012)
13. Overall, I'm satisfied with the performance measures we use (modified from Jääskeläinen and Roitto, 2015)

J. Outcomes

1. The practices of information and knowledge management improve the performance of our organization (Lahrman et al., 2011)

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2. The practices of information and knowledge management save time used in internal decision-making (Lahrman et al., 2011)
3. Information and knowledge management has a great impact on the efficiency of our internal processes (Lahrman et al., 2011)
4. The practices of information and knowledge management make our decision-making more transparent (Lahrman et al., 2011)